

WANG

2200
INTRODUCTORY
MANUAL

SYSTEM 2200





2200 Introductory Manual

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LABORATORIES, INC.

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HOW TO USE THIS MANUAL

This manual has been provided as an introduction to your Wang System. It gives information on the CRT's (video displays) and the keyboards available and provides instructions for their operation. Auxiliary hardware such as the extended chassis and the auxiliary display are also described.

It is intended that this manual provide sufficient information for the new user to turn on and operate his system. Additional documents that should be available are:

- The Wang BASIC Language Reference Manual
- The Device Address Guide (card)
- The System 2200 Summary of syntax (card)
- The BASIC Programming Manual

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1. INTRODUCTION

Your Wang System contains a visual display unit (the CRT) and a keyboard for direct communication with your Central Processing Unit (CPU). Systems can additionally contain tape cassette drives, disk units, plotters, digitizers, etc.

UNPACKING, INSPECTION AND INSTALLATION

Your system must be unpacked, inspected and installed by your Wang Service Representative. Upon receipt of your system, 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.

2. THE WANG FAMILY OF 2200 COMPUTERS

The following Wang 2200 Systems in which the BASIC language is used for programming are available:

System	Base RAM	Upgradeable to
2200A	4K	32K in 4 or 8K increments
2200B	4K	32K in 4 or 8K increments
2200C	4K	32K in 4 or 8K increments
2200S	4K	8,12,16,24 or 32K
2200T	4K	8, 12, 16, 24 or 32K

The BASIC language instruction sets in these systems are not identical; they are defined in the BASIC Language Reference Manual. The systems have the following standard CPU's and can support different peripherals. All can obtain the Audio Alarm and an Upper/Lowercase CRT as options.

System	Standard CPU	Supports	ROM Options
2200A	'A' Statements	Keyboard, CRT, Printing Devices Tape Cassette Drives Interface and Telecommunications Controllers (limited use) Card Readers and Digitizer (limited)	Edit
2200B	'A' Statements DATALOAD BT, DATASAVE BT Data Manipulation Statements* HEXPRINT,KEYIN,ON,PLOT Disk Statements	All Peripherals	Edit Matrix [†] or Sort [‡] Statements General I/O Statements [§]
2200C	'B' Statements COM CLEAR, DEFFN' HEX ON ERROR, RETURN CLEAR Edit	All Peripherals	Matrix [†] or Sort [‡] Statements General I/O Statements [§]
2200S	'A' Statements CONVERT, HEXPRINT, KEYIN,ON RETURN CLEAR Edit	'A' Configurations	Matrix [†] Statements General I/O Statements [§] , Data Manipulation* plus BT Statements Disk plus Sort [‡] Statements
2200T	'C' Statements Edit Matrix [†] Statements General I/O Statements [§] Sort [‡] Statements	All Peripherals	None (standard unit equivalent to 2200S with all ROM options).

*ADD, AND, BIN, BOOL, CONVERT, HEXPRINT, INIT, NUM, OR, PACK, POS, ROTATE, UNPACK, VAL, XOR
[†] MAT +; MAT CON; MAT =; MAT IDN; MAT INV,D; MAT*; MAT READ; MAT()*; MAT-; MAT TRN; MAT INPUT;
 MAT PRINT; MAT REDIM; MAT ZER
[‡] MAT CONVERT, MAT COPY, MAT MERGE, MAT MOVE, MAT SEARCH, MAT SORT
[§] \$GIO, \$IFON, \$PACK, \$UNPACK, \$TRAN

3. THE SYSTEM 2200 (2200A, 2200B, 2200C, 2200S, 2200T)

Your System 2200 contains either a Model 2220 Integrated Console (Figure 1), a Model 2226 CRT/Keyboard Console (Figure 2) or a Model 2216 CRT Executive Display (Figure 3).



Figure 1. The Model 2220 Integrated Console



Figure 2. The Model 2226 CRT/Keyboard Console



Figure 3. The Model 2216 CRT Executive Display

A Model 2220 or 2216 can contain a tape cassette drive (the Model 2217 Single Tape Cassette Drive).

4. THE CENTRAL PROCESSOR

The CPU (Central Processing Unit) of your system consists of four parts, a central processor, a control memory (containing the BASIC interpreter), data memory (Random Access Memory (RAM)) and a set of I/O (input/output) controllers. User RAM can be increased up to 32K bytes, (In your Wang System 2200, one byte contains eight bits.) To interface control memory and RAM, approximately 700 bytes of RAM are used for 'housekeeping'. A Power Supply provides the voltage necessary to run the system.

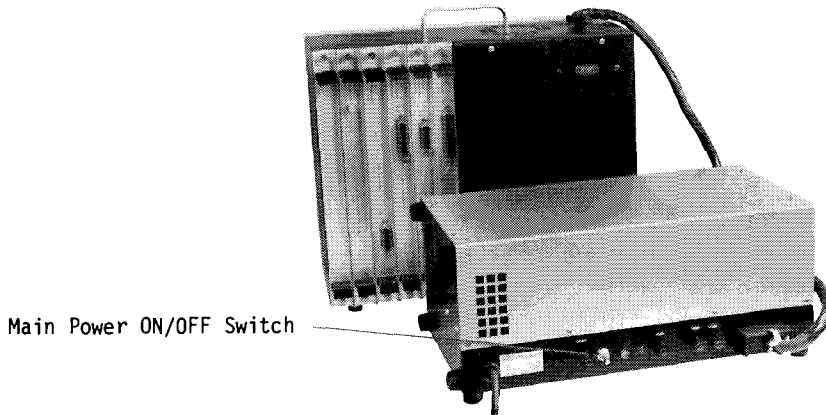


Figure 4. A System 2200 CPU and Power Supply

5. THE I/O CONTROLLERS

In the same chassis as the CPU are controllers for the I/O devices. Every peripheral attached to your CPU such as keyboards, the video display, tape and disk drives, etc., is directly connected to the CPU via its own controller interface. In general, only one peripheral device can use a given controller, although certain controllers can be used with more than one device. For example, any one of three printers (Models 2221, 2231 or 2261) can be attached to the multi-purpose printer controller. A controller generally has the model numbers of devices to which it can be attached written on its face plate.

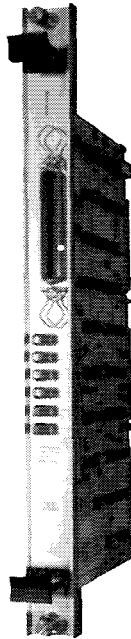


Figure 5. A System 2200 I/O Controller

Once a controller is installed in the CPU, its face-plate screws are tightened, the appropriate peripheral cable is attached to it and its lock clips are locked.

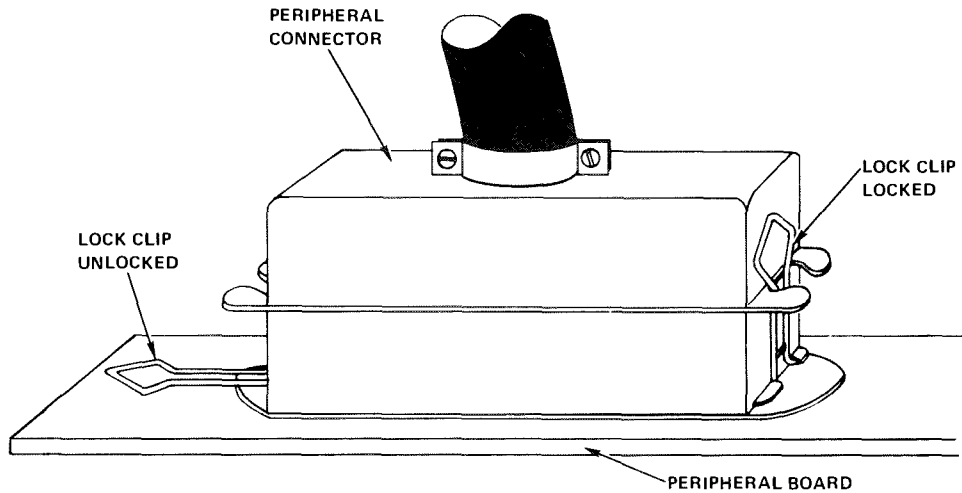


Figure 6. A Controller Face-Plate Showing Lock Clips

To provide flexibility for arranging system configurations, chassis containing from three to eleven I/O slots are available in a System 2200.

In any standard System 2200A, B or C a minimum chassis contains six I/O slots. Any of these systems can be provided with Model 2219, the I/O Extended Chassis, which contains five additional I/O slots (for a total of eleven).

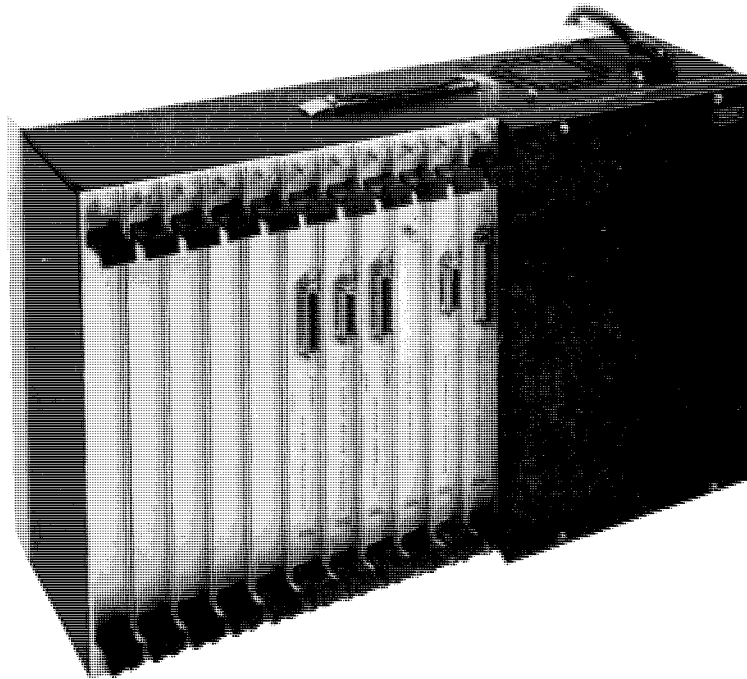


Figure 7. Model 2219 I/O Extended Chassis

A minimum chassis containing three I/O slots is provided with a standard System 2200S or T.

A System 2200S or T can contain a total of six I/O slots with the addition of Option 20, or nine I/O slots with the addition of Option 20A.

6. THE CRT VIDEO DISPLAY

The CRT 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 the 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.

MOVING THE CURSOR

Cursor movement commands can be issued to the CRT using a PRINT HEX statement (see PRINT HEX*):

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).

Example:

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

This routine produces the following output on the CRT:

```
AAAAA  
BBBBB  
  
ZZZZZ  
11111  
22222  
*****&&&&&/&
```

*In the BASIC Language Reference Manual

USING THE CURSOR WITH THE EDIT KEYS

All system keyboards contain the Edit Mode Keys which are convenient for rapid editing of program text or data being input. Their operations are:

<u>Key</u>	<u>Operation</u>
EDIT	used to enter EDIT mode; when pressed, an asterisk replaces the usual colon at the beginning of the current line.
RECALL	used to recall a program line from memory to be edited.
← - - -	moves the cursor five spaces to the left.
←	moves the cursor a single space to the left.
- - - →	moves the cursor five spaces to the right.
→	moves the cursor a single space to the right.
INSERT	expands a line for additional text or data entry by inserting a space character prior to current cursor position.
DELETE	deletes the character at the current cursor position.
ERASE	erases a line from the current cursor position to the end of the line.

NOTE

The Edit Mode keys operate as described as long as the CRT is the Console Output (CO) device and is selected with a line length of 64 (see SELECT*). The CRT is the default device for CO set when the system is Master Initialized (see Turn-On Procedure and System Operation).

When the system is in EDIT Mode, an asterisk (*) replaces the usual colon which appears at the beginning of a program line.

NOTE:

These keys do not operate in the manner described on a System 2200A or 2200B unless Option 3, the Character Edit ROM is available. On such systems, the keys are Special Function keys only; the right-most EDIT key must not be used.

The use of these keys is more fully described in the BASIC Language Reference Manual.

CLEANING THE CRT SCREEN

The CRT screen should be cleaned periodically with a damp cloth using a mild soap and water. 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.

NOTE:

On systems which contain the Audio Alarm (Option 4 or Option 31), HEX code (07) activates the alarm tone.

*In the BASIC Language Reference Manual

UPPER/LOWER CASE CHARACTERS

The Model 2216A, and both the Model 2220 and the Model 2226 with Option 31 have the capability to display both upper and lowercase characters. To input both upper and lowercase text, with any keyboard containing an A/A to A/a or Keyword/A to A/a toggle switch, place the keyboard in A/a mode. With the keyboard in Keyword/A mode, only uppercase letters can be input. Lowercase characters can also be generated as alphanumeric literals within single quotes, so long as the output device to which the characters are sent has the upper/lowercase capability.

For the complete character set available on Wang System CRT's, see the appendix of ASCII codes in the BASIC Language Reference Manual.

NOTE:

BASIC programs must be input in all uppercase letters.

THE AUDIO ALARM

This alarm can be turned on only under program control using the code HEX(07) (ASCII Bell Code). Receipt of this code by the CRT causes a 960 Hz beep for a fraction of a second. The display is not affected. A sequence of codes can be transmitted to produce a longer signal or a series of beeps.

There are a variety of uses for this option in your system. Some examples are:

1. Data entry applications: An operator, when entering data, often may be reading a data sheet instead of reviewing the CRT screen for error messages. Therefore, if the data is validated under program control, the alarm code can be sent when errors occur to gain the operator's attention. For example, numeric data can be INPUT* into an alphanumeric variable, tested for numerics (with the NUM* function), converted to internal numeric form (CONVERT*), and then validated for proper range; at each point the alarm can be used to indicate an error condition.

NOTE:

The audio alarm is not automatically activated for system-generated errors (e.g., ERR 02, etc.).

2. In a telecommunication system: The audio alarm can be used to notify an operator of an incoming message or completion of transmission, by having the alarm code transmitted over the line to the receiver, just before or just after the message is sent.
3. The alarm can be used to signal completion of a program or a segment of a program. By programming the alarm to go off at program termination, an operator does not have to "baby-sit" the equipment waiting for program completion.

*See the BASIC Language Reference Manual

THE MODEL 2292 AUXILIARY DISPLAY

In addition to the console display unit, a peripheral slave display can be attached to your system (see Figure 8). It receives all material displayed on the console display unit and can be stationed up to 500 feet away from your CPU with the appropriate cable. Up to twelve slave displays can be attached to the system.

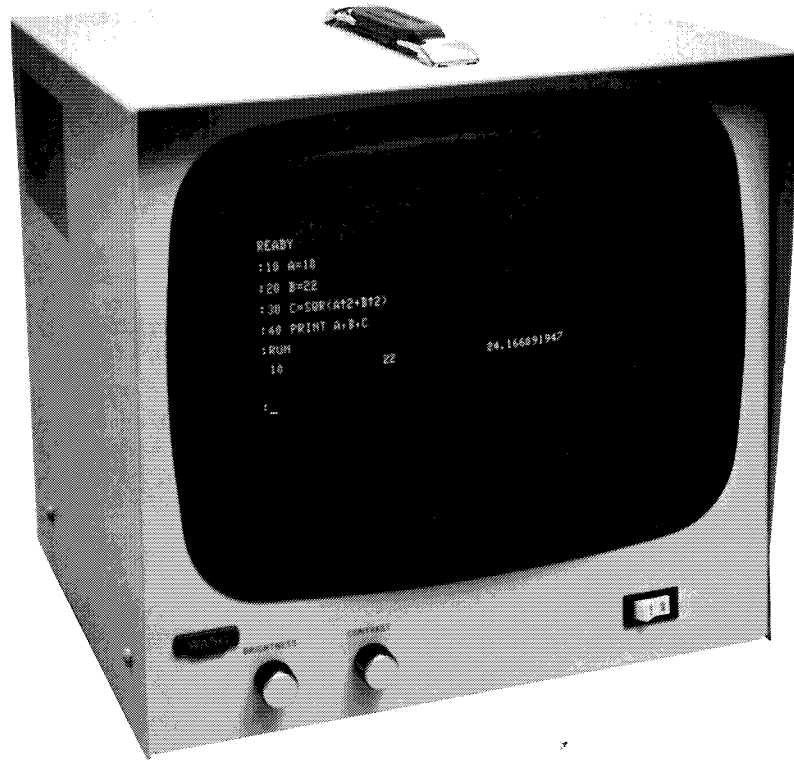


Figure 8. The Model 2292 Auxiliary Display

7. KEYBOARDS

With a System 2200A, B, C or T you can obtain any of the three keyboards described below. With a 2200S, the usual configuration contains the Model 2223 keyboard.

THE MODEL 2215 BASIC KEYWORD KEYBOARD

This keyboard permits most BASIC language words to be entered by single keystrokes. For example, pressing the



key causes the entire word "PRINT" to be entered.



Uppercase characters can be entered by touching the key containing the desired symbol or function. The SHIFT LOCK key (upper left corner) causes the SHIFT to remain on while any number of upper case keys are entered; the SHIFT can be subsequently turned off by touching either SHIFT key. Alternatively, if several uppercase characters are to be entered, the SHIFT key can be held down as on a typewriter.

Certain keys cause immediate action and do not require an EXEC key for execution. They are: RESET, HALT/STEP, Special Function Keys, Edit Mode Keys, LINE ERASE, STMT NUMBER, BACKSPACE and SPACE .

The keyboard is divided into four zones.

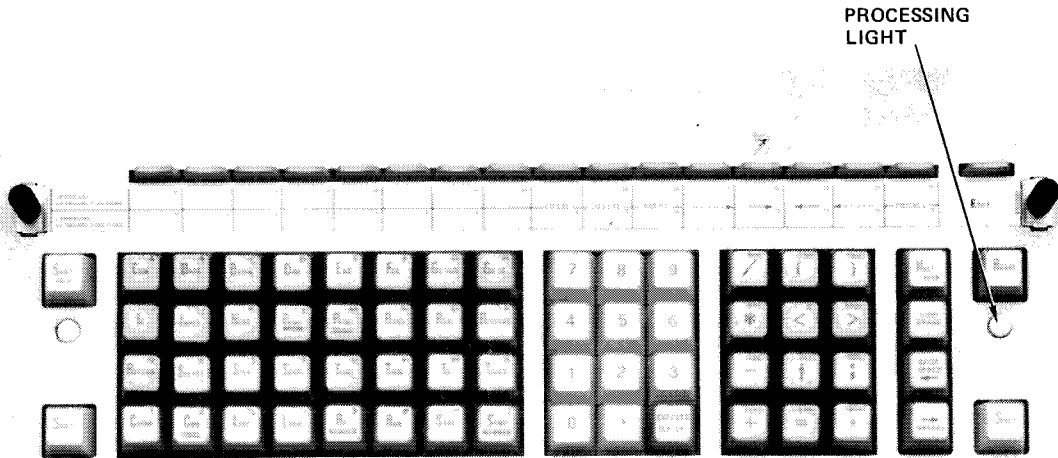









Figure 9. The Model 2215 BASIC Keyword Keyboard

- ZONE 1 The first zone contains the alphabetic and special character keys, most BASIC language words, and the statement number key.
-  Enters a line number for the next line to be entered; the highest line number + 10.
- ZONE 2 The second zone consists of the numeric entry keys, the arithmetic operators, mathematical functions and punctuation, and the EXECUTE CR/LF key.
-  Causes the line just keyed in to be processed by the system and/or stored in memory.
- ZONE 3 Zone 3 consists of the following special keys, used for entry, system and program control:
-  Immediately stops program execution or listing and I/O operations, clears the CRT screen and returns control to the user (Console Input Mode); leaves program text and variables intact. (Should not generally be used to terminate program execution; HALT/STEP should be used for this purpose.) Must be used after disk formatting.
-  Terminates program execution at the completion of the current program statement or executes the program line by line each time the key is touched.
-  Removes the line currently being entered.
-  Removes the last character or keyword entered.
-  Enters a space character.
- ZONE 4 The processing light is on when processing is going on in the CPU.
 Zone 4 contains 16 user defined Special Function Keys for access of up to 32 subroutines or text entry operations, and the Edit Mode keys. If this keyboard is used on a system without an Edit ROM, these keys operate only as Special Function Keys; the right-most Edit key must not be used.

THE MODEL 2222 ALPHANUMERIC TYPEWRITER KEYBOARD

This keyboard is designed for users who are already familiar with a standard typewriter, or for those users whose applications require large amounts of alpha input. It is divided into four major zones which are similar to the zones of the Model 2215; the differences lie in the way BASIC words are generated. With the Model 2222 most BASIC language words must be keyed in one character at a time (as on a typewriter), unlike the keyword section of the Model 2215 or 2223 where one keystroke can generate an entire word. Either way, however, the keyword takes up the same amount of space in memory. Certain keys cause immediate action and do not require an EXEC key for execution. They are: RESET, HALT/STEP, Special Function Keys, Edit Mode Keys, BACKSPACE, space bar, INDEX/REV INDEX, LINE ERASE.

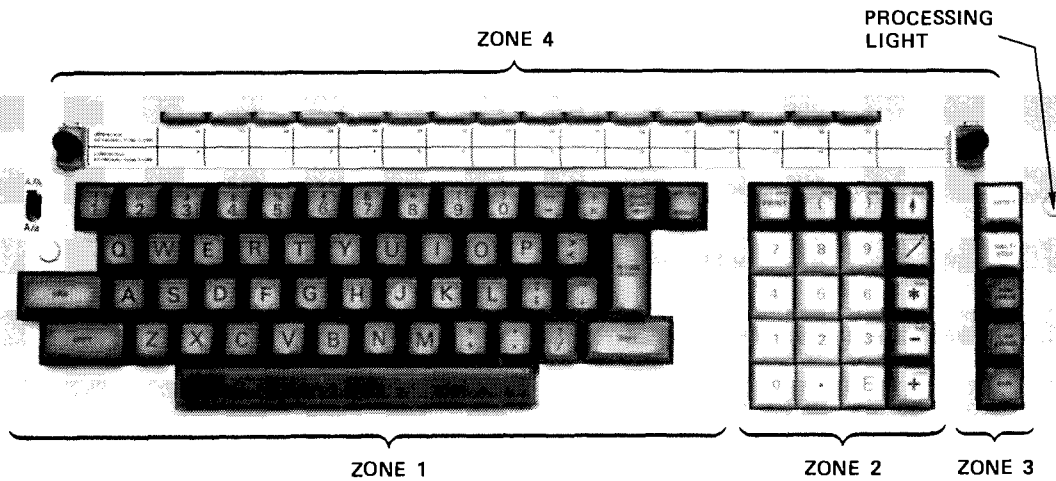


Figure 10. The Model 2222 Alpha-Numeric Typewriter Keyboard

ZONE 1 Zone 1 of this keyboard is very similar to a Selectric® typewriter keyboard. It includes all alpha characters, both upper and lowercase letters, numbers 0 through 9, and all of the available special characters.

Alpha Control Switch An integral part of Zone 1 is the A/A to A/a Switch.

Down Position When the toggle switch is in the down position, the keyboard acts as a standard typewriter keyboard.

Up Position When the switch is in the up position, only uppercase alpha characters are generated regardless of the position of the shift key; this in no way changes the input capabilities of the other keys on the keyboard. For uppercase keys other than alpha characters, the shift key must be used. This is the normal

setting when entering BASIC programs, since BASIC statements and variables must be entered with uppercase alphabetic characters.

RETURN
(EXEC)

Causes the line just keyed in to be processed by the system and stored in memory.

BACK
SPACE

Removes the last character or keyword entered.

ZONE 2

Zone 2 contains all the numeric entry keys and arithmetic operators, along with a number of math functions. Immediate Mode calculations can be generated using the PRINT key followed by a legal expression. This set of keys is a "scratch pad" calculator for Immediate Mode calculations; these keys can also be used to enter program line numbers, numbers and functions.

ZONE 3

Zone 3 consists of the following keys used for program and system control.

RESET

Immediately stops program execution or listing and I/O Operations, clears the CRT screen and returns control to the user (Console Input Mode); leaves program text and variables intact. (Should not generally be used to terminate program execution; HALT/STEP should be used for this purpose.) Must be used after disk formatting.

HALT/
STEP

Terminates program execution at the completion of the current program statement or executes the program line by line each time the key is touched.

LINE
ERASE

Removes the line currently being entered.

CONTINUE

Continues program execution after a STOP verb has been executed or the HALT/STEP key has been touched.

RUN

Initiates execution of the user's program.

The processing light is on when processing is going on in the CPU.

NOTE:

CONTINUE and RUN must be followed by RETURN(EXEC).

ZONE 4

Zone 4 consists of 16 user defined special function keys for access of up to 32 subroutines or text entry operations, and the Edit Mode Keys.

NOTE:

Edit Mode Keys do not operate on a System 2200A or B unless Option 3 is available. Without the Edit ROM the right-most Edit Key must not be used.

THE MODEL 2223 ALPHANUMERIC/BASIC KEYWORD KEYBOARD

The Model 2223 Alphanumeric/BASIC Keyword Keyboard provides two modes of operation for entering data and programs into the Central Processing Unit (CPU). 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 must be 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. Lowercase characters cannot be obtained without the lowercase capability in the CRT or output device.

Certain keys on the Model 2223 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.

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)). STMT NUMBER enters a line number for the next line to be keyed in; the highest line number +10. LINE ERASE removes the current line; BACKSPACE removes the current character or keyword.
- 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 verb or having used HALT/STEP. Must be followed by a RETURN(EXEC). |
| CLEAR | Followed by no parameters, clears all program text and variables; followed by V, removes all variables from memory; followed by N, removes all non-common variables from memory; followed by P, removes program text but not variables. Must be followed by RETURN(EXEC) (also see the BASIC Language Reference Manual). |
| LOAD | Loads a program from currently selected tape unit into memory. Must be followed by RETURN(EXEC). |
| RUN | Initiates execution of user program which is in memory. Must be followed by RETURN(EXEC). |

The processing light is on when processing is going on in the CPU.

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 strings of text characters.

Contains the EDIT Mode keys which permit discrete line editing, and the RESET pushbutton switch. The RESET button (upper right), 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 should not generally be used to terminate program execution; HALT/STEP should be used for this purpose. RESET must be used after disk formatting.

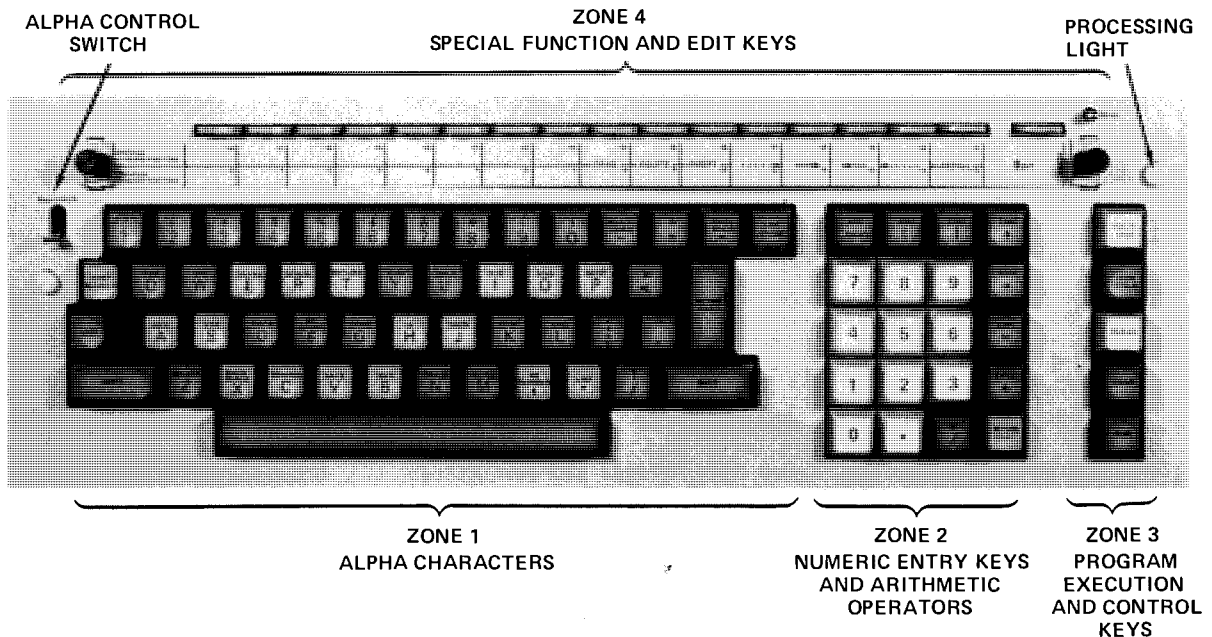


Figure 11. The Model 2223 Keyboard

Each of the keywords on the Model 2223 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 BACK SPACE keys in Zone 1; that in the upper right of Zone 1 is used to backspace the cursor and that in the lower left, to backspace a file or record on tape.

When entering programs with the Model 2223 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.

8. TURN-ON PROCEDURE FOR ANY SYSTEM 2200

1. Verify that all units are properly connected and attached to a source of electric power.
2. Turn on power switches on all peripherals* (printers, console, tape drives, etc.).
3. Turn on the Power Supply (lamp on Power supply is lit).
4. This procedure Master Initializes the system; :READY appears on the display after about 15 seconds .

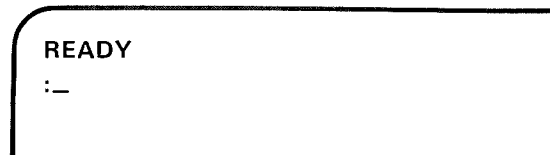


Figure 12. The READY Display

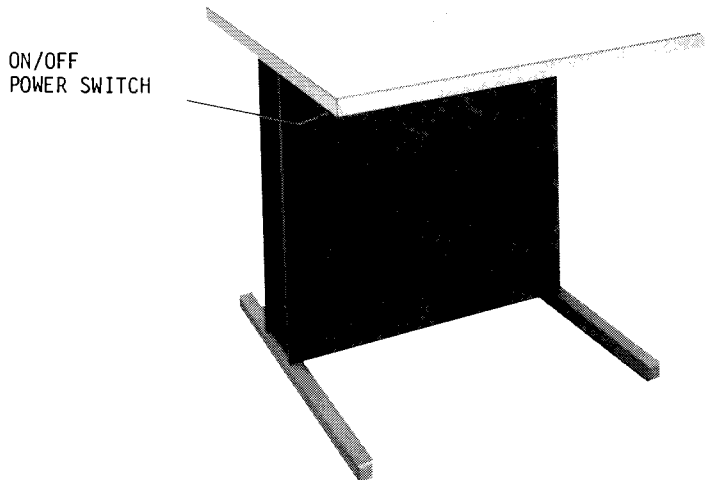
5. Your System 2200 is now ready to use.

NOTE:

If the READY display does not appear, touch the RESET button or Key; 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 normal operation is not restored, call your Wang Service Representative.

***NOTE:**

If your System 2200 has a Model 2290 CPU/Peripheral Stand to which all peripherals are attached and which holds both the CPU and the Power Supply, your entire system can be turned on and Master Initialized with a single switch, located under the left front corner of the table.



9. SYSTEM OPERATION

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:

<u>Primary Device</u>	<u>Default Address</u>
Keyboard	001
CRT	005
Cassette Drive	10A
Disk Drive	310
Plotter	413

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

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

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

THE EXECUTE KEY

The Execute Key is used to terminate every line input to the system. Depending upon the available keyboard, it looks like:

RETURN (EXEC)

 or

EXECUTE CR/LF

Throughout this manual it is referred to as the EXEC key; in the BASIC Language Reference Manual it is usually referred to as CR/LF - EXECUTE (carriage return/ line feed).

To input a program line, enter the line number, the program text and touch EXEC.

Example:

EXEC

10 A = 10

To do a quick calculation (for example, to evaluate the expression $25 + 25 = ?$), enter the PRINT verb, the necessary text and touch EXEC.

Example:

EXEC

PRINT 25 + 25

SPACING

Spaces are customarily used between characters in a line for readability; the system ignores them. For example, 10 READ A, B, C, D is easier to read than 10READA,B,C,D. Both are clear to the system, however.

*In the BASIC Language Reference Manual

TWO 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 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
```



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

Once a line is entered and the EXEC key is depressed, the system checks the line for syntax and, providing there are no syntax errors, immediately executes the line. The line 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)	PRINT USING	RETURN CLEAR
GOSUB	KEYIN	READ	STOP

Program Mode

In Program Mode, each line must be preceded by a line number of 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 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; the line has nevertheless been stored in memory. The line can be corrected by re-entering the line number and the program text, or by using Edit Mode with the Edit Keys. For example,

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

+ ERR10 is displayed (1A is not a legal BASIC variable.)

:_

Touch EDIT * (To enter Edit Mode.)
10 *10 (Asterisk replaces colon.)
RECALL (To recall the line from memory.)


* 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  to re-store 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; the up-arrow points to the keyword in error. Control 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 (not on all keyboards) which generates line numbers in increments of ten. Line numbers must not be preceded by spaces.

Example:

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

The RENUMBER* facility can be used to renumber automatically all lines in a stored program in specifiable increments.

WHAT IS A KEYSTROKE?

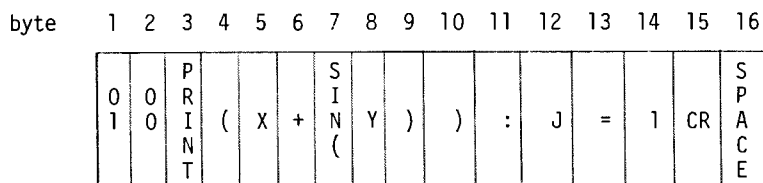
A keystroke is a depression of a single key on the keyboard. On certain keyboards, the keys contain not only the entire alphabet, all the decimal digits and many special characters (such as \$, #, %, etc.) but also complete BASIC words. On such keyboards, an entire BASIC word (such as PRINT or PRINTUSING) can be entered with a single keystroke. A BASIC word can always be entered character by character and is generally stored in memory in a single byte (some BASIC words require two bytes).

WHAT IS 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:



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

*See the BASIC Language Reference Manual

WHAT IS 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
```

WHAT IS A BASIC COMMAND?

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

Examples:

```
RUN
LOAD "PROG1"
SAVE
```

WHAT IS 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.

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 EXEC key. As each character is keyed in on the keyboard it is held in the keyboard buffer. When EXEC is touched, the entire line is sent to the CPU and saved.

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

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).

Example:

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

} program in
memory

Touch . 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 re-execution.

Example:

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

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
                ↑ERR 03
```

Note that 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.)

EDITING PROGRAMS

Deleting a Program Line

An existing program line can be deleted by entering its line number and touching .

Example:

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

To delete line 30, enter:

30

Replacing and Changing a Line

An existing line can be replaced by entering its line number, the new text and touching . The previous version of the line is destroyed. A line 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 ← Key to position the
 cursor under the 7. *PRINT 1000 - 714

Enter 4. *PRINT 1000 - 414

Touch 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 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 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. :10 PRINT 1000 - 414
(Move cursor, enter 4, : _
touch EXEC).

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.

LISTING PROGRAMS

Listing a Program on the CRT

When a program has been entered, it can be reviewed by using the LIST command. LIST EXEC lists the entire program stored. LIST S EXEC lists the program 16 lines at a time; to see the next 16 lines, touch EXEC again.

LIST line no. 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 EXEC .

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

LIST EXEC

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

SELECT LIST 005 EXEC

Further discussion of the SELECT statement and its various parameters can be found in the BASIC 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 GO TO 20
```

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

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

HALT/STEP

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

PRINT A, B 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

To continue execution starting with line 20, enter

RUN 20

Touch

Enter PRINT A, B

The new values for A and B are displayed.

An Immediate Mode GOTO can be used to set execution pointers to a particular line once execution has been initiated with a RUN command. The Immediate Mode GOTO 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). Begin execution by touching

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

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

Touch

to halt program execution. Enter an Immediate Mode GOTO:

GO TO 30

This sets the execution pointer at line 30. Touch

Line 30 is displayed and executed:

Touch

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

The next line is displayed and executed. (The value in the last column depends on how many loops have been completed.)

```
10      25      -15      -1065
```

Touch

The next line is displayed and executed.

```
50 GOTO 20
```

To drop out of HALT/STEP mode, enter

(You can use the CONTINUE key, if it is available on your keyboard, or enter CONTINUE character by character.)

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

Example:
 RUN 20

This command starts execution at line 20; program resolution occurs normally.

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 .

You can use the CLEAR key if it is available on your keyboard.

PROGRAM LINE	MEANING
10 A\$ = "ABCDEF":K = 1	Assigns character string to A\$, the value 1 to K.
20 GO TO 40	Branches to line 40.
30 STR (B\$, 3, K) = A\$	Assigns K characters of A\$ to 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 EXEC). Turn on Trace Mode by entering:

TRACE

Execute the program: RUN

The first display is:

```

TRACE output - - - - -> A$ = ABCDEF
TRACE output - - - - -> K = 1
TRACE output - - - - -> TRANSFER TO 40
program output - - - - -> 414243444546202020202020202020
program output - - - - -> 202020202020202020202020202020
TRACE output - - - - -> K = 2
program output - - - - -> ABCDEF
program output - - - - -> STOP
:

```

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

```

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

```

```

Enter: CONTINUE EXEC

```

```

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

```

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

Note:

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

30 STR(B\$,3,15)

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

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 EXEC

```

(To view the new version of the program, enter

```

LIST EXEC )

```

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

```

TRACE EXEC

```

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

```

SELECT P3 EXEC

```

```

Enter: RUN 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 EXEC

To remove the pause, enter:

SELECT P EXEC

or

SELECT PO EXEC

To rerun, touch

RUN EXEC

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

SUMMARY

You now have the primary 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 meanings and the System 2200 Summary (card) which provides syntax and error messages in abbreviated form. The Device Address Guide (card) provides further information on addresses used with Wang peripherals in SELECT statements. For the inexperienced user, the Wang BASIC Programming 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.



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Printed in U.S.A.
700-3687A
10-76-2.5M

Price: see current list