WANG

PCS-II
INTRODUCTORY GUIDE

SYSTEM 2200

PCS-II INTRODUCTORY GUIDE

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PREFACE

This manual has been written to introduce new users to the Wang PCS-II. A description of the system, the power-on procedures, and information on the operation and programming of the PCS-II are contained herein.

Along with this manual, the following documents are provided with the system:

- 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 (manual)
- System 2200 Summary (card)
- System 2200 $GIO Microcommands (card).

If optional equipment is ordered with the PCS-II, the equipment is accompanied by a user manual; if Wang-supported software packages are ordered, each package is accompanied by an operator's manual.

Anyone using the PCS-II solely for executing a pre-programmed software package may skip the details of programming the PCS-II, but should carefully read Chapter 3, particularly the section on running software packages, before proceeding directly to the documentation provided with the software. Anyone using the PCS-II to write programs must become thoroughly familiar with the Wang BASIC Language described in several of the manuals received with the system. For convenience, Appendix A provides a list of the BASIC statements and the documents in which each is described. The System 2200 Summary card provides a quick, syntax-only reference for the BASIC statements.

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CHAPTER 1

GENERAL INFORMATION

1.1 SYSTEM DESCRIPTION

The PCS-II is a minidiskette-based computer system powerful enough to meet the specialized needs of engineers, laboratory technicians, and scientists, yet flexible enough to meet the data processing needs of students, accountants, business people, and administrators. This small computer system offers both first time and experienced computer users many capabilities found in large scale computer systems.

In a single compact unit (see Figure 1-1), the standard PCS-II features a central processor with 8K (8,192) bytes of user memory, a 42.5K-byte BASIC language interpreter, a 9-inch (22.9 cm) diagonal measure Cathode Ray Tube (CRT) display, a multi-zone keyboard, a single minidiskette drive and three peripheral connnectors. The minidiskette drive provides 89,600 bytes of online storage, and extensive offline storage limited only by the number of minidiskette platters acquired for the system.

Several available options, including increased user memory to 32K bytes (maximum), a second minidiskette drive, a printer or plotter, and a communications or instrumentation interface controller, provide user flexibility initially or when the need for expanded capability arises. The standard and optional components are described in detail in Chapter 2.

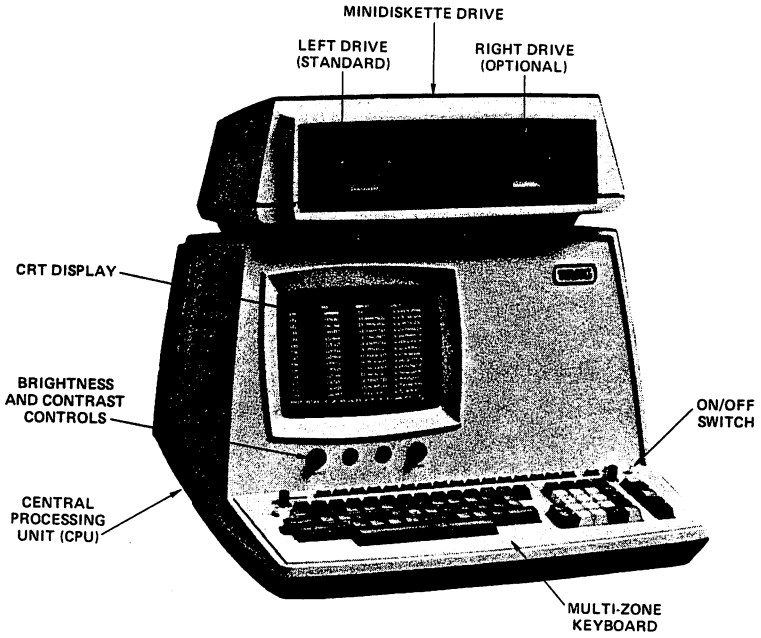


Figure 1-1. The PCS-II

1.2 INSTALLATION

The PCS-II must be unpacked, inspected, and installed by a Wang Service Representative. When the system arrives, contact the Wang Service Representative to schedule the installation. Failure to have the system properly installed voids the warranty. Wang's Service Representative ensures that any peripheral connectors are correctly attached to the system, and the system is properly attached to a dedicated power line.

> CAUTION:
>
> The PCS-II console is equipped with an exhaust fan on the right side and entry vents on the left. The vents and fan must not be obstructed.

1.3 ENVIRONMENT

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

- temperature
- humidity
- cleanliness
- AC power line.

The temperature of the room should be maintained within the recommended range of 65°F to 75°F (18°C to 24°C), although the allowable range is 50°F to 90°F (10°C to 32°C). Where these temperatures are exceeded, component failure rates are likely to increase.

Humidity should be maintained within the recommended range of 40% to 60% relative humidity, although 20% to 80% is allowable. It should be noted that the indoor humidity can become extremely low and fall outside the recommended range, particularly during the winter months when buildings are heated. Furthermore, when the humidity is low, a carpeted floor can generate a significant amount of static electricity which may cause system malfunctions; therefore, non-static carpeting is recommended.

Accumulated dust can cause equipment malfunctions; hence, filters should be installed in heating, cooling, and ventilating units. The filters should be cleaned or replaced regularly to minimize difficulties due to the surrounding air.

The power line used for the PCS-II must be dedicated to the system and be noise free. The line voltage (115 or 230 VAC) must be regulated to within ±10%. If necessary, a constant voltage transformer should be installed.

If electrical interference occurs in the power line, its source must be established and eliminated. Interference can enter the system by conduction along wiring and cabling, or by direct radiation from such sources as adjacent office machines, air conditioners, electric motors, and arc welders. To minimize such interference, a dedicated AC power line should be properly installed in steel conduit, and the conduit must be properly connected to junction boxes. The Wang Service Representative who installs the system is equipped to help set up the PCS-II for trouble-free operation.

CHAPTER 2

PCS-II COMPONENTS

2.1 THE CONFIGURATION

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

- A central processor with 8K bytes of user memory and a 42.5K-byte BASIC language interpreter.
- A CRT display.
- A multi-zone keyboard.
- A single minidiskette drive.
- Three connectors for peripheral devices.

An optional printer or plotter may be placed on a separate stand near the system for connection via the PCS-II outlet panel. An optional second minidiskette drive may also be installed (see Figure 1-1). Both the standard components and the options are described in the sections which follow.

2.2 THE KEYBOARD

Via the keyboard, the operator interactively controls the PCS-II while entering data, performing quick calculations, issuing commands to the processor, writing programs, and initiating program execution. The keyboard is divided into several distinct "zones" containing keys with similar functions.

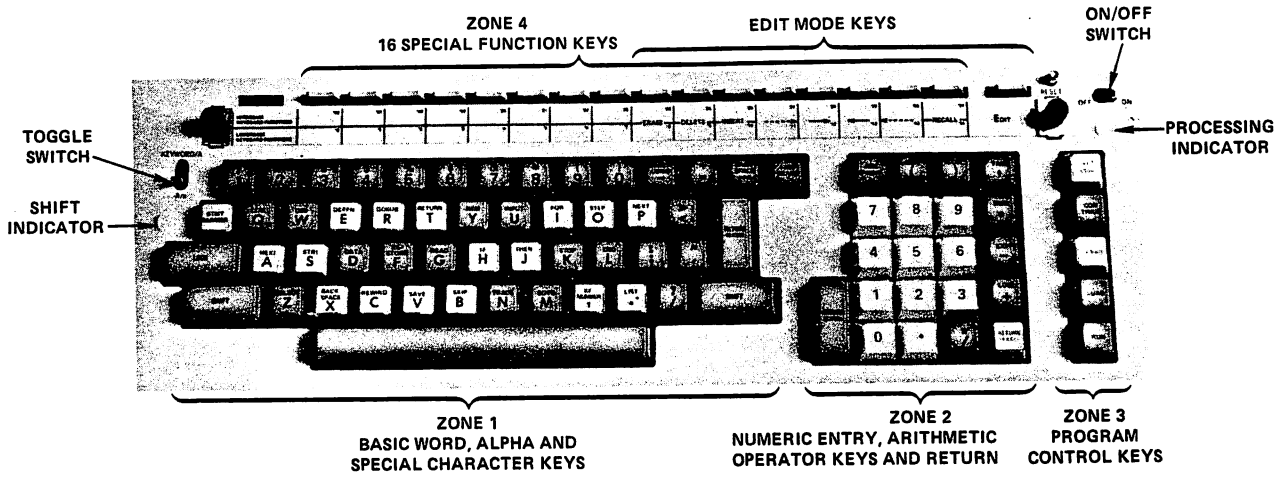


Figure 2-1. The PCS-II Keyboard

The Alphanumeric Zone

The keyboard's alphanumeric zone is similar in design to a standard typewriter keyboard; however, two modes of operation are available to produce quite different results. The modes are selected by means of the toggle switch, labeled "KEYWORD/A" and "A/a", located in the upper left corner. (See Figure 2-1.)

The KEYWORD/A mode is specifically designed for use during program creation. In the KEYWORD/A mode, any word appearing above an alphabetic character can be entered by simply depressing SHIFT and the particular key; uppercase alphabetic characters are produced without shifting. The words on the keys are known as "keywords"; they are the principal words in Wang's BASIC language. The KEYWORD/A mode is convenient whenever only uppercase characters are to be entered.

In the A/a mode, the alphanumeric zone becomes a typewriter-like keyboard. Uppercase characters can be entered by depressing SHIFT and the desired key; lowercase characters are entered without shifting.

It is important to note that the keyboard mode switch affects only the keys in the alphanumeric zone with keywords on the labels.

The Numeric Zone

The keyboard's numeric zone is designed for rapid entry of numeric data or expressions. The numeric keys are grouped together with the arithmetic operators (+, -, *, /, ↑) and mathematical functions (SIN, LOG, SQR, etc.) 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 PRINT key in the upper left corner of the numeric zone facilitates the use of the system as a powerful, one-line calculator for obtaining quick results in the "Immediate Mode".

The Special Function Keys

Across the top of the keyboard are 16 Special Function Keys which can be used in conjunction with the SHIFT key to access up to 32 user-defined subroutines, text strings, and program entry points. A special function strip shows the numbers 0 through 15 and 16 through 31 corresponding to the special function keys; the SHIFT key is used to obtain the latter range.

The EDIT Keys

The EDIT key, located to the right of the Special Function Keys, is used to enter the EDIT mode. When the system is in EDIT mode, the Special Function Keys temporarily lose any program-designated significance, and the eight rightmost keys become system-defined edit keys. 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 described in the Wang BASIC Language Reference Manual.)

The RESET Button and HALT/STEP Key

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

```
READY
:_
```

Since RESET immediately interrupts a current operation, depressing RESET during a minidiskette operation can leave half-written, unreadable data on a minidiskette; alternatively, the HALT/STEP key should be used. If the HALT/STEP key is depressed, program interruption is delayed until the current operation is complete; furthermore, execution usually resumes at the point of interruption when the CONTINUE and (EXEC) keys are used.

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, used to signal that a keyboard response or an 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 an operator. The CRT serves as a vital feedback mechanism by displaying the result of each keystroke, thereby allowing easy review and editing of data and program lines. The CRT's speed, flexibility, and character capacity are ideal for the interactive features built into Wang's BASIC language. The screen's brightness and contrast are adjustable manually via the two controls on the front panel.

The standard display capacity is 16 lines with a maximum of 64 characters per line; the optional display capacity is 24 lines with a maximum of 80 characters per line. In either case, the complete keyboard character set can be displayed. However, the 24 x 80 display (Option 60A) also provides foreign language characters, additional special symbols, and an underlining capability. (See the alternate CRT character set described in the Wang BASIC Language Reference Manual.)

The CRT Cursor

A special display character resembling an underline, called the CRT cursor, indicates the position where the next entered character will appear. As each character is typed and displayed, the cursor automatically advances to the next entry position. In the EDIT mode, the cursor can be moved manually to any position in the program line where character insertion or deletion is to be performed. The cursor also may be moved to any display position under program control, a useful feature when formatting displays for data entry applications. A list of the available cursor control codes is given 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:
>
> Due to the danger of high voltage, do not attempt to remove the cover of the PCS-II console for any reason. Call the Wang Service Representative if maintenance is required for the system.

The Audio Alarm

If the system contains the optional Audio Alarm (available as part of Option 60A), hex code 07 activates the alarm tone, a 960 Hz beep. A sequence of 07 codes can be programmed 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 thin, flexible disk platter 5 1/4 inches (13.4 cm) in diameter, enclosed in a semi-rigid protective plastic jacket. The minidiskette turns freely within the jacket, and is coated on one side with magnetic material arranged in concentric circular tracks. When formatted (initialized), the tracks are divided into "sectors" with unique, randomly accessible addresses by which rapid, direct access methods of data storage and retrieval are possible. Typically, one minidiskette is used to store several programs while other minidiskettes are used to contain the data needed for use by the programs. The procedure for mounting and initializing a minidiskette is described in Chapter 3.

The total online storage capacity for the PCS-II is 89,600 bytes (standard) or 179,200 bytes with the optional dual minidiskette drive. In either case, the offline storage capability is limited only by the number of minidiskettes acquired for the system.

2.5 THE OPTIONS

The back panel of the PCS-II provides connectors for the optional peripheral devices which may be attached to the system. (See Figure 2-2.)

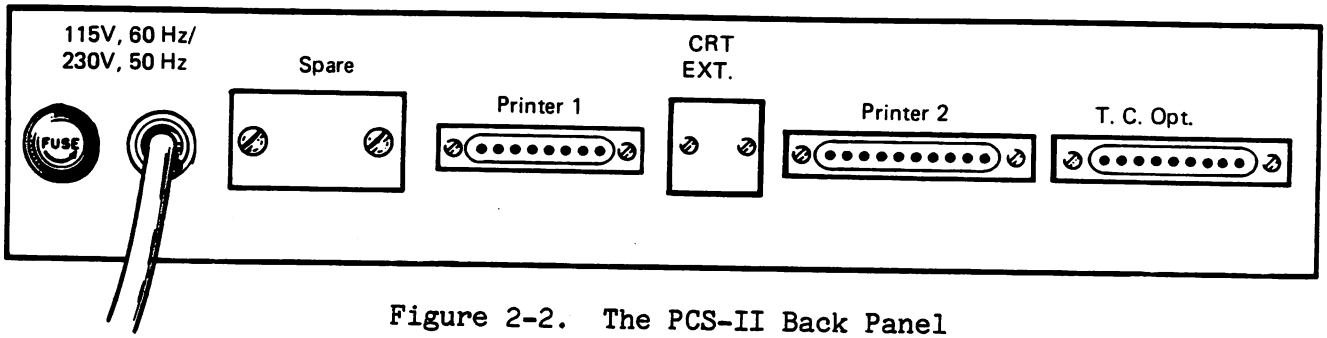


Figure 2-2. The PCS-II Back Panel

The connector labeled "Printer" may be used for attachment of one printer or plotter. The list of available printers and plotters is as follows:

- Model 2201L Output Writer
- Model 2221W Line Printer
- Model 2231W-1 or 2231W-2 Line Printer
- Model 2251 Line Printer
- Model 2261W Line Printer
- Model 2263-1 or 2263-2 Line Printer
- Model 2271 Printer
- Model 2271P Plotting Output Writer
- Model 2272-2 Drum Plotter
- Model 2281 Printer

If Option 60A is purchased, an auxiliary CRT connector is installed in the back panel at the "CRT EXT" location. If one of the telecommunications controllers (Option 62 or 62B) is purchased, the controller is internally installed in the CRT/keyboard housing; a modem (not supplied by Wang Laboratories) can then be attached at the "T.C. Opt." location.

When connecting a peripheral cable, observe that the trapezoidal shaped connector permits only one orientation. Little pressure is needed to insert a properly aligned cable connector. After inserting a cable connector, screw its retaining screws into place to ensure a proper connection (see Figure 2-3).

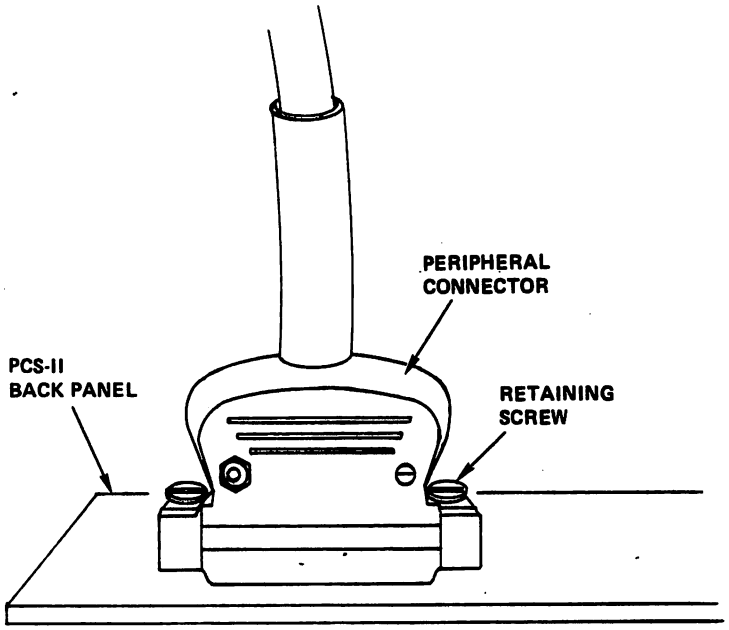


Figure 2-3. A Peripheral Connector

To remove a peripheral cable from the PCS-II, unscrew the retaining screws and pull the cable connector out with a slight wiggling motion.

CHAPTER 3

OPERATING THE PCS-II

3.1 MASTER INITIALIZATION (POWER-ON) PROCEDURE

When power is applied to the PCS-II, certain critical internal parameters are initialized to their system default values. Therefore, the power-on procedure is called "Master Initialization" and includes the following steps:

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

2. Turn on the PCS-II by placing the toggle switch (located at the top right of the keyboard) in the ON position.

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

4. As soon as the system is Master Initialized (after about 15 seconds), the display shown in Figure 3-1 appears.

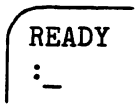


Figure 3-1. The Ready Display

> NOTE:
>
> If the READY display does not appear, press the RESET button. If the display still does not appear, Master Initialize again. If normal operation is not restored after checking all connections and master initializing the system, call the Wang Service Representative.

5. The PCS-II is ready to use as soon as the ready display appears.

Master Initialization (power on) sets default values for line length and the length of alphanumeric variables, and also establishes a table containing the "primary" addresses for the following classes of input and output operations:

I/O Class	Primary Address	and Associated Device
CI (Console Input)	001	Keyboard
INPUT	001	Keyboard
CO (Console Output)	005	CRT
PRINT	005	CRT
DISK	310	Diskette Drive
PLOT	413	Plotter (if included)
TAPE	10A	none

The default length for alphanumeric variables is 16 bytes. The default value for line length is 64 characters for the standard PCS-II, or 80 characters if the system includes Option 60A.

Default addresses and line length can be changed with a SELECT statement (see SELECT in the Wang BASIC Language Reference Manual). Also, see Chapter 5 in the Programming in BASIC manual if the system includes a printer and detailed information is needed.

To alter the default length of specific alphanumeric variables, 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 signaling the termination of operator entry to the system. In this manual the key is called the (EXEC) key.

When entering a program line, use the (EXEC) key to signal the end of the line and cause the system to store the line in memory. For example:

```
:10 A=25   (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 the syntax is incorrect, an error message is displayed). The program line is appended to any program statements currently in memory; the line is not executed until the program is run.

To perform a quick calculation, use the (EXEC) key to signal the end of a line entered in Immediate Mode (without a line number). For example:

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

In this case, when (EXEC) is keyed, the line is immediately executed; 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 entered.

3.3 PREPARATION OF MINIDISKETTES

The minidiskette drive on the system accepts minidiskettes 5 1/4 by 5 1/4 inches (13.4 by 13.4 cm) in size.

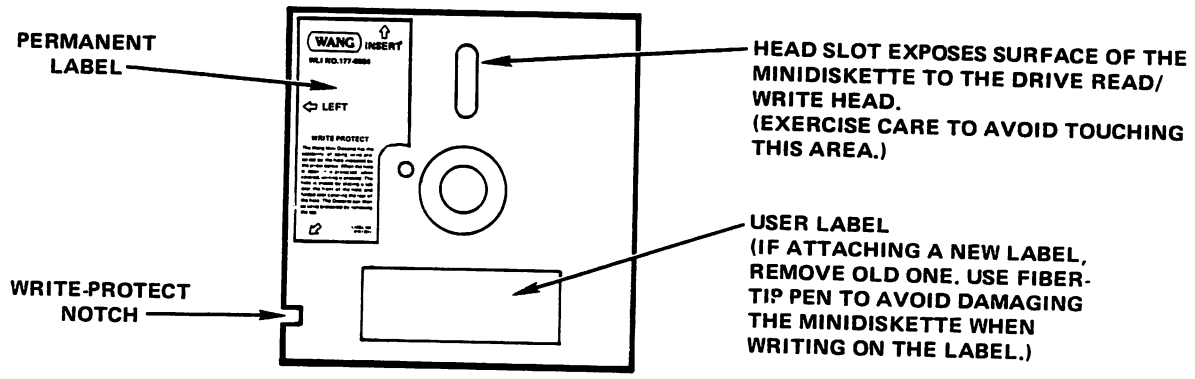


Figure 3-2. A Minidiskette

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

A blank, unused minidiskette must be formatted before it can be used to store the first program or data file. Ordinarily, a used minidiskette is not formatted before storing additional files. Minidiskettes containing packaged programs must never be formatted or scratched because the process destroys any information previously recorded on the minidiskettes.

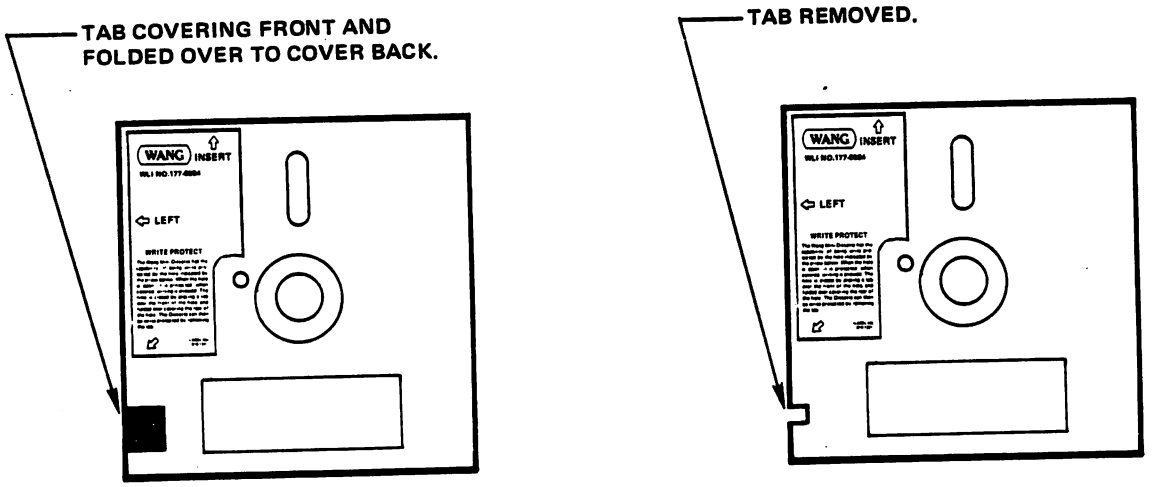
The recording surface of a minidiskette is divided into 350 sectors, each with a capacity for 256 bytes of data (or program text) and control information, in addition to the two sector-address bytes, and two CRC (cyclic redundancy check) bytes for data verification. During formatting, the system writes a sector address and CRC control information in each sector, filling the remainder of the sector with zeros.

Mounting and Formatting a Minidiskette

To mount and format a minidiskette, follow these steps:

1. Turn on the PCS-II and await the READY display. 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 the Wang Service Representative.

2. Remove the minidiskette from its envelope. Check the write-protect notch; it must be covered.



Write-Protect disabled (writing permitted)

Write-Protect enabled (writing not permitted)

Figure 3-3. Write-Protect Feature

3. Properly orient the minidiskette (as indicated by arrows on the label) before inserting it into the slot in the minidiskette drive. Be sure the minidiskette is firmly seated in the drive. Then close the drive latch.

4. Depress the RESET button on the keyboard.

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

6. The lamp on the minidiskette unit is illuminated throughout the formatting operation (45 to 50 seconds). If the lamp remains on, or begins to flash, formatting has not been properly concluded and the minidiskette may not be formattable. Generally, format errors result from three causes:

   a) drive latch not tightly closed,
   b) write-protect notch not covered, or
   c) defective minidiskette.

7. Remove the minidiskette from the drive and proceed to format another.

> NOTE:
>
> If a minidiskette cannot be formatted, it cannot be used for storage and should be discarded.

If the formatting procedure aborts repeatedly with several minidiskettes, there may be a hardware problem with the minidiskette drive. Contact the 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 a minidiskette: (1) 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 (2) an "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 the file name and location in the Catalog Index. When a particular file is subsequently accessed, the system automatically looks up the file name in the Index to determine the file's location. Thus, the programmer is relieved of the task of remembering the exact sector location of each file on a minidiskette. Only the file names need be remembered, or a LIST DC statement can be used to obtain the names of existing files.

Because the Automatic File Cataloging mode of operation is so much easier and more convenient than direct addressing, the Catalog mode is generally preferred by beginning programmers and those not yet familiar with the system. Automatic File Cataloging mode is also the mode used by most Wang software for maintaining data files. Before the first program or data file can be stored on a minidiskette in Catalog mode, however, someone must 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 to be recorded), and also specify the last sector to be used for the Catalog Area (where the contents of the files are actually stored). The Catalog Index always begins at the first sector on a 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 user-specified last, or ending, sector. Since cataloged information cannot be stored beyond the end of the Catalog Area, the end of the Catalog Area is usually specified as the last available 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 sometimes referred to as a "Catalog Library"; "LS" is an abbreviation of "Library Sectors".) For example, setting LS = 10 indicates that 10 sectors are to be reserved for the Catalog Index. If no value is specified, the system assigned (default) value is 24.

The last sector in the Catalog Area is specified with the "END" parameter in a SCRATCH DISK statement. For example, setting END = 349 indicates that sector #349 (the last accessible sector on a minidiskette, containing a total of 350 sectors numbered from 0 through 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 a statement such as the following:

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

   and key (EXEC). Here, "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. The number of sectors allocated for the catalog and data storage may be other values (see the Disk Memory Reference Manual discussion of "Automatic File Cataloging Procedures" for more information).

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

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

3.4 USING THE PCS-II AS A CALCULATOR

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

```
PRINT SQR(55) (EXEC)
PRINT 7*13+5 (EXEC)
```

Multiple statement lines (individual statements separated by colons) are acceptable in the Immediate Mode. For example:

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

Upon execution, 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 Chapter 4). Keep in mind, however, that some BASIC statements can be used only in the Program Mode.

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)
```

if the program minidiskette contains a program module named START (which is usually true for Wang-developed software packages). Some software packages have starting modules with names other than START; the name required for loading a software package is indicated in the manual supplied with the software package.

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

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

```
RUN  (EXEC)
```

During program execution, operator prompts usually appear on the video display. Remember the following facts 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 Mode keys may be used to correct a response before keying (EXEC) to enter the information.

5. 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.

6. If a message of the form:

   ERR xx (where xx represents the number identifying the error code)

   appears after keying (EXEC) and the question mark reappears, the entered response is unacceptable to the system. Check the form of the response, and enter another.

7. If the program uses minidiskettes for data storage, format and scratch one or more minidiskettes unless initialized minidiskettes are already available (see Section 3.3).

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. Then, to continue the program from the point at which it was halted, key CONTINUE (EXEC), if desired, unless an action has occurred which would prevent the program from being continued. (See the Wang BASIC Language Reference Manual for actions that prohibit program continuation.)

Although the RESET button also stops program execution, it should not be used unless HALT/STEP fails to display the system colon. RESET can leave half-written, unreadable information on a minidiskette if pressed during program execution. 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. 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 from memory for editing.
←----	Moves the cursor five spaces to the left.
←	Moves the cursor one space to the left.
----→	Moves the cursor five spaces to the right.
→	Moves the cursor one space to the right.
INSERT	Expands the current line by inserting a space character prior to the current cursor position; when this key is pressed successively, space for additional text or data can be inserted in the line without destroying the previous characters.

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 only if the CRT is the currently selected Console Output (CO) device and the correct line length 64 or 80 is in effect; see SELECT in the Wang BASIC Language Reference Manual. The CRT is automatically selected as the Console Output device when the system is Master Initialized.

Example

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

(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:

Step	Result	
1. Depress the EDIT key.	*_	(An asterisk replaces the colon in the third line of the display.)
2. Enter the line number.	*10_	
3. Depress the RECALL key.	*10 PRINT 1A,B1,C1_	
4. Move the cursor to the incorrect variable name.	*10 PRINT 1A,B1,C1	
5. Correct the variable name.	*10 PRINT A1,B1,C1	
6. Key (EXEC) to store the corrected line and exit from Edit Mode.	*10 PRINT A1,B1,C1 :_	

> NOTE:
>
> It does not matter where the cursor is positioned when exiting from the Edit Mode; the entire line is stored.

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 interactive programming language which utilizes many English words such as PRINT, READ, STOP, etc. Although such words are given a special and clearly defined meaning when used in a BASIC program, their purposes are similar to ordinary usage and meanings to reduce learning time for beginning programmers.

This 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. Detailed information about the BASIC instruction set is covered in the Wang BASIC Language Reference Manual, and programming techniques are discussed in detail in the Programming in BASIC manual.

4.2 USING SPACES

Spaces are customarily used between characters in a line for readability; however, 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 enclosed in quotes, e.g., the character strings "ABC" and "A B C" are different.

4.3 PROGRAM MODE

In Program Mode, each line must be preceded by a unique line number in the range from 0 through 9999. 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. The line 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 reentering both the line number and the correct text, or by recalling the entered line and correcting it with the Edit Mode 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 sequentially; at execution time, the system automatically processes the lines in proper order according to the line numbers.

Line numbers should be assigned with suitable increments between them to allow for the insertion of additional lines, as needed. 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 zeros, e.g., 0010 can be entered simply as 10.

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 according to a specified increment (see the Wang 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 depressing a single key on the keyboard rather than the individual characters in the word. 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 so-called "atomization" process saves space in memory and speeds up program execution.

BASIC Statement

A BASIC "statement" is a programmable instruction which serves as a fundamental building block when writing a BASIC language program. A BASIC statement generally includes one or more operands which specify the data to be used by the statement when performing its operation. Many of the statements can be used in the Immediate Mode as well as the Program Mode, e.g., the PRINT statement can be used in either mode while the KEYIN statement can be used only in the Program Mode.

Examples of Wang BASIC statements:

```
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 in the previous examples). In such a case, the individual statements are separated by colons (:).

BASIC Command

A BASIC "command" is a nonprogrammable instruction by which the operator may control 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
RENUMBER
SAVE DC R "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; a function cannot stand alone in a program or in Immediate Mode.

Examples of BASIC statements with SIN, STR, and HEX functions as operands:

```
30 READ STR(A$,9,3)
40 PRINT HEX(51)
50 PRINT SIN(K*2/C)
```

The following incorrect examples of function use:

```
50 STR(B$,3,5)
60 SIN(M)
```

produce error messages.

The result of a function can be displayed in Immediate Mode if the function is included in a PRINT statement. For example:

```
PRINT SQR(55)
```

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. For more information see the Programming in BASIC manual.

Executing a Program

Once a program has been saved in memory (assuming no syntax errors have been found), the program can be run by executing the RUN command, i.e., by keying RUN (EXEC). For example, enter the following program in memory:

```
10 A = 14 + 2
20 PRINT "A=";A
```

Then, key RUN (EXEC).

The program is resolved and executed and the result is displayed as:

```
A= 16
```

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

Once execution is underway, an execution error may occur. In such a case, the program line in which the error occurred is displayed, with an ERR code immediately below the line, usually pointing to the approximate location of the error. Corrective action can be taken before the program is rerun. For example, suppose a program contains the following lines:

```
10 T = 0
20 B = 15
30 A = SIN(B)/T
40 PRINT A
```

Because division by zero is an illegal operation, an execution error (ERR 03 - Math Error) is signaled when line 30 is executed. The display is as follows:

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

However, if line 10 is edited or entered again to assign a non-zero value to T, the program can be run successfully.

> NOTE:
>
> Numeric variables are set to zero and alpha variables are set to spaces at resolution time; these default values are retained until specific values are assigned 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 text 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), the line can be edited using the Edit Mode keys. Once a line has been stored in memory, however, an additional step is required before editing can begin; the line 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 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

To review a program entered in memory, use the LIST command. LIST (EXEC) lists the entire program. LIST S (EXEC) lists the program 15 lines at a time; however, the operator must key (EXEC) when ready to view each group of 15 lines. LIST line no. (EXEC) lists the specified line only, e.g., LIST 10 (EXEC) 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 manually select the printer (push the SELECT button). When the printer is selected (i.e., on-line), the SELECT button is backlighted. Then, 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 the I/O class parameter LIST from the primary address 005 (the address of the CRT) to the address 215 (the address of the printer). Next, enter

```
LIST  (EXEC)
```

Program listings formerly displayed on the CRT are now listed on the printer.

To again obtain program listings on 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

Several debugging techniques are available on the PCS-II. Keep in mind that the Immediate Mode permits a programmer to interrogate variables at any time during program execution. For example, enter the following short program:

```
10 A = 10
20 B = B + A
30 GOTO 20
```

Then, key RUN (EXEC), but do not expect a display since there is no PRINT statement. Also, since the program is an endless loop, B is continuously incremented. (During execution, a cursor without a colon indicates the system is not awaiting operator action.)

To interrupt program execution and interrogate the variables A and B, proceed as follows:

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

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

If desired, the Immediate Mode can be used to change the current values of a variable in an executing program. 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 (EXEC).

> NOTE:
>
> 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.

Now key HALT/STEP, and then PRINT A, B (EXEC); the 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. However, the Immediate Mode GOTO does not 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; furthermore, there is no recovery from such an error since the system must be Master Initialized (power off, and then on) which clears memory.

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 is incremented continuously; the first line of output is:

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

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

```
GOTO 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 the 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)
```

starts execution at line 20. Program resolution occurs normally; all variables are initialized prior to resuming execution.

TRACE Mode

When a program is executed in TRACE Mode, the system automatically displays intermediate values and any internal program transfers such as branches in GOTO, GOSUB statements, FOR/NEXT loops, etc. Also, if an alpha function is executed on the left side of an equation, the function name is displayed. As an exercise, enter the following program:

PROGRAM LINE	MEANING
10 A$="ABCDEFGHIJ":K=0	Assign the character string to A$, and zero to K.
20 GOTO 40	Branch to line 40.
30 K=K+1: B$=STR(A$,3,K)	Increment K; then, starting with the third character of A$, store K characters of the A$ string in B$.
40 HEXPRINT A$, B$	Print hexcodes of characters in A$ and B$.
50 PRINT A$, B$	Print the characters currently in A$ and B$.
60 STOP	Stop program execution.
70 GOTO 30	Branch back to line 30.

Now, to execute the program in TRACE Mode, turn on the TRACE Mode by keying TRACE (EXEC). Then RUN the program. The first display is:

```
A$=ABCDEFGHIJ
K= 0                                    TRACE output
TRANSFER TO 40
41424344454647484 94A202020202020
20202020202020202020202020202020
ABCDEFGHIJ                              program output

STOP
:_
```

The STOP statement in line 60 halts program execution and returns control to the operator as indicated by the colon and cursor. To proceed, enter:

```
CONTINUE   (EXEC)
```

The second display is:

```
TRANSFER TO 30
K= 1                                    TRACE output
B$=C
41424344454647484 94A202020202020
43202020202020202020202020202020
ABCDEFGHIJ      C                       program output

STOP
:_
```

Now, again enter:

```
CONTINUE   (EXEC)
```

The third display is:

```
TRANSFER TO 30
K= 2
B$=CD
414243444546474849 4A202020202020
434420202020202020202020202020202020
ABCDEFGHIJ       CD

STOP
:_
```

The TRACE Mode can be continued for this example program until K=15, although after K = 8 there are no further changes to B$ (all eight non-blank characters of A$ beginning with character C have been used).

> **NOTE:**
>
> Once K = 15, a program error (ERR 41) occurs; the error arrow points to the variable K. The error is "illegal STR argument" since in line 30 B$=STR(A$,3,15), but A$ contains only 16 bytes, the default dimension 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 by entering the line number without text:

```
60   (EXEC)
```

To view the new version of the program and verify that the line has been removed, 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 (one P = 1/6 second), enter:

```
SELECT P3   (EXEC)
```

Now RUN the program.

During program execution, TRACE output is displayed with a pause of one-half second between each line. Execution terminates when K = 15 produces 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 P0    (EXEC)
```

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

4.9 SUMMARY

This PSC-II Introductory Manual has presented fundamental information necessary to Master Initialize the PCS-II and enter and run programs. See the Wang BASIC Language Reference Manual for information on the general purpose BASIC instructions, their syntax and meanings. For further information on using the minidiskette drive for program and data storage, see the System 2200 Disk Memory Reference Manual. Also see the System 2200 Summary (card) which provides syntax and error messages in abbreviated form. For the inexperienced user, the Programming in BASIC manual is recommended reading.

APPENDIX A

PCS-II SUPPORTING LITERATURE

The BASIC Language available on the PCS-II is fully documented in five reference manuals supplied with the system. The names of the BASIC instructions and the manuals which describe them are listed below.

BASIC INSTRUCTIONS	SUPPORTING DOCUMENT
ABS, ADD, AND, ARCCOS, ARCSIN, ARCTAN, BIN, BOOL, CLEAR, COM, COM CLEAR, CONTINUE, CONVERT, COS, DATA, DEFFN, DEFFN', DIM, END, EXP, FN, FOR, GOSUB, GOSUB', GOTO, HALT/STEP, 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, RESET, RESTORE, RETURN, RETURN CLEAR, RND, ROTATE, RUN, SELECT, SGN, SIN, SQR, STOP, STR, TAB, TAN, TRACE, UNPACK, VAL, XOR	Wang BASIC Language 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
$GIO, $IF ON, $PACK, $TRAN, $UNPACK	General I/O Instruction Set Reference Manual
MAT CONVERT, MAT COPY, MAT MERGE, MAT MOVE, MAT SEARCH, MAT SORT	Sort Statements 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

APPENDIX B

PCS-II OPTIONS AND PERIPHERALS

OPTIONS

OP-60A	Keyboard Clicker, Audio Alarm, Auxiliary CRT Connector, and 24 x 80 CRT (24 lines with 80 characters per line capacity).
OP-62*	Buffered Asynchronous Communications Controller.
OP-62B*	Synchronous/Asynchronous Communications Controller.
OP-65*	IEEE-488 Standard Interface.
OP-67*	I/O Interface Controller (8-bit parallel).
MEM-PCS-8K	Memory Upgrade of 8K Bytes (32K maximum).
MEM-PCS-16K	Memory Upgrade of 16K Bytes (32K maximum).
OP-101	A second minidiskette drive.

PERIPHERALS

2201L	Output Writer (156 Col/15 CPS).
2221W	200 Characters/Sec Printer, 10 Pitch, 132 Characters/Line.
2231W-1	120 Characters/Sec Printer, 10 Pitch, 112 Characters/Line.
2231W-2	120 Characters/Sec Printer, 12 Pitch, 132 Characters/Line.
2231W-3	2282 Graphic CRT Accessory Printer.
2251	110 CPS Printer, 40 Characters/Line.
2261W	Line Printer (240 LPM/Dual Pitch).
2263-1	Line Printer (400 LPM).
2263-2	Line Printer (600 LPM).
2271	Bi-directional Output Writer.
2271P	Plotting Output Writer.
OP-120	Pin Feed Platen for 2271P.

* Mutually exclusive

2272-2	Drum Plotter with Three Pens.
2281	Daisy Output Writer (30 CPS).
OP-121	Pin Feed Forms Tractor for 2281.
2281P	Plotting Daisy Output Writer (30 CPS).
OP-122	Pin Feed Platen for 2281P.
2282	Graphic CRT.
2295	2231W Printer Stand.

APPENDIX C

PROGRAMMING CURSOR MOVEMENT

The CRT cursor can be moved under program control by using a PRINT statement (see the Wang BASIC Language Reference Manual) and the following hex codes which produce cursor movement:

HEX CODE	CURSOR MOVEMENT
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 the cursor movement commands, but output produced on the CRT cannot be directly reproduced on a printer or an output device which does not have a cursor or similar symbol.

```
10 PRINT "AAAAA"
20 PRINT HEX(09);"BBBBB"
30 PRINT HEX(0C0C0909090909);"##"
```

This routine produces the following output on the CRT:

```
AAAAA##
 BBBBB
```

NOTE:

See the PRINT statement syntax in the Wang BASIC Language Reference Manual for a discussion of the use of semicolons and commas between the print elements or at the end of a particular statement..

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)

Weight

62 lb (30 kg) approximately

CRT

Display size	9 in. (22.9 cm) diagonal
Capacity	16 lines, 64 char/line
Character size	
Height	0.125 in. (0.32 cm)
Width	0.125 in. (0.32 cm)

Central Processor

Memory size: 8K, 16K, 24K, or 32K bytes
Language: Wang BASIC
Average Execution Time (Milliseconds)*

Add/Subtract	0.8
Multiply	3.8
Divide	7.4
Square	46.4
e^x	25.3
$\log_e x$	23.2
x^y	45.4
Integer Value	0.24
Absolute Value	0.25
Sign	0.25
Sine	38.3
Cosine	38.9
Tangent	78.5
Arctangent	72.5

*Average execution times are determined using random number arguments with 13 precision digits. Speeds are faster for arguments with fewer precision digits.

Appendix D

Minidiskette Drive

Online storage capacity (single drive)

Number of platters	1
Sectors per platter	350
Bytes per platter	89,600

(With dual drive--179,200 bytes)

Rotation Speed	300 RPM

Access Time (Position Head to Track)

Average (across one-half available tracks)	533 ms

Latency Time (Platter Rotation to Sector)

Average (one sector read/write one-half revolution)	100 ms

Transfer Rate	125 kilobits/sec (15,625 bytes/sec)

Power Requirements

115 or 230 VAC ± 10%
50 or 60 Hz ± 1/2 Hz
260 Watts

Fuses

3 amp 115V/60Hz
1.5 amp 230V/50Hz

Operating Environment

50°F - 90°F (10°C - 32°C)
20% - 80% Relative Humidity
(Recommended: 40% - 60%, non-condensing)

To help us to provide you with the best manuals possible, please make your comments and suggestions concerning this publication on the form below. Then detach, fold, tape closed and mail to us. All comments and suggestions become the property of Wang Laboratories, Inc. For a reply, be sure to include your name and address. Your cooperation is appreciated.

700-4255B

TITLE OF MANUAL: **PCS-II INTRODUCTORY GUIDE**

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