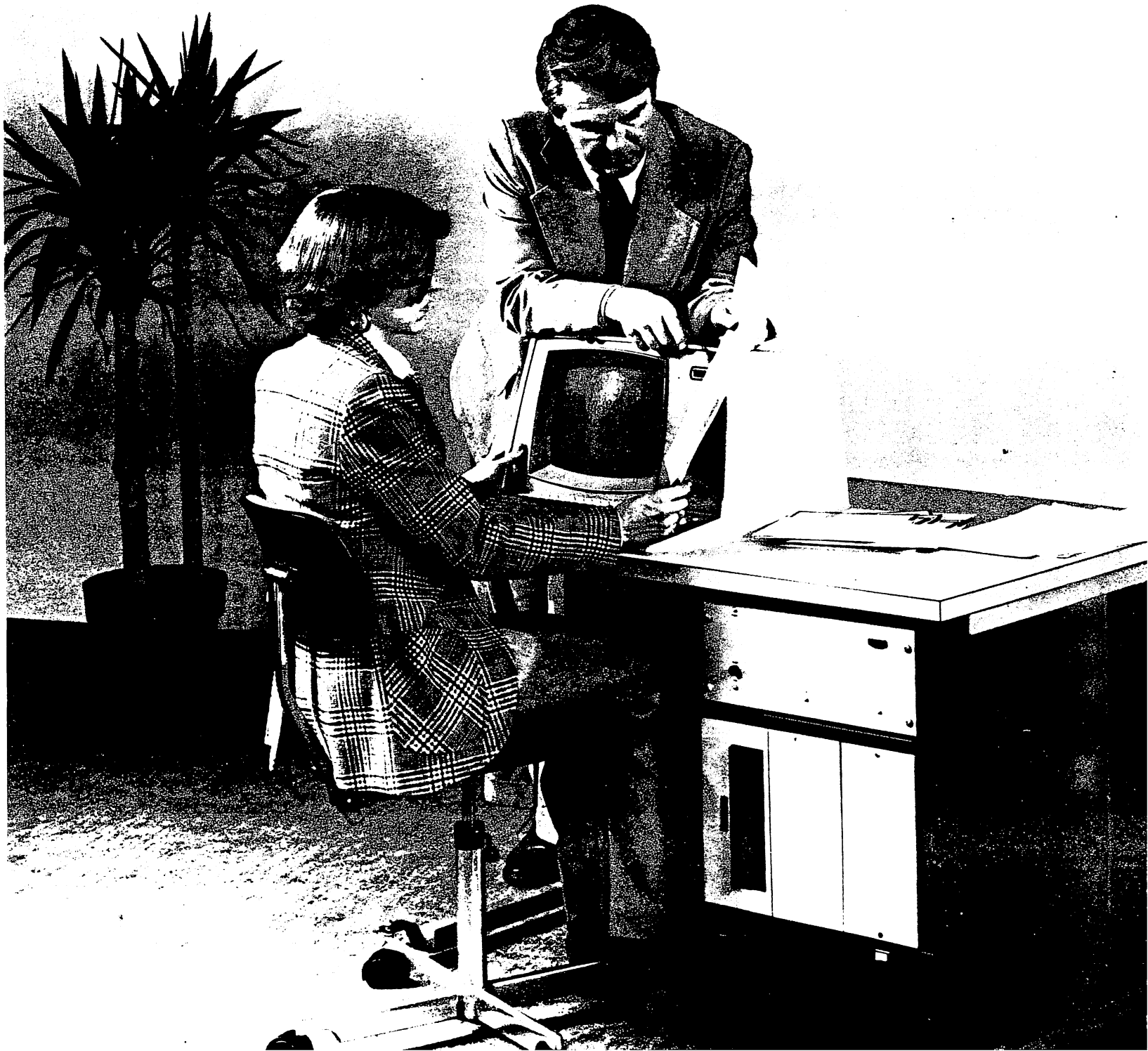
WCS/15 Technical Information

Wang Computer Systems



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Wang's powerful, low-cost, diskette based WCS/15 is ideally suited to a broad spectrum of commercial, technical, scientific, and educational needs. Here is a small computer system which offers both first time and experienced computer users many capabilities found in large scale computer systems. The fully standalone WCS/15 performs data entry, retrieval, editing, and processing tasks required in widely diverse applications. Furthermore, a library of available Wang software often reduces or eliminates the need for extensive programming skills in cases involving scientific or commercially oriented applications.

The WCS/15 features a central processor with 16K (16,384) bytes of user memory, a 12-inch (30.5 cm) diagonal measure Cathode Ray Tube (CRT) Display, a multi-zone keyboard, and a single diskette drive – all in one coordinated, desk-styled piece of furniture. The diskette drive provides 262K (262,144) bytes of online storage, and extensive offline storage limited only by the number of diskette platters acquired for the system.

Several available options, including increased user memory, a second diskette drive, a printer or plotter, and a communications or instrumentation interface controller, provide user flexibility initially or when the need for expanded capability arises. Detailed information follows.

THE PROCESSOR

The WCS/15 central processor has a standard 16K-byte random access memory (RAM), expandable to 24K or 32K bytes. Only 700 bytes of RAM are utilized for "housekeeping" purposes, leaving all remaining RAM accessible to the user. A 42.5K-byte BASIC language interpreter, "hardwired" in read only memory (ROM), translates and executes Wang's BASIC language instruction set. With the many interactive programming and debugging capabilities provided by Wang BASIC, learning time as well as program development time are minimized.

THE CRT

The large, easy-to-read upper/lowercase CRT has manually adjustable brightness and contrast controls. The display capacity is 16 lines by 64 characters per line (standard), or 24 lines by 80 characters per line (optionally). Once the screen is full, the lines of information scroll upward as each new line appears at the bottom; the top line disappears.

The cursor (the symbol indicating where the next character will appear on the screen) can be operated under program control using the eight available cursor-positioning codes, thus specially formatted displays can be created to increase operator efficiency for particular applications.

The interactive BASIC language utilizes the CRT for automatic displays of information designed to assist programmers during text entry and debugging operations, and ensure operational simplicity during program execution.

An optional audio alarm is programmable. With the feature, operator monitoring of the system is minimized when application programs utilize the audio alarm to signal special events, such as the need for input or the completion of a task.

THE KEYBOARD

The dual-mode keyboard can be converted from a standard typewriter keyboard to a BASIC language keyboard by moving the toggle switch in the upper left corner from the standard A/a position to the Keyword/A position. In the A/a position, shifted (SHIFT key depressed) alpha keys produce uppercase letters while unshifted keys produce lowercase letters. In the Keyword/A position, shifted alpha keys produce BASIC words, as labeled, while unshifted keys produce uppercase letters, thereby reducing the number of keystrokes necessary to enter program text. The BASIC words are arranged in logical groups, e.g., FOR, STEP, and NEXT (used to control loops) occupy adjacent keys.

THE KEYBOARD (Cont.)

The keyboard is divided into zones. The largest zone contains the double-duty standard/BASIC keys, plus some operational keys such as TRACE, LIST, LINE ERASE, and RETURN(EXEC). Next in size is the numeric pad which contains the digits (0, 1, . . ., 9), the arithmetic operators (+, -, *, /, ↑), the mathematical functions (e.g., SIN, LOG, SQR), and the PRINT key used for immediate mode calculator-type output or as a text entry word. Other keyboard zones contain program control keys (e.g., HALT/STEP, CONTINUE), special function keys for user-defined functions, edit mode keys, and the system RESET key.

An optional keyboard clicker feature provides audio feedback when a key is touched with sufficient pressure to ensure entry of the corresponding character, BASIC word, or command. Thus, an experienced typist need not "bottom out" a key to ensure entry, thereby increasing input speed; also, the click lessens the need to verify entry by checking the CRT.

DISKETTE STORAGE

The WCS/15 has a single diskette drive (standard), or dual diskette drive (optionally) to provide high speed, direct access, online storage. Offline storage is limited only by the number of available diskette platters. The platters are approximately 7.5 inches in diameter; only one surface is used to record data. The recording surface is divided into 64 concentric tracks, and each track is divided into 16 sectors. The 1,024 sectors are numbered from 0 to 1,023. Each sector can store 256 bytes of information. The standard 262,144 bytes of online storage can be increased to 524,288 bytes with the dual drive option.

The total time required to read or write an item of data on a diskette consists of 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 specific track on a platter. The disk latency time is the time required for the desired sector to rotate to the read/write head. The staggered arrangement of sequential sectors on a track is transparent to user software and produces significant savings in total latency time when reading or writing multi-sector records. Average times are included in the specifications.

Files can be maintained on diskettes in one (or both) of two modes: Automatic File Cataloging mode and Absolute Sector Addressing mode.

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

COMMUNICATIONS CAPABILITIES (OPTIONAL)

A wide range of data transmission and reception capabilities can be added to the standalone computer capabilities of the WCS/15 by including an optional communications controller in the system. With either one of Wang's microprocessor based communications controllers, separate tasks related to data transmission/reception can be performed concurrently by the central processor and the communications controller. With the Option 62 asynchronous controller, a WCS/15 can be programmed (or software is available) to emulate a Teletype® terminal or an IBM 2741 Selectric® Typewriter Terminal. Alternatively, the Option 62B synchronous/asynchronous communications controller, together with a Wang-supplied turnkey software package, supports batch data transmission to or from a host system via IBM's 2780, 3780, or 3741 Binary Synchronous Communications protocol.

THE WCS/15 BASIC INSTRUCTION SET

Generally speaking, BASIC is a popular, high-level, English-like language utilized by a number of companies in the computer industry today;

however, few companies, if any, offer a version of the language as comprehensive as the BASIC instruction set developed by Wang Laboratories for its successful System 2200 and related product lines.

The Wang BASIC instruction set falls into categories representing functionally and historically related statements. Included within the general-purpose category are statements which facilitate common programming tasks such as formatting printed output, decision-making and branching, looping, passing data to subroutines, controlling the format of the CRT display, overlaying program modules, and accepting and processing operator-entered data. Other categories include special-purpose statements which perform operations such as code conversion, sorting, matrix arithmetic, and customized I/O control. Brief descriptions follow for several categories of the BASIC instruction set.

General-purpose Statements

The general-purpose category includes some statements commonly found in less comprehensive BASIC language versions, and other statements which qualify Wang BASIC as a powerful and versatile high-level programming language. For example, the PRINTUSING and % (Image) statements facilitate concise formatting of printed reports containing both text and numeric data fields with or without automatically inserted commas, decimal points, and leading dollar signs ($) in numeric fields. The PRINTUSING, PRINT, HEXPRINT, and PLOT statements can be used to control output to the CRT or a hardcopy output device.

The COM and COM CLEAR statements reduce memory usage when common data must be passed between overlayed program modules. The GOSUB' statement passes multiple arguments to a subroutine. The FOR and NEXT statements define loops which can be nested, if desired. Simple program branching can be implemented with GOTO statements, while more sophisticated branching can be achieved with IF, ON, and ON ERROR statements. These and other general-purpose statements are included in the following list:

COM	HEXPRINT	PRINT
COM CLEAR	IF END THEN	PRINTUSING
DATA	IF THEN	READ
DEFFN	(%) Image	REM
DEFFN	INPUT	RESTORE
DIM	KEYIN	RETURN
END	LET	RETURN CLEAR
FOR	NEXT	SELECT
GOSUB	ON	STOP
GOSUB'	ON ERROR	TRACE
GOTO	PLOT	

Matrix Statements

The so-called Matrix Statements represent a category containing fourteen statements designed primarily for mathematically-oriented operations on entire arrays. In addition to input and output operations, the statements perform calculations and manipulations according to the rules of linear algebra; redimensioning of arrays is automatic for arithmetic operations and optional for other operations. The names of the statements are as follows:

MAT addition	MAT PRINT
MAT CON	MAT READ
MAT equality	MAT REDIM
MAT IDN	MAT scalar multiplication
MAT INPUT	MAT subtraction
MAT INV, d	MAT TRN
MAT multiplication	MAT ZER

Sort Statements

The so-called Sort Statements represent a category containing six matrix statements designed to facilitate text editing operations as well as high-speed data sorting, searching, merging, moving, and copying. Names of the statements are as follows:

MAT CONVERT	MAT MOVE
MAT COPY	MAT SEARCH
MAT MERGE	MAT SORT

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Disk Statements

The Automatic File Cataloging mode statements provide rapid access to cataloged files on a diskette. With such statements, a user can save or retrieve program and data files by name, without concern for where or how the files are actually stored on a diskette. The system automatically keeps track of the size and location of each file.

Absolute Sector Addressing mode statements permit a programmer to address specific sectors on a diskette directly, and design a diskette operating system if desired. Two of the statements are special instructions by which unformatted 256-byte sectors can be read or written, with any control information the programmer wishes to supply.

Automatic File Cataloging Mode Statements:

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

Absolute Sector Addressing Mode Statements:

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

General I/O Statements

The five statements in the so-called General I/O Instruction Set represent a category of historically related operations identified by names beginning with a dollar sign ($) character as follows:

$GIO	$PACK
$IF ON	$UNPACK
$TRAN	

One statement, $GIO, uses a machine-language technique to custom-tailor I/O operating sequences which are executable within the framework of Wang's BASIC language. The $GIO statement accommodates many special interfacing requirements associated with online instrumentation and non-Wang peripherals. The $IF ON statement performs a conditional branch to a specified program line after testing the device-ready or data-ready condition of a specified I/O device. The $TRAN, $PACK, and $UNPACK statements perform data conversion operations often required before or after I/O operations associated with data communications or specially-interfaced equipment.

Numeric Instructions

Wang BASIC provides a standard set of arithmetic operators including + (addition), - (subtraction), * (multiplication), / (division), and ↑ (exponentiation). The set of relational symbols include < (less than), <= (less than or equal to), = (equal to), > (greater than), >= (greater than or equal to), and <> (not equal to).

System-defined trigonometric and algebraic functions for a specified expression include SIN, COS, TAN, ARCSIN, ARCCOS, ARCTAN, absolute value (ABS), natural logarithm (LOG), exponentiation (EXP), square root (SQR), random value (RND), sign (SGN), and integer value (INT). The value of π is obtained by using the function #PI. Arguments for trigonometric functions can be specified in degrees, radians, or grads, as preferred.

Most numeric operations are executed with 13-digit precision. The range of legal values for data entry or storage is as follows:

$-10^{100} < \text{value} <= -10^{-99}, 0, 10^{-99} <= \text{value} < 10^{100}$.

System-defined Functions

System-defined functions include LEN, which determines the number of characters (excluding trailing blanks) currently stored in a specified alpha variable; NUM, which determines the number of legal numeric characters currently stored in a specified alpha variable; POS, which scans a specified alpha variable to determine the first byte-position in the current value where a particular relationship (e.g., >) is satisfied with respect to a specified character; HEX, which permits any 8-bit codes (whether represented by keyboard characters or not) to be introduced in a program in

hexadecimal notation; STR, which specifies a substring of an alpha variable; TAB, which specifies the column position to which the CRT cursor (or the print head of an output device) is to be moved; VAL, which converts the binary equivalent of an ASCII character to a decimal-system integer; BIN, which converts the integer value of a specified expression (if non-negative and < 256) to an equivalent binary code and stores the corresponding ASCII hexadecimal character in the specified alpha variable.

System Commands

System commands provide the operator with a means of directly controlling system operations from the keyboard. Some commands provide convenient and powerful debugging features, such as the ability to interactively modify, trace, renumber, list, and step through programs. Names of commands are as follows:

CLEAR	LIST	RESET
CONTINUE	LOAD	RUN
HALT/STEP	RENUMBER	

WCS/15 FEATURES

Immediate Mode

- Unnumbered single or multistatement lines, up to 192 keystrokes long, can be entered and executed immediately to perform quick calculations.
- Since unnumbered lines can be entered and executed, in many cases without altering programs or data currently stored in memory, selective program dumps can be obtained as a debugging tool.

Program Mode

- Numbered statements, entered in any order, are stored in memory for later execution.
- Most BASIC words are automatically converted into one-byte "text atoms" when stored, thereby conserving memory ordinarily required by systems which store all program text character-by-character.
- Multistatement program lines are legal; they conserve memory and reduce program execution time.

Special Function Keys

- Sixteen Special Function Keys, in conjunction with the SHIFT key, can be used to access up to 32 user-defined subroutines, text strings, and program entry points.
- Via the Special Function Keys, the keyboard can be customized for special applications, thereby increasing operator efficiency.

Edit Mode

- The EDIT key automatically activates edit mode operations on the eight rightmost Special Function Keys, without affecting any user-defined functions on those keys. A line currently being entered can be changed quickly, or the RECALL key can be used to recall a specified line from memory for quick and discrete editing.
- To indicate where a change is to occur, the four cursor-positioning edit operation keys can be used individually or successively to move the cursor one space to the left, one space to the right, five spaces to the left, or five spaces to the right, as needed.
- Once the cursor is properly positioned, the INSERT key can be used to expand the line prior to insertion of additional characters; the DELETE key can be used to delete the character at the current cursor position; the ERASE key can be used to erase the remainder of the line beginning with the current cursor position.
- After changes are complete, the RETURN key deactivates the edit mode, and the edited line is automatically stored.

Error Diagnostics and Debugging

- Coded error messages automatically identify errors at each stage of program entry and execution. Normally, an arrow points to the approximate position where an error occurs in the program line.

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- The HALT/STEP key enables the programmer to step through the execution of a program one statement at a time.
- The TRACE statement enables the programmer to trace through program execution, observing variable assignments and program transfers as they occur.
- The ON ERROR GOTO statement can be used to implement error recognition and/or recovery procedures under program control.
- Program lines are easily inserted and deleted, as needed; furthermore, the RENUMBER command can be used to renumber an entire program, or a portion of a program, with a specified line-number increment between successive lines.

Options

- Memory expansion from the standard 16,384 (16K) bytes to 24,576 (24K) or 32,768 (32K) bytes in 8K or 16K-byte modules.
- A Wang 2200/IBM 3740 Compatible Diskette Drive in lieu of the standard diskette drive.
- A second diskette drive.
- A left-handed desk in lieu of the standard desk.
- Option 60– a keyboard clicker, audio alarm, and auxiliary CRT connector.
- Option 66–the 24 lines by 80 characters per line CRT display capacity.
- Any one of the following Wang printers or plotters:
  Model 2201L Output Writer (15 cps)
  Model 2221W Line Printer (200 cps)
  Model 2231W-1 or 2231W-2 Line Printer (120 cps)
  Model 2251 Line Printer (110 cps)
  Model 2261W Line Printer (240 lpm)
  Model 2263-1 or 2263-2 Line Printer (400/600 lpm)
  Model 2271 Printer (15 cps)
  Model 2271P Plotting Output Writer
  Model 2272-2 Drum Plotter
  Model 2281 Printer (30 cps).
- Any one of the following communications or instrumentation interface controllers:
  Option 62 Buffered Asynchronous Communications Controller
  Option 62B Synchronous/Asynchronous Communications Controller
  Option 65 IEEE-488 Standard Interface
  Option 67 I/O Interface Controller (8-bit-parallel).

Software

Wang Laboratories, Inc., maintains and continually expands its comprehensive software library. Information regarding available software is provided upon request.

SPECIFICATIONS

Size (Console, CPU, Diskette, & Desk)

Height	40 in. (101.6 cm)
Width	46 in. (176.84 cm)
Depth	30 in. (76.2 cm)

Weight

189 lb (85.6 kg) approximately

CRT (Standard)

Display size	12 in. (30.4 cm) diagonal
Capacity	16 lines, 64 char/line
Character size	
Height	0.20 in. (0.51 cm)
Width	0.12 in. (0.30 cm)

CRT (Optional)

Display size	12 in. (30.4 cm) diagonal
Capacity	24 lines, 80 char/line
Character size	
Height	0.16 in. (0.41 cm)
Width	0.09 in. (0.23 cm)

Central Processor

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

Add/Subtract	0.8
Multiply	3.8
Divide	7.4
Square	46.4
e^x	25.3
$\log_e x$	23.2

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x^y	45.4
Integer value	0.24
Absolute value	0.25
Sign	0.25
Sine	38.3
Cosine	38.9
Tangent	78.5
Arctangent	72.5

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

Diskette Drive

Online storage capacity (Single drive)

Number of platters	1
Sectors per platter	1,024
Bytes per platter	262,144

(With dual drive—524,288 bytes)

Rotation Speed	360 RPM

Access Time (Position Head to Track)

Minimum (one track)	14 ms
Average (across one-half available tracks)	363 ms
Maximum (across all available tracks)	726 ms

Latency Time (Platter Rotation to Sector)

Average (one sector read/write one-half revolution)	84 ms
Additional sectors in the same revolution	40 ms

Read/Write Time

One 256-byte sector, including system overhead	21.8 ms

MOVE/COPY Time (Entire platter)
Approximately 2 minutes

Power Requirements

115 or 230 VAC ± 10%
50 or 60 Hz ± ½ Hz
425 Watts

Fuses

Cabinet	.10 amp (115 or 230 VAC)
CPU	2.5 amp (115 VAC/60 Hz)
	1.2 amp (230 VAC/50 Hz)
Diskette	4 amp (115 or 230 VAC)

Operating Environment

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

ORDERING SPECIFICATIONS

The standalone computer system must include the following components: (1) a central processor with Wang's 42.5K-byte hardwired BASIC interpreter, 16K bytes of random access memory, expandable to 32K bytes, (2) a dual-mode, zone-arranged, standard/BASIC keyboard providing special function keys to access user-defined functions and system-defined edit mode operations, standard typewriter keys with alternative single-keystroke BASIC words and commands, numeric keys with arithmetic operations and system-defined mathematical functions, and a reset key, (3) a 12-inch diagonal CRT supporting displays with up to 16 lines and 64 characters per line (standard) or 24 by 80 (optionally), (4) a single diskette drive, expandable to two drives (maximum), supporting Wang 2200 formatted 262K-byte flexible diskette platters and BASIC language disk statements and commands, (5) a coordinated, desk-styled piece of furniture housing the system, (6) printer/plotter controller hardware capable of supporting one optional Wang printer or plotter, and (7) provision for installation of one optional microprocessor based asynchronous or synchronous/asynchronous communications controller, or an alternative instrumentation interface controller.

Standard Warranty Applies

Maintenance Contract Available

Wang Laboratories reserves the right to change specifications without prior notice.

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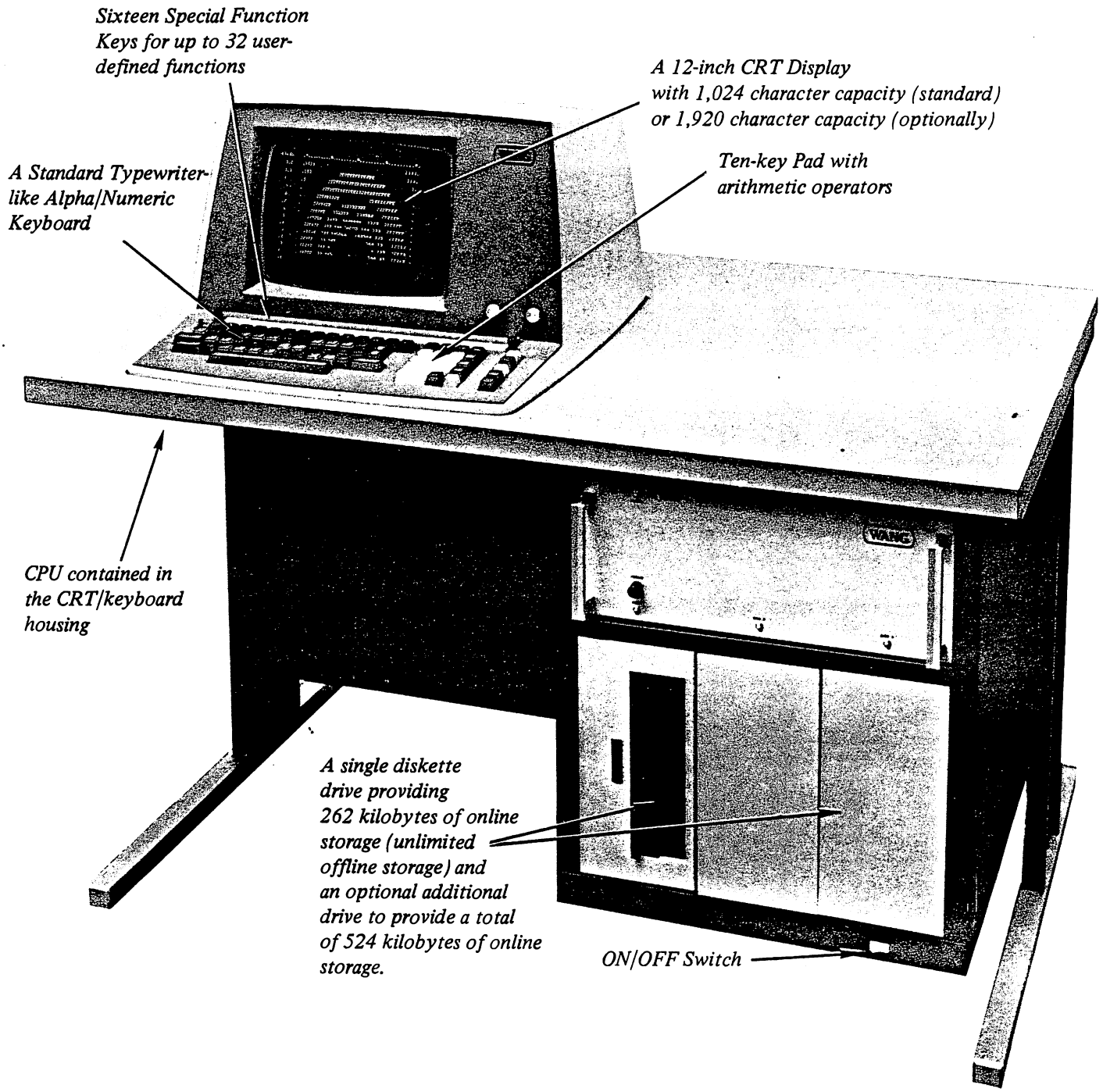

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