WANG

WCS/20 INTRODUCTION & INSTALLATION GUIDE

SYSTEM 2200

WCS/20 INTRODUCTION & INSTALLATION GUIDE

WANG LABORATORIES, INC.
836 NORTH STREET, TEWKSBURY, MASSACHUSETTS 01876, TEL. (617) 851-4111, TWX 710 343-6769, TELEX 94-7421

Disclaimer of Warranties and Limitation of Liabilities

The staff of Wang Laboratories, Inc., has taken due care in preparing this manual; however, nothing contained herein modifies or alters in any way the standard terms and conditions of the Wang purchase agreement, lease agreement, or rental agreement by which this equipment was acquired, nor increases in any way Wang's liability to the customer. In no event shall Wang Laboratories, Inc., or its subsidiaries be liable for incidental or consequential damages in connection with or arising from the use of this manual or any programs contained herein.

WANG LABORATORIES, INC.
ONE INDUSTRIAL AVENUE, LOWELL, MASSACHUSETTS 01851, TEL (617) 851-4111, TWX 710 343-6769, TELEX 94-7421

TABLE OF CONTENTS

1. INTRODUCTION

Wang Laboratories, Inc. welcomes you to the community of Wang users. You have entered the world of small computers by purchasing the Wang Computer System, WCS/20, which provides you with a powerful tool for developing new and more advanced methods for managing your daily activities.

The WCS/20 features an 8K Central Processing Unit (CPU) with a "hardwired" Extended BASIC language interpreter, an operator console comprised of a 1,024-character Cathode Ray Tube (CRT) Display and a keyboard, and a single diskette drive for mass storage - all in one coordinated, compact and attractive piece of office furniture.

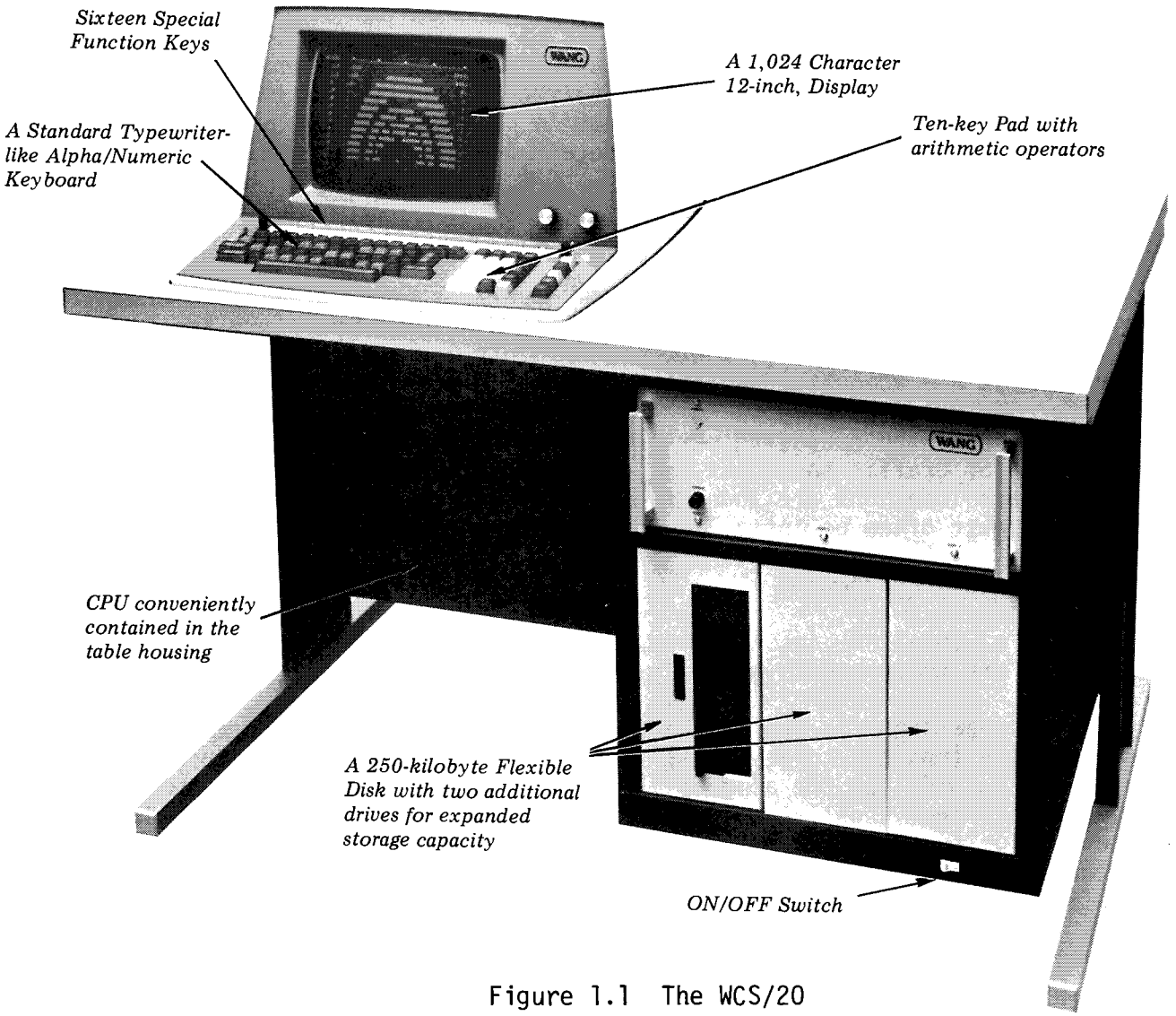

Figure 1.1 The WCS/20

1.1 UNPACKING, INSPECTION, AND INSTALLATION

Your system must be unpacked, inspected, and installed by a Wang Service Representative. Upon receipt of your system, be sure to notify your Service Representative so that he may perform this service. Failure to follow this procedure will void your warranty.

Your Service Representative will ensure that the connectors for any peripherals are properly connected to the CPU and locked in place, that power cords are properly plugged into a source of power and that the main power cord of the CPU is correctly attached to your system's power supply. It is recommended that your system be connected to a power line reserved exclusively for its use; the line should not be shared by other office equipment such as water coolers, calculators, typewriters, and copiers.

1.2 INSTALLATION GUIDE

When your WCS/20 is delivered, it is not sufficient to merely find floor space for it and insert the plugs into an AC outlet. Some preparation prior to delivery is necessary to select a suitable location for the system and to determine if the AC power lines are adequate. The following describes the environment in which a system must operate and the preparations necessary to meet these criteria.

Selecting a Location

The environment in which a system operates can greatly affect its performance. An ideal location would be one in which temperature and humidity are controlled; airborne dirt and contaminants are reduced to a minimum; the power outlets are adequate, regulated, and noise free; and there is enough room for future expansion. The selected location should also be one that is easily accessible by operating personnel, yet sufficiently removed from the main flow of traffic so as not to interfere with the smooth operation of the system. Such locations are indeed very difficult to find, and as a result, the system must often be installed in a less than favorable environment.

Controlling the Environment

Once a location is selected, the three factors that need to be considered are temperature, humidity, and cleanliness.

The temperature is the most important factor to consider because it can vary greatly from day-to-day. The recommended operating temperature range is from 65°F to 75°F, but the allowable range is from 50°F to 90°F. Low outside temperatures are usually not a problem because nearly all locations are heated. High temperatures can be a problem because many locations do not have air conditioning. If the system is used where temperatures exceed the maximum specified, component failure rates will drastically increase, resulting in costly downtime for the user. High temperatures can also cause warpage and distortion of data storage material, resulting in lost data.

If an air conditioning unit is already installed or if one is to be installed, it is imperative that a separate power line be used. If a separate power line is not used, system errors will occur when the air conditioning is in use.

While air conditioning is good for maintaining the proper temperature, it also removes moisture from the air, thereby lowering the humidity. If the system is installed in a carpeted room, the lower humidity plus the static generating capability of carpets and synthetic clothing impart a static electrical charge on operating personnel. When the operator comes in contact with the system, the resultant static discharge is not only uncomfortable, but will cause system malfunctions and the destruction of recorded data.

If carpeting is to be installed, be sure it is a non-static variety. If carpeting already exists and it is not a non-static carpet, it will either have to be treated with a non-static spray or an electrical conductive mat must be installed to prevent a static charge build-up. Carpets treated with non-static spray should be thoroughly cleaned before the first treatment, and retreated at least once every three months, thereafter. If an electrically conductive mat is used, it should be installed under the system operating area and must be properly connected to an earth ground.

The recommended humidity range is from 40% to 60% R.H., but 20% to 80% R.H. is allowable. (In cold weather, the humidity in heated buildings can be 10% or lower.) Low humidity not only increases the certainty of static build-up, but also can cause oxide shed in data storage material. Humidifiers and dehumidifiers should be installed to increase or decrease the humidity as required.

Dirt and grease can accumulate rapidly on circuit boards and components, and can form a film that prevents heat dissipation from components and also creates a leakage path for signals. They also can cause excessive mechanical wear in tape and disk drives and scratches in the oxide coating of the storage material and on the read/write heads.

To prevent unnecessary failures due to dirt, all air conditioning, heating and ventilating units should have air filters installed; these filters should be cleaned or replaced regularly. In areas where filters do not remove airborne dirt sufficiently, an electrostatic filter should be installed.

Electrical Environment

For most Wang systems, a 20 ampere, 115 VAC power line is adequate. Further system requirements dictate that this line must be regulated to within + 10% and must be noise free. It is recommended that the system have its own AC power line.

If the line is not sufficiently regulated to the limits indicated above, a constant voltage transformer should be installed. If the line is noisy, however, a detailed analysis of the problem must be performed to insure a correct solution.

Since computers and peripherals are extremely susceptible to Electromagnetic Interference (EMI), the source of the EMI must be determined before a solution is proposed. EMI can enter the system by conduction along wiring and cabling or by direct radiation. If sources of EMI, which include office machines, air conditioning units, electric motors, machinery and arc welders, are in close proximity to the system, EMI will enter by direct radiation. The noise generating device should be relocated, repaired or filtered to prevent it from interfering with the system. If the source of the

noise cannot be found, an EMI filter with a cut-off frequency near 10 KHz should be installed on the system's AC power line. In all cases, be sure the AC power line has been properly installed in steel conduit and the conduit is properly connected to junction boxes. Also, insure that other devices, including fluorescent lighting, are not connected to the AC power line. In extreme cases, such as where arc welders are used in the vicinity, it may also be necessary to shield the peripheral cables.

2. WCS/20 HARDWARE

2.1 THE CENTRAL PROCESSOR

The nucleus of the WCS/20 is a Central Processing Unit consisting of four parts - a central processor, a data memory (RAM), a control memory (ROM) containing the BASIC Interpreter, and a set of I/O (input/output) controllers. RAM (Random Access Memory) contains 8K (8,192) bytes of data memory, expandable in 8K increments to 32K bytes. The powerful 42.5K BASIC Interpreter is resident in a separate ROM (Read Only Memory) area of the CPU, and by "hardwiring" the interpreter, the time and space necessary to "page" the system in and out of user memory is eliminated. Approximately 700 bytes of the user area (RAM) are allocated for system use. Finally, in the same chassis as the CPU are controllers for the I/O devices. Every peripheral attached to your CPU such as the keyboard, the video display, tape and disk drives, etc., is directly connected to the CPU via its own controller interface.

2.2 THE INTEGRATED CRT DISPLAY

The Integrated CRT Display is designed to display up to 1024 characters of data or program text. With it you can write, review, modify, and correct programs speedily and easily. It contains a screen with two controls used to set brightness and contrast. The screen can hold a maximum of 16 lines, each 64 characters long. Lines are displayed sequentially on the screen. If more than sixteen lines are input at any one time, when the last line is filled, a new line is added to the bottom of the CRT, and all previously entered lines move up a line.

Cleaning the CRT Screen

The CRT screen should be cleaned periodically with a mild soap and water using a soft cloth. Do not use an alcohol pad or abrasive compound which can cause damage to the rim surrounding the screen.

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

Moving The Cursor

Cursor movement can be issued to the CRT using the PRINT HEX code (see BASIC Language Reference Manual):

HEX CODE	COMMAND
01	home cursor
03	clear screen and home cursor
08	cursor left ()
09	cursor right ()
0A	cursor down ()
0C	cursor up ()

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

2.3 THE INTEGRATED ALPHANUMIC/BASIC KEYWORD KEYBOARD

The Integrated Keyboard provides two modes of operation for entering data and programs into the Central Processing Unit. Mode is selected by use of the toggle switch labeled Keyword/A and A/a at the upper-left corner of the keyboard.

When the toggle switch is set to Keyword/A, each touch of a key on the keyboard produces either a BASIC language keyword (if the SHIFT Key is depressed) or an uppercase letter (if the SHIFT Key is not depressed). This mode is used for entering programs.

When the toggle switch on the keyboard is set to A/a, the keyboard acts like a typewriter. Each touch of a key produces an uppercase letter on the CRT (if the SHIFT Key is depressed) or a lowercase letter (if the SHIFT Key is not depressed). This mode must be used if lowercase data entry is desired.

During most operations, the system is normally in Console Input Mode. In this mode, program lines, commands, or data are entered. When each line has been completely keyed in, the RETUR(EXEC) is touched; this causes the system to accept and process the line.

Data can be entered from the keyboard into memory each time a running BASIC program in the system executes an INPUT statement. As with program lines, each line is terminated by touching the RETURN(EXEC) key; this causes the system to accept and process the data line.

The keyboard is divided into four zones as follows:

ZONE 1 — Contains all alphanumeric characters, special characters (e.g., #, $, %, etc.), many BASIC language keywords (e.g., PRINTUSING, FOR, etc.), and some operations keys (STMT NUMBER, TRACE, RENUMBER, LIST, BACKSPACE (), LINE ERASE, and RETURN(EXEC)).

ZONE 2 — Contains a full numeric keyboard, the mathematical function keys (ARC, SIN(, COS(, etc.), the arithmetic operators (+, -, *, /), a RETURN(EXEC) key and a keyword PRINT key.

ZONE 3 — Contains the operation keys for loading, executing and controlling a program during execution.

HALT/STEP — Stops program execution after completion of the current statement, and is used to step through a program one statement at a time.

CONTINUE — Continues program execution after encountering a STOP or having used HALT/STEP, and must be followed by a RETURN(EXEC).

CLEAR — When followed by no parameters, clears all program text and variables. When followed by V, removes all variables from memory. When followed by N, removes all non-common variables from memory. When followed by P, removes program text but not variables. Must be followed by RETURN(EXEC).

LOAD — Loads a program from currently selected tape unit into memory, and must be followed by RETURN(EXEC).

RUN — Initiates execution of user program in memory, and must be followed by RETURN(EXEC).

ZONE 4 — Contains 16 Special Function Keys which are used to access up to 32 user-defined routines. To be used, a Special Function Key must be defined by the user with a DEFFN' statement in the currently loaded program. Special Function Keys can be used to start program execution, to enter and execute subroutines, and to enter a string of text characters.

Also contains the EDIT Mode keys which permit discrete line editing. Individual alphanumeric characters in a line of program text resident in memory, or in data values of program text currently being entered from the keyboard, can be altered, inserted, or deleted, without retyping the entire line.

Also contains the RESET pushbutton switch (upper-right) which immediately stops program execution, listing and I/O operations, clears the CRT, and returns control to the user (Console Input Mode). Program text and variables are left intact. RESET generally should not be used to terminate program execution; HALT/STEP should be used for this purpose.

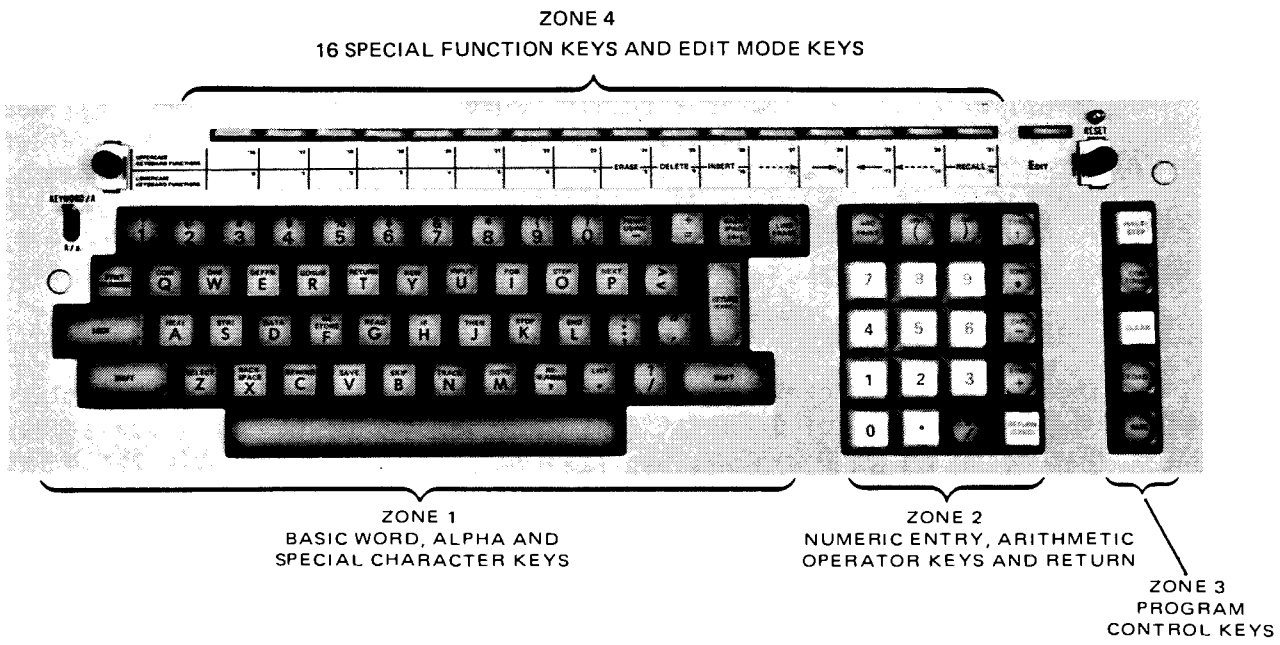

Figure 2.1 The Integrated Alphanumeric/BASIC Keyword Keyboard

Each of the keywords on the Integrated Alphanumeric/BASIC Keyword Keyboard is described in the Wang BASIC Language Reference Manual. Note that there are two RETURN(EXEC) keys, one in Zone 1 and the other in Zone 2 of the keyboard. Their operation is identical. There are also two BACKSPACE keys in Zone 1. The one in the upper-right of Zone 1 is used to backspace the cursor, and the one in the lower-left of Zone 1 is used to backspace a file or record on tape.

When entering programs with the Integrated Alphanumeric/BASIC Keyword Keyboard, most compound keywords (such as DATALOAD) can be entered by touching the keys DATA and LOAD, but the keyword PRINTUSING must be entered either by using the PRINTUSING key or by entering it one character at a time.

Finally, certain keys on the Integrated Alphanumeric/BASIC Keyword Keyboard cause immediate action, and do not require a RETURN(EXEC) key for execution. They are: RESET, HALT/STEP, Special Function Keys, Edit Mode Keys, BACKSPACE, LINE ERASE, and STMT NUMBER. (BACKSPACE removes the current character or keyword. LINE ERASE removes the current line. STMT NUMBER enters a line number for the next line to be keyed in - the highest line number + 10.)

2.4 DISKETTE DRIVE

The standard single diskette drive provides high-speed, direct-access, on-line storage, and by using removable diskette platters, the off-line program and data storage capacity of the system is limited only by the number of diskette platters one has on hand.

Physical Characteristics

The diskette drive holds one easily replaceable diskette platter, about 7-1/2 inches in diameter. Data is recorded on only one surface of a platter which is divided into 64 concentric circular tracks, with each track segmented into 16 sectors. The recording surface therefore contains a total of 1,024 sectors, numbered sequentially from 0 through 1,023, with each sector storing 256 bytes of information.

Storage Capacity

Since each sector can store 256 bytes of information, a diskette platter can store 262,144 bytes of information (1,024 sectors x 256 bytes per sector). (In a non-standard WCS/20 System, up to three drives are available for a total of 786,432 bytes of on-line storage.)

Speed

Information is transferred to and from the diskette at high speed. The total time required to read or write an item of data on diskette can be broken down into two components - the Track Access Time and the Disk Latency Time.

The Track Access Time is the time required to position the read/write head to a specified track on the diskette platter. The "average access time" is the time required for the read/write head to move from track #0 to the middle track on a diskette platter. For the WCS/20 diskette, the average access time is 401 ms (about 0.4 second). If information is written or read sequentially on a platter, access time is minimized.

The Disk Latency Time is the time required for the desired sector on a track to rotate to the read/write head. The "average latency time" is the time required for a sector which is one-half track (eight sectors) away from the read/write head to rotate to the read/write head. Since the platter makes one complete revolution in 160 ms, the average latency time is one-half this time, or 80 ms (0.08 second). The staggered arrangement of sequential sectors on a track (which is transparent to the user software) makes it possible to read or write multi-sector records with significant savings in total latency time.

File Maintenance

Files can be maintained on diskette in one (or both) of two modes: Automatic File Cataloging Mode and Absolute Sector Addressing Mode. The BASIC commands and statements in both modes are built into the Wang Computer System/20.

Automatic File Cataloging includes 17 BASIC statements and commands which constitute an internal data management system. Catalog Mode permits the user to save and load programs or data files by name, without concern for where or how the files are actually stored on diskette or the actual sector address of the data. (This information is recorded in a special "catalog index" which is automatically maintained by the system itself.)

Absolute Sector Addressing includes eight BASIC statements which permit the programmer to address specific sectors on diskette, thus enabling him to

design his own data management system. Two Absolute Sector Mode statements are provided which make possible the saving and loading of unformatted data. This enables the programmer to include his own control information in individual records.

Reliability

Although the diskette unit is an extremely reliable device, both cyclic redundancy (CRC) and logical redundancy (LRC) checksum tests are made automatically on all data read from the diskette. If a CRC error is detected in a sector, that sector is automatically reread four times before an error is signalled. An additional read-after-write verification test can be optionally specified by the programmer simply by including a single parameter in the appropriate BASIC statement or command.

2.5 WCS/20 INSTRUCTION SET

General BASIC Statements

ADD	GOTO	POS
AND	HEXPRINT	PRINT
BIN	IF END THEN	PRINTUSING
BOOL	IF THEN	READ
COM	% (Image)	REM
COM CLEAR	INIT	RESTORE
CONVERT	INPUT	RETURN
DATA	KEYIN	RETURN CLEAR
DEFFN	LET	ROTATE
DEFFN'	NEXT	SELECT
DIM	ON GOTO/GOSUB	STOP
END	ON ERROR	TRACE
FOR	OR	UNPACK
GOSUB	PACK	XOR
GOSUB'	PLOT	

BASIC Commands

CLEAR	LIST	RUN
CONTINUE	RENUMBER	
HALT/STEP	RESET	

Tape Cassette Commands and Statements

BACKSPACE
DATALOAD
DATALOAD BT
DATARESAVE
DATASAVE
DATASAVE BT
IF END THEN
LOAD (command)
LOAD (statement)
REWIND
SAVE (command)
SKIP

Disk Statements

Automatic File Cataloging Mode Commands and Statements
DATALOAD DC
DATALOAD DC OPEN
DATASAVE DC
DATASAVE DC CLOSE
DATASAVE DC END
DATASAVE DC OPEN
DBACKSPACE
DSKIP
LIST DC
LOAD DC (statement)
LOAD DC (command)
MOVE
MOVE END
SAVE DC
SCRATCH
SCRATCH DISK
VERIFY

Absolute Sector Addressing Mode Statements
COPY
DATALOAD BA
DATALOAD DA
DATASAVE BA
DATASAVE DA
LIMITS
LOAD DA
SAVE DA

The Matrix Instruction Set

MAT +	-	matrix addition.
MAT CON	-	provides the constant matrix (every element a one).
MAT =	-	matrix equivalence.
MAT IDN	-	the identity matrix (main diagonal ones).
MAT INPUT	-	rapid data input can be effected.
MAT INV,d	-	the inverse and determinant of a matrix are output.
MAT *	-	matrix multiplication.
MAT PRINT	-	output can be produced.
MAT READ	-	rapid data input can be effected.
MAT REDIM	-	array size can be changed.
MAT ( )*	-	matrix scalar multiplication.
MAT -	-	matrix subtraction.
MAT TRN	-	matrix transposition.
MAT ZER	-	the zero matrix (every element a zero).

The General I/O Instruction Set

$GIO - a generalized I/O statement designed to perform data input, data output, and I/O control operations with a programmable Signal Sequence.

$IF ON - a statement designed to test the device-ready condition of a specified output device or test the data-ready condition of a specified input device and initiate a branch to a specified line number if a ready condition is sensed.

$TRAN - a statement designed to facilitate high-speed character code translations.

$PACK - statements designed to facilitate data packing and unpacking by
$UNPACK fields or delimiters, between a specified alphanumeric array buffer and specified arguments in an argument list.

The Character EDIT Instruction Set

(Multispace left) <----	-	moves cursor five spaces to the left.
(Multispace right) ---->	-	moves cursor five spaces to the right.
(Space left) <-	-	moves cursor one space to the left.
(Space right) ->	-	moves cursor one space to the right.
INSERT	-	expands a line to allow for additional text or data.
DELETE	-	deletes character at the current cursor position.
ERASE	-	erases a program or data line from the current cursor position.
RECALL	-	recalls a program line already in memory.

The SORT Instruction Set

MAT CONVERT	-	converts numeric to alpha array, and places items in sort format.
MAT COPY	-	transfers data by bytes from one array to another.
MAT MERGE	-	creates a locate-mode array to be used by MAT MOVE in performing a merge operation.
MAT MOVE	-	moves array elements from one array to another.
MAT SEARCH	-	seeks certain substrings in an array and stores their locations.
MAT SORT	-	Creates a locate-mode array which gives the location of array elements in sorted order.

2.6 MATHEMATICAL FUNCTIONS

LOG	-	natural logarithm
ABS	-	absolute value
SQR	-	square root
RND	-	random number
INT	-	greatest integer function
SGN	-	assigns 1 if positive, 0 if zero. or -1 if negative
EXP	-	e^X
#PI	-	π(3.14159265359)
SIN	-	sine*
COS	-	consine*
TAN	-	tangent*

ARCSIN - arcsine*
ARCCOS - arccosine*
ARCTAN - arctangent*

(*Trig arguments: degrees, radians, gradians.)

Arithmetic Operators

↑ exponentiation
* multiplication
/ division
+ addition
- subtraction
= assignment symbol

Relational Symbols

= equal
< less than
<= less than or equal to
> greater than
>= greater than or equal to
<> not equal

2.7 ALPHANUMERIC FUNCTIONS

STR VAL
LEN NUM
HEX

3. TURN-ON PROCEDURE FOR THE WCS/20

Your entire system is turned on and Master Initialized with a single switch on the right-front panel of your console (see Figure 1.1).

When your WCS/20 is turned on, :READY appears on the display after about 15 seconds. Your WCS/20 is now ready to use.

> NOTE:
>
> If the READY display does not appear, touch the RESET button. If it still does not appear, Master Initialize again (turn power off, then on again). If your system still does not operate, check your installation and try again. If your system still does not operate, call your Wang Service Representative.

4. SYSTEM OPERATION

4.1 MASTER INITIALIZATION

When your system is off, all programs and data in memory are cleared. Once the system is turned on, Master Initialization occurs. Master Initialization sets default values for line length and the length of alphanumeric variables, and establishes a table containing the default addresses for the following peripherals:

I/O Class	Default Address	Normal Device
Console Input	001	Keyboard
Console Output	005	CRT
Print	005	CRT
Input	001	Keyboard
Tape	10A	Tape Cassette
Disk	310	Diskette
Plot	413	Plotter

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 BASIC Language Reference Manual), but 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 (see BASIC Language Reference Manual). 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.

4.2 THE COLON

Once your system has been Master Initialized, the colon(:) is displayed. This indicates that the system is ready to receive BASIC statements or commands. The colon is also used when inputting statements to separate several BASIC statements occurring on the same program line.

Example:

```
:10 PRINT A
:20 A,B=1:G2=A+B
```

4.3 THE EXECUTE KEY

The Execute Key is used to terminate every line input to the system. On the Integrated Alphanumeric/BASIC Keyword Keyboard, it is called the RETURN(EXEC) Key; in the BASIC Language Reference Manual, it is usually referred to as the CR/LF-EXECUTE (carriage return/line feed) Key.

Example:

To input a program line, enter 10A = 10 RETURN(EXEC)

To do a quick calculation (evaluate the expression 25+25=?), enter:

PRINT 25+25 RETURN(EXEC)

4.4 SPACING

Spaces are customarily used between characters in a line for readability, but the system ignores them. For example, 10 READ A, B, C, D is easier to read than 10READA,B,C,D. Both are clear to the system, however. Finally, when a line is stored, extraneous spaces are eliminated automatically to condense user text area.

4.5 MODES OF OPERATION

Your system has two modes of operation, Immediate Mode and Program Mode. In both modes, BASIC Keywords are entered on a line (up to 192 keywords long) and entry is terminated by touching the RETURN(EXEC) Key.

Immediate Mode

In Immediate Mode, your system can be used as a powerful one-program-line calculator. In this mode, BASIC Keywords are entered without a line number and are not saved in memory.

Example:

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

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

Once a program line is entered and the RETURN(EXEC) Key is depressed, the system checks the line for syntax and, providing there are no syntax errors, immediately executes the line which is not retained.

Immediate Mode can be particularly useful for interrogating specific variables during program execution (see example in section on Debugging).

Certain BASIC words cannot be used in the Immediate Mode. They are:

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

Program Mode

In Program Mode, each line must be preceded by a line number from 1 to 4 digits. In this mode, each line entered is saved in memory. Once the line number and program line are entered and the RETURN(EXEC) Key is depressed, the line is checked for syntax and saved in memory. It is not executed immediately. If a syntax error is discovered, the appropriate error code (↑ ERR..) is displayed, although the line has nonetheless been stored in memory. The line can be corrected by either reentering the line number and the program text or by using EDIT Mode with the Edit Keys. For example,

```
Enter :10 PRINT 1A,B1,C1 RETURN(EXEC) (The line is checked for syntax and
                                        stored.)

                  ↑ERR 10 is displayed (1A is not a legal BASIC variable).
      :_

Touch EDIT     *   (Asterisk replaces colon.)
      10       *10 (To enter Edit Mode and recall the line from memory.)
      RECALL
               *10 PRINT 1A,B1,C1
                                   (Cursor at end of line when line recalled.)
```

Move the cursor with the Edit Key.

```
               *10 PRINT 1A,B1,C1
```

```
Enter A1
               *10 PRINT A1,B1,C1
```

Touch RETURN(EXEC) to restore the corrected line and drop out of Edit Mode.

> NOTE:
>
> 1. It does not matter where the cursor is positioned when you drop out of Edit Mode; the entire line is stored.
>
> 2. To recall the original line, press the Recall Key again before dropping out of Edit Mode.

> NOTE:
>
> If a syntax error is found in either mode, the appropriate ↑ERR code is displayed with the up-arrow pointing to the keyword in error. Control of the system is then returned to the user as the colon is displayed.

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 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 must not be preceded by spaces.

Example:

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

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

4.6 A KEYSTROKE

A keystroke is the depression of a single key on the keyboard. On the Integrated Alphanumeric/BASIC Keyword Keyboard, the keys contain not only the entire alphabet (uppercase and lowercase), all the decimal digits, and many special characters (such as $,#,%, etc.) but also complete BASIC words. These BASIC words (such as PRINT or PRINTUSING) can be entered with a single keystroke. They also can be entered character by character, and are generally stored in memory in a single byte (some require two bytes).

4.7 A KEYWORD

A keyword is a BASIC word or ASCII character which is stored as a single byte in memory. For example, the program line:

```
100 PRINT (X + SIN(Y)): J = 1
```

when stored in memory looks like this:

byte	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16
	01	00	SPACE	PRINT	(	X	+	SIN(	Y	)	)	:	J	=	1	CR	SPACE

Each box in the diagram contains a keyword. Note that the terminating CR (carriage return) is part of the line. When the line is displayed, spaces are provided (after the line number and the word PRINT) for readability.

4.8 A BASIC STATEMENT

A BASIC statement is any group of words, variables, expressions, etc. valid in Wang 2200 BASIC. A BASIC statement with its arguments, if any, can form a complete program line.

Examples:

```
PRINT A
J = 1
PRINT 10 + 2
10 REM
```

4.9 A BASIC COMMAND

A BASIC command is any group of words, variables, expressions, etc. valid in Wang 2200 BASIC that are not programmable, i.e., they can be used only in the Immediate Mode.

Examples:

```
RUN
LOAD "PROG 1"
SAVE
```

4.10 A BASIC FUNCTION

A BASIC function is a valid BASIC word which is used within a BASIC statement, but cannot stand alone on a program line. A BASIC Function must have an argument specified, and can appear as an argument within a BASIC statement.

Examples of BASIC statements:

```
10 READ A$,B$,C
20 PRINT A,B,C;A$
PRINT J+3
```

Examples of BASIC statements with Functions as arguments:

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

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.

4.11 ENTERING PROGRAM LINES

A program line is entered by keying in a line number followed by BASIC language text. Each line is terminated by touching the RETURN(EXEC) Key. As each character is keyed in on the keyboard, it is held in the keyboard buffer. When RETURN(EXEC) is touched, the entire line is sent to the CPU and saved.

Examples:

```
10 A = 14 + 2          RETURN(EXEC)
20 PRINT "A="; A       RETURN(EXEC)
```

4.12 EXECUTING A PROGRAM

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

Examples:

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

Touch RUN, RETURN(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 setting up all tables and buffers in memory. It is possible for an error of execution to occur. In this case, the program line in which the error occurred is displayed with an ERR code. The program must be corrected before reexecution.

Example:

```
 5 K, J=1:T=1
10 A = (SIN(K)-4*J)/T
20 PRINT
```

This program executes normally when run, but if the variable T in line 5 is zero or omitted, an error of execution occurs. The display is:

```
10 A = (SIN(K)-4*J)/T
                   ↑ERR03
```

> NOTE:
>
> Any undefined numeric variable is set to zero and any undefined alpha variable is set to spaces, at resolution time. (An 'undefined' variable is one to which no value is assigned.)

4.13 EDITING PROGRAMS

Deleting a Program Line

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

Example:

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

To delete line 30, enter:

```
30 RETURN(EXEC)
```

Replacing and Changing a Line

An existing line can be replaced by entering its line number, the new text, and touching RETURN(EXEC). The previous version of the line is destroyed. A line also can be changed by using the Edit Keys.

Using Edit Mode

Once you have keyed in a line of text, you can use Edit Mode to change it. To do so, you must enter Edit Mode (by pressing the Edit Key) and use the Edit Mode Keys to move the cursor under the character you wish to change or delete. To insert a character, move the cursor under the character where the insertion is to be made. When deletions or insertions are made, Edit Mode automatically adjusts the line.

Example:

You wish to calculate the value 1000-414 but enter

```
PRINT 1000-714
             cursor position
```

(PRINT must be used to display the value.)

Touch Edit Key.	*PRINT 1000-714
Use the Space Left Key to position the cursor under the 7.	*PRINT 1000-714
Enter 4.	*PRINT 1000-414
Touch RETURN(EXEC) to compute the value and drop out of Edit Mode.	:PRINT 1000-414 :586

If the line is a program line and has been stored in memory, it must be recalled from memory and edited.

Example:

You enter:	10 PRINT 1000-714 RETURN(EXEC)
The line is stored in memory.	
Touch Edit.	*
Enter the line number.	*10

Touch RECALL.	*10 PRINT 1000-714 Cursor at end of recalled line.
Move the cursor.	*10 PRINT 1000-714
Enter 4.	*10 PRINT 1000-414
Touch RETURN(EXEC) to store corrected line in memory and drop out of Edit Mode.	:10 PRINT 1000-414

If you make an error in correcting a line recalled from memory, you can recall the original line so long as the new line has not been stored in memory.

Example:

The incorrect line is in memory.	10 PRINT 1000-714
Enter Edit Mode and recall it.	
Edit	*
10	*10
RECALL	*10 PRINT 1000-714
Move the cursor (too many spaces).	*10 PRINT 1000-714
Enter 4.	*10 PRINT 1004-714
Touch RECALL (to recall the original line).	*10 PRINT 1000-714
Correct the line and drop out of Edit Mode. (Move cursor, enter 4, and touch RETURN(EXEC).)	*10 PRINT 1000-414 :

NOTE:

Edit Mode can only be used when the Console Output device is the CRT (CO=005) and its line length is set at 64 (see SELECT in the BASIC Language Reference Manual). These are the values automatically set when the system is Master Initialized, but they can be changed with a SELECT statement.

4.14 LISTING PROGRAMS

Listing a Program on the CRT

When a program has been entered, it can be reviewed by using the LIST command. LIST RETURN(EXEC) lists the entire program stored. LIST S RETURN(EXEC) lists the program 16 lines at a time; to see the next 16 lines, touch RETURN(EXEC) again. LIST line no. RETURN(EXEC) lists the specified line only.

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 switch). The SELECT lamp must be lit. Enter on the keyboard:

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

This changes the default output address from the CRT (005) to the printer (215). Then enter:

```
LIST RETURN(EXEC)
```

Output formerly displayed on the CRT is output to the printer. To return output to the CRT, enter:

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

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

Debugging

A number of features to aid in debugging programs are available on your system.

Immediate Mode permits you to interrogate variables at any time during program execution.

Example:

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

Store this program in memory (key in each line and touch RETURN(EXEC)). To execute the program, touch

```
RUN RETURN(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, touch

```
HALT/STEP
```

(this halts program execution) and enter the Immediate Mode statement

PRINT A,B RETURN(EXEC)

Current values of A and B are displayed.

Immediate Mode can be used to change the current value of a variable.

Example:

After performing the previous exercise, enter a value for A in Immediate Mode. For example,

A = 10.51 RETURN(EXEC)

To continue execution starting with line 20, enter

RUN 20 RETURN(EXEC)

Touch HALT/STEP

Enter PRINT A,B RETURN(EXEC)

The new values for A and B are displayed.

An Immediate Mode GOTO can be used to set execution pointers to a particular line; it does not, however, initiate execution, but must be followed by a touch of the HALT/STEP Key. (Using the RUN command without a line number initiates execution at the first program line.)

> NOTE:
>
> An Immediate Mode GOTO cannot be used unless program execution has been initiated once with a RUN command; other use of an Immediate Mode GOTO results in a SYSTEM ERROR! diagnostic.

Example:

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

Store this program in memory (key in each line and touch RETURN(EXEC)). Begin execution by touching

RUN RETURN(EXEC)

The variable D increments continuously; the first line of output is:

10 25 -15 -15

Touch HALT/STEP

to halt program execution. Enter an Immediate Mode GOTO:

GOTO 30 RETURN(EXEC)

This sets the execution pointer at line 30. Touch

HALT/STEP

Line 30 is displayed and executed:

30 D = D + C

Touch HALT/STEP

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

Touch HALT/STEP

The next line is displayed and executed.

50 GOTO 20

To drop out of HALT/STEP Mode, enter CONTINUE RETURN(EXEC).

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

Example:

RUN 20 RETURN(EXEC)

This command starts execution at line 20.

TRACE 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.

Example:

NOTE:

Before beginning this example, clear any other program from memory by entering

CLEAR RETURN(EXEC)

PROGRAM LINE	MEANING
10 A$ = "ABCDEF":K=1	Assigns character string to A$, the value 1 to K.
20 GOTO 40	Branches to line 40.
30 STR(B$,3,K)=A$	Assigns K characters of A$ to character 3 etc. of B$.
40 HEXPRINT A$,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.

Store this program in memory (key in each line and touch RETURN(EXEC)). Turn on Trace Mode by entering:

```
                                TRACE RETURN(EXEC)
```

Execute the program:

```
                                RUN RETURN(EXEC)
```

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 RETURN(EXEC)

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

                                ABCDEF     AB

                                STOP
                                :_
```

```
Enter:                          CONTINUE RETURN(EXEC)

                                TRANSFER TO 30
                                STR(
                                B$=ABCDEF
      TRACE output              41424344454620...
                                20204142432020...
                                R=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 (ERR 41) 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 SELECT and STR in the BASIC Language Reference Manual.

Programmable Pause

Programmable Pause can be used with TRACE to review the tracing of a program without operator intervention.

Example:

Using lines 10 through 70 of the previous program, remove line 60.

```
Enter:          60 RETURN(EXEC)
```

(To view the new version of the program, enter LIST RETURN(EXEC).)

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

```
                TRACE RETURN(EXEC)
```

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

```
                SELECT P3 RETURN(EXEC)
Enter:          RUN RETURN(EXEC)
```

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 Trace Mode, enter:

TRACE OFF RETURN(EXEC)

To remove the pause, enter:

SELECT P RETURN(EXEC)

or SELECT PO RETURN(EXEC)

To rerun, touch RUN RETURN(EXEC)

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

4.15 SUMMARY

You now have the basic information on how to turn on your system, enter program lines and execute programs. See the BASIC Reference Manual for information on all BASIC words, their syntax and meaning, and for the inexperienced user, the Programming in BASIC Manual is recommended reading.

To store programs on tape cassette or disk, see the SAVE and SAVE DC commands in the manuals for cassettes or disk.

5. SYSTEM MANUALS

Several manuals accompany your WCS/20 and provide you with the information necessary to properly and effectively utilize your system. The following information describes the contents of these manuals.

5.1 PROGRAMMING IN BASIC

The Wang Programming in BASIC Manual is provided with your WCS/20 as an introduction to the BASIC language as it is utilized in the system. It is designed for the user who is familiar neither with BASIC, nor with the WCS/20.

The manual is primarily a beginner's introduction to programming in the BASIC language on the System 2200. Starting on the most elementary level, it introduces the reader in a step-by-step fashion to the fundamentals of BASIC, the mechanics of creating programs on a System 2200, and all the concepts and statements needed for competent fundamental programming in BASIC. It presumes no prior knowledge of BASIC or of programming in general.

The reader is urged to try out new statements and programming concepts as they are introduced, and to experiment with example programs by making changes to them, predicting the effects of the changes, and then confirming or correcting one's knowledge based on the observed effects. Example programs are drawn from both commercial and non-commercial or "technical" applications, and there is nothing that can be done from the keyboard that can damage the System. Cautions are included in the text when statements that might destroy on-line data files are introduced. Thus, the reader is able to feel free to experiment at every stage of learning.

5.2 BASIC LANGUAGE REFERENCE MANUAL

In addition to the Wang Programming in BASIC Manual, the BASIC Language Reference Manual is provided with your system. It is not recommended that the Reference Manual be used for instructional purposes. It should be used as a quick refresher once you are familiar with the WCS/20, or as a means of familiarizing yourself with the BASIC language features available on your system (if you are already somewhat familiar with BASIC or programming in general).

Thus the BASIC Language Reference Manual is designed for users who are already quite familiar with a Wang system and its BASIC language. The manual is divided into sections, some of which summarize operational features applicable to the WCS/20 and others which present functionally related BASIC language statements. The non-programmable commands in Section VI and the BASIC statements in Section VII are arranged in alphabetical order for user convenience in locating a desired command or statement, and each statement or command is provided with a General Form (to demonstrate syntax), a Purpose (to describe its function or operation), and some examples.

5.3 MATRIX STATEMENTS

This manual provides quick and concise answers to questions concerning the Matrix Statements Supplement, and assumes that the reader is familiar with the general operation of a Wang system and its BASIC language. Section I provides information on Array Dimensioning, Array Redimensioning, and Matrix Statement Rules, and Section II deals with the operation of the fourteen matrix statements available on the WCS/20.

5.4 GENERAL I/O INSTRUCTION SET

This manual describes the five BASIC language statements that belong to the General I/O Instruction Set, and is designed for readers already familiar with a Wang system and its BASIC language. Chapter 1 gives an overview of the General I/O Instruction Set, while Chapter 2 discusses data conversion using $TRAN, $PACK, or $UNPACK, and Chapter 3 discusses I/O operations using $IF ON and $GIO.

5.5 CHARACTER EDIT REFERENCE MANUAL

This manual provides information concerning the operation of the Character EDIT Mode, and expects that the user who reads this manual is already familiar with a Wang system and its supporting documentation, particularly the BASIC Reference Manual and the Programming in BASIC Manual. A self-teaching approach is followed, and each key used is presented in alphabetical order and described with examples of its operation.

5.6 SORT STATEMENTS

This manual provides information concerning the SORT Statements available on your WCS/20, and assumes the reader is thoroughly familiar with the operation of a Wang system, has access to the BASIC Reference Manual and the Programming in BASIC Manual, and possesses a general knowledge of data processing techniques. Section 1 provides general information on Fundamentals, Arrays, Internal Storage, Sort/Merge Operations, and Descending Sorts, while Section 2 discusses the operation of the Sort Statements which include six matrix statements for flexible and rapid searching, moving and sorting data, and are particularly effective in speeding up sorting, performing multi-file merges, and executing multi-pass searches over large bodies of data.

5.7 DISK MEMORY REFERENCE MANUAL

The Disk Memory Reference Manual covers the physical characteristics of each 2200 Series disk unit, as well as the BASIC instruction set used to control disk operations. Chapter 1 of the manual introduces the concept of random-access storage, and briefly explains the physical hardware of each disk model. Chapters 2-4 cover general information, formatting procedures, and addressing techniques for the disk units. Wang's built-in set of disk file maintenance procedures, collectively known as the Automatic File Cataloging procedures, are explained in Chapters 5 through 8, while a separate group of statements available for directly addressing sectors on disk, the Absolute Sector Addressing procedures, are covered in Chapters 9 and 10. Chapter 11, finally, deals with the operation and programming of the disk multiplexers. Disk timing information, explanations of error messages, maintenance information, a bibliography, and a glossary are collected in the Appendices.

6. SOFTWARE

Wang Laboratories, Inc. provides an extensive software library which is continually being updated and expanded to meet the changing needs of the user. Software currently available in the 2200 Series are also compatible with the WCS/20, thereby making available a vast library of programs that have been developed over the years. The software contained in our library include applications in the areas of Business, Education, Medicine, Public Service, Science, Engineering, Mathematics, and Utilities.

7. OPTIONS AND PERIPHERALS

Memory

Additional 8,192 (8K) byte blocks. (Memory is available in 8K increments from 16K to 32K.)

CPU/Keyboard/Display Options

Option 20	Up to 6 I/O Slots
Option 20A	Up to 9 I/O Slots
Option 31	Audio Signal for 2220 & 2226 CRT
Option 32	Keyboard Clicker
Option 33	24 x 80 CRT

Display Peripheral

Model 2292 Auxiliary Display with 25' cable

Output Peripherals

Model 2201	Output Writer (156 column/15 CPS)
Model 2202	Plotting Output Writer (13 CPS)
Model 2212	Analog Flatbed Plotter (10" x 15")
Model 2221W	Wang Line Printer (132 column/200 CPS)
Model 2231W-1	Line Printer (112 column/120 CPS)
Model 2231W-2	Wang Line Printer (132 column/120 CPS)
Model 2232A/B	Digital Flatbed Plotter (31" x 48")
Model 2232BM	Metric Digital Flatbed Plotter
Model 2251	110 CPS Printer, 40 Characters/Line
Model 2261	High Speed Printer (132 column/330 CPS)
Model 2272-1	Wang Drum Plotter, 16" Wide, Single Pen
Model 2272-2	Wang Drum Plotter, 16" Wide, Three Pens
	Wang Line Printer Controller
Model 2291	Digital Flatbed Plotter Stand

Interface Controllers

Model 2207A	I/O Interface Controller (RS-232-C) Selectable BPS
Model 2227	Asynchronous Telecommunications Controller
Model 2227B	Buffered Asynchronous Communications Controller
Model 2227N	Null Modem for 2227
Model 2228	Communications Controller
Model 2250	I/O Interface Controller (8-bit parallel)
Model 2252A	Scanning Input Interface Controller (BCD 1-10 digit parallel)
Model 2254	IEEE-488 Interface Controller

Input Peripherals

Model 2203	Punched Tape Reader
Model 2214	Mark Sense Card Reader
Model 2234A	Hopper-Feed Punch Card Reader
Model 2244A	Hopper-Feed Mark Sense/Punch Card Reader
Model 2262-1	Digitizer 20" x 20" Tablet
Model 2262-2	Digitizer 30" x 40" Tablet (special order)
Model 2262-3	Digitizer 36" x 48" Tablet (special order)
	Annunciator option for Digitizer

Mass Storage Peripherals

Model 2209	Nine-Track Tape Drive
Model 2217	Single Tape Cassette Drive
Model 2218	Dual Tape Cassette Drive
Model 2224-2	Disk Multiplexer (for 2 CPU's)
Model 2224-3	Disk Multiplexer (for 3 CPU's)

Model 2224-4	Disk Multiplexer (for 4 CPU's)
Model 2230-1	Fixed/Removable Disk Drive 1,228,800 bytes
Model 2230-2	Fixed/Removable Disk Drive 2,457,600 bytes
Model 2230-3	Fixed/Removable Disk Drive 5,013,504 bytes
Model 2230 MXA	Daisy-Chain-Type Disk Multiplexer (1st CPU)
Model 2230 MXB	Daisy-Chain-Type Disk Multiplexer (2nd, 3rd, or 4th CPU)
Model 2260B-1/4	Fixed/Removable Disk Drive (2.5 meg)
Model 2260B-1/2	Fixed/Removable Disk Drive (5 meg)
Model 2260B	Fixed/Removable Disk Drive (10 meg)
Model 2260B-2	Dual 10 Meg Disk System (20 meg)
Model 2270-2	Dual Removable Diskette Disk Drive 524,288 bytes
Model 2270-3	Triple Removable Diskette Disk Drive 786,432 bytes

8. SPECIFICATIONS

WCS/20 Central Processing Unit

*Average Execution Time (Milliseconds)

Add/Subtract	0.8
Multiply	3.8
Divide	7.4
Square Root	46.4
e^x	25.3
$Log_e x$	23.2
y^x	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
Read/Write Cycle	1.6 sec

*Average execution times are determined using random number arguments with 13 digits of precision. Speeds are faster in calculations with arguments of less precision.

CRT 16 lines
64 characters/line

Memory Size: 8K, 16K, 24K and 32K

WCS/20 Diskette Drive

Storage Capacity

Platter	1
Sectors per Platter/Total Sectors	1,024
Bytes per Platter/Total Bytes	262,144

(up to 3 drives with a total of 786,432 bytes storage)

Performance

Rotation Speed	375 RPM

Access Time (Position Head to Track)
Minimum (one track). . . . . .15 ms
Average (across one-half available tracks) . . . .401 ms
Maximum (across all available tracks). . . . . .803 ms

Latency Time (Platter Rotation to Sector on Track)
Average (one sector read/write one-half revolution). . . . . .80 ms
Additional sectors in the same revolution. . . . .40 ms

Read/Write Time
One 256-byte sector (including CPU/controller overhead). . . . . .21.8 ms

MOVE/COPY TIME (Entire Disk Platter)
Approx 2 min

Size of WCS/20 Console & CPU & Storage
Height. . . . . .40 in. (101.6 cm)
Depth . . . . . .30 in. (76.2 cm)
Width . . . . . .46 in. (176.84 cm)

Weight
189 lb (85.6 kg)(approx)

Power Requirements
115 or 230 VAC +10%
50 or 60 Hz ± 1/2 Hz

Wattage: 425W

Fuses

Cabinet	10A (115V and 230V)
CPU	3ASB (115V)
	1.5ASB (230V)
Diskette	4A (115V and 230V)
CRT/Keyboard	1.5SB (115V)
	1ASB (230V)

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

9. PREVENTIVE MAINTENANCE INFORMATION

It is recommended that your equipment be serviced annually. Wang Laboratories offers a Maintenance Agreement which automatically ensures proper servicing. If no Maintenance Agreement is acquired, all servicing must be requested by the customer. A Maintenance Agreement protects your investment and offers the following benefits:

Preventive Maintenance

Annually, your equipment is inspected for worn parts, lubricated, cleaned, and updated with engineering changes, if any. Preventive maintenance minimizes "downtime" by anticipating repairs before they are necessary.

Fixed Annual Cost:

When you buy a Maintenance Agreement, you issue only one purchase order for service for an entire year and receive one annual billing, or more frequent billing, if desired.

Further information regarding your Maintenance Agreement can be acquired from your local Wang Sales/Service Office.

NOTE:

Wang Laboratories, Inc. can neither guarantee nor honor maintenance agreements for any equipment modified by the user. Damage to equipment incurred as a result of such modification becomes the financial responsibility of the user.

10. CONCLUSION

We are sure you will find your WCS/20, both in workmanship and user-design features, to be the finest small computer available. If for any reason you need assistance in the operation of your system or if you have any comments or suggestions, please do not hesitate to use the (self-mailer) Customer Comment Form provided for your convenience on the last page of your manuals.

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.

700-3854A

TITLE OF MANUAL: **WCS/20 INTRODUCTION AND INSTALLATION GUIDE**

COMMENTS:

Fold

Fold

(Please tape. Postal regulations prohibit the use of staples.)

WANG

Fold

FIRST CLASS
PERMIT NO. 16
Tewksbury, Mass.

BUSINESS REPLY MAIL
NO POSTAGE STAMP NECESSARY IF MAILED IN THE UNITED STATES

– POSTAGE WILL BE PAID BY –

WANG LABORATORIES, INC.
ONE INDUSTRIAL AVENUE
LOWELL, MASSACHUSETTS 01851

Attention: Marketing Department

Fold

Cut along dotted line.

Printed in U.S.A.

WANG COMPUTER PTY. LTD.
55 Herbert Street
St. Leonards, 2065, Australia
TELEPHONE 439-3511
Telex: 25469

WANG GESELLSCHAFT M.B.H.
Merlingengasse 7
A-1120 Vienna, Austria
TELEPHONE 85.85.33
Telex: 74640 Wang a

WANG EUROPE S.A./N.V.
250, Avenue Louise
1050 Brussels, Belgium
TELEPHONE 02/6400617
Telex: 61186

WANG DO BRASIL COMPUTADORES LTDA.
Rua Barao de Lucena No. 32
Botafogo ZC-01 20,000
Rio de Janeiro RJ, Brasil
TELEPHONE 226-4326, 266-5364
Telex: 2123296 WANG BR

WANG LABORATORIES (CANADA) LTD.
49 Valleybrook Drive
Don Mills, Ontario M3B 2S6
TELEPHONE (416) 449-2175
Telex: 069-66546

WANG FRANCE S.A.R.L.
Tour Gallieni, 1
78/80 Ave. Gallieni
93170 Bagnolet, France
TELEPHONE 33.1.3602211
Telex: 680958F

WANG PACIFIC LTD.
9th Floor, Lap Heng House
47-50 Gloucester Road
Hong Kong
TELEPHONE 5-274641
Telex: 74879 WANG HX

WANG COMPUTER LTD.
Shindaiso Building No. 5
2-10-7 Dogenzaka Shibuya-Ku
Tokyo 150, Japan
TELEPHONE (03) 464-0644
Telex: 2424909WCLTKO J

WANG NEDERLAND B.V.
Damstraat 2
Utrecht, Netherlands
(030) 93-09-47
Telex: 47579

WANG COMPUTER LTD.
302 Great North Road
Grey Lynn, Auckland
New Zealand
TELEPHONE Auckland 762-219
Telex: CAPENG 2826

WANG DE PANAMA (CPEC) S.A.
Apartado 6425
Calle 45E, No. 9N. Bella Vista
Panama 5, Panama
TELEPHONE 69-0855, 69-0857
Telex: 3282243

WANG COMPUTER PTE., LTD.
Suite 1801-1808, 18th Floor
Tunas Building, 114 Anson Road
Singapore 2, Republic of Singapore
TELEPHONE 2218044, 45, 46
Telex: RS 24160 WANGSIN

WANG COMPUTERS (SO. AFRICA) PTY. LTD.
Corner of Allen Rd. & Garden St.
Bordeaux, Transvaal
Republic of South Africa
TELEPHONE (011) 48-6123
Telex: 960-86297

WANG SKANDINAVISKA AB
Pyramidvaegen 9A
S-171 36 Solna, Sweden
TELEPHONE 08/27 27 98
Telex: 11498

WANG S.A./A.G.
Markusstrasse 20
CH-8042 Zurich 6, Switzerland
TELEPHONE 41-1-60 50 20
Telex: 59151

WANG INDUSTRIAL CO., LTD.
7 Tun Hwa South Road
Sun Start Tun Hwa Bldg.
Taipei, Taiwan
Republic of China
TELEPHONE 7522068, 7814181-3
Telex: 21713

WANG ELECTRONICS LTD.
Argyle House, 3rd Floor
Joel Street
Northwood Hills
Middlesex, HA6INS
TELEPHONE Northwood 28211
Telex: 923498

WANG LABORATORIES GmbH
Moselstrasse 4
6000 Frankfurt AM Main
West Germany
TELEPHONE (0611) 252061
Telex: 04-16246

DATA CENTER DIVISION
20 South Avenue
Burlington, Massachusetts 01803
TELEPHONE (617) 272-8550

WANG COMPUTER SERVICES
One Industrial Avenue
Lowell, Massachusetts 01851
TELEPHONE (617) 851-4111
TWX 710-343-6769
Telex: 94-7421

WANG INTERNATIONAL TRADE, INC.
One Industrial Avenue
Lowell, Massachusetts 01851
TELEPHONE (617) 851-4111
TWX 710-343-6769
Telex: 94-7421

WANG LABORATORIES, INC.

ONE INDUSTRIAL AVENUE, LOWELL, MASSACHUSETTS 01851, TEL. (617) 851-4111, TWX 710 343-6769, TELEX 94-7421

Printed in U.S.A.
700-3854A
2-77-1M