WCS/20
Technical
Information

Wang
Computer
System

WCS/20

Wang Computer Systems

The WCS/20 is a powerful, low-cost, flexible disk based system offering the first time user or the branch office the capabilities of large scale computers.

The WCS/20 features an 8K Central Processing Unit including a "hardwired" Extended BASIC language interpreter, 8K bytes of user memory, an operator console comprised of a 1,024 character Cathode Ray Tube (CRT) Display and operator keyboard, and a single flexible disk for mass storage — all in one coordinated piece of office furniture. Through additional options (e.g., matrix printers, tape cassette drives, telecommunications capability, etc.), the WCS/20 maintains flexibility for the user.

PROCESSOR

The nucleus of the WCS/20 is a Central Processing Unit containing 8,192 (8K) bytes of Random Access Memory (RAM) expandable in 8K modules to a maximum of 32K bytes. A powerful 42.5K BASIC Interpreter is resident in a separate Read Only Memory area of the CPU. By "hardwiring" the interpreter, the necessity and time of 'paging' the system in and out of user memory is eliminated. Only 700 bytes of the user area are allocated for system use. In this way, WCS/20 compares favorably to a large computer with a much greater memory.

OPERATOR CONSOLE

The WCS/20 Console is situated on a desk unit which also houses the CPU, memory and flexible disk storage. The compact and attractive operator's console contains Wang's 1,024 character display and a functional user's keyboard. The keyboard includes a standard alphanumeric typewriter key configuration which includes our unique "Single Key BASIC Verb" feature, a numeric 10-key pad with arithmetic operations, a set of special function keys capable of turn-key operations and Wang's indispensable line EDIT feature.

STORAGE

Completing the WCS/20 System is a flexible disk providing high speed, direct access, and on-line storage. The use of removable flexible disks provides off-line program and data storage capacity limited only by the number of flexible disks one has on hand.

Physical Characteristics

The WCS/20 disk contains an easily replaceable Flexible Disk Platter, about 7½ inches in diameter. Only one surface of the platter is used for recording data. The recording surface is divided into 64 concentric circular tracks; each track is segmented into 16 sectors. The recording surface thus contains a total of 1,024 sectors, numbered sequentially from 0 to 1,023. Each sector can store 256 bytes of information.

Storage Capacity

The flexible disk can store 262,144 bytes of information (1,024 sectors x 256 bytes per sector). Up to three drives are available for a total of 786,432 bytes of storage.

Speed

Information is transferred to and from the disk at high speed. The total time required to read or write an item of data on disk can be broken down into two components — the track access time and the disk latency time.

Track Access Time — is the time required to position the read/write head to a specified track on the disk 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 disk platter. For the WCS/20 disk, 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.

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 disk 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 disk 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 disk, 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.

WCS/20 Options

Available as System/20 options are a second and third flexible disk drives. And, your WCS/20 doesn't stop here . . .

Reliability

Although the Disk 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 disk. 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.

SOFTWARE

Software currently available in the 2200 Series products is also compatible with WCS/20, making available a vast library of programs that have been developed over the years.

AVAILABLE 2200 PERIPHERALS

Model 2201 Output Writer
Model 2202 Plotting Output Writer
Model 2203 Punched Tape Reader
Model 2207A I/O Interface Controller (RS-232-C)
Model 2209 9-Track Tape
Model 2212 Analog Flatbed Plotter
Model 2217 Single Tape Cassette Drive
Model 2218 Dual Tape Cassette Drive
Model 2221W Matrix Printer
Model 2227 Asynchronous Telecommunications
Model 2230 Fixed/Removable Disk
Model 2231 Line Printer (80 column)
Model 2232A Digital Flatbed Plotter
Model 2234A Hopper-Feed Punched Card Reader
Model 2244A Hopper-Feed Marked Punched Card Reader
Model 2250 I/O Interface Controller (8-bit parallel)
Model 2252A Input Interface Controller (BCD 1 to 10-Digit-Parallel, scannable)
Model 2262 Digitizer
Model 2260 10-megabyte Disk
Model 2261 High Speed Line Printer
Model 2292 Auxiliary Display

INSTRUCTION SET

LIST OF COMMANDS
General Basic Statements

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

Basic Commands

CLEAR	LIST
CONTINUE	RENUMBER
HALT/STOP	RESET

Disk Statements
Automatic File Cataloging Mode Statements

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

Absolute Sector Addressing Mode Statements

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

The Character EDIT Instruction Set provides greater editing flexibility for the WCS/20 in all memory sizes. Individual alphanumeric characters in a line of program text resident in memory, or in data values of program text currently being entered from a keyboard, can be altered, inserted, or deleted, without retyping the entire line.

The SORT Instruction Set includes six matrix statements for flexible and rapid searching, moving and sorting data on the WCS/20. These statements are particularly effective in speeding up sorting operations, performing multi-file merges, and executing multi-pass searches over large bodies of data. The six statements are:

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

Matrix Instruction Set on the WCS/20 provides fourteen built-in matrix operations.

OPERATION

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

The General I/O Instruction Set for the WCS/20 adds five BASIC language statements to the system.

Statement	Description
$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 Ready/Busy signal of an I/O device (or test the Empty/Full signal of the input buffer on a device controller board) and initiate execution of a conditional branch to a specified line number.
$TRAN	A statement designed to facilitate high-speed character code translations.
$PACK $UNPACK	Statements designed to facilitate data packing and unpacking by fields or delimiters, between a specified alphanumeric array buffer and specified variables in an argument list.

Mathematical functions, when used as WCS/20 statements, are calculated to 13 significant digits.

LOG – NATURAL LOGARITHM
ABS – ABSOLUTE VALUE
SQR – SQUARE ROOT
RND – RANDOM NUMBER
INT – INTEGER PART
SGN – assigns 1 if positive, 0 if zero, or – 1 if negative.
*SIN – SINE
*COS – COSINE
*TAN – TANGENT
*ARCSIN – ARCSINE
*ARCCOS – ARCCOSINE
*ARCTAN – ARCTANGENT
#PI – π (3.14159265359)
EXP – e^x

(*trig arguments: degrees, radians, or gradians)

Arithmetic Operators: **Relational Symbols:**

$\uparrow$ exponentiation $=$ equal
$*$ multiplication $<$ less than
$/$ division $\leq$ less than or equal to
$+$ addition $>$ greater than
$-$ subtraction $\geq$ greater than or equal to
 $<>$ not equal

String Functions:
STR
LEN
HEX
VAL
NUM

User Defined Special Function Keys

All 32 Special Function Key operations can be defined by the user and instantly redefined to meet changing requirements. The keys can be used to access, with a single keystroke, commonly used character strings for text entry, or they can provide program entry points directly from the keyboard.

WCS/20 Keyboard Operations

Most BASIC words are entered with a single stroke and require only one byte of memory. The keyboard has two modes of operation: Keyword/A and A/a. The Keyword/A mode provides most BASIC words and uppercase alpha characters. A/a mode functions as a standard typewriter providing upper and lowercase alpha characters.

Character EDIT Mode

The Character EDIT Mode is designed to facilitate editing of lines of program text recalled from memory or data being input and displayed on the CRT:
←– (Multispace left); ← (Space left); → (Space right); –→ (Multispace right); INSERT; DELETE; ERASE; and RECALL.

The EDIT Key is used to enter EDIT mode. The RECALL key is used to recall a program line previously entered into memory. The Multispace (left and right) keys are provided to move the cursor five spaces to the left or right. The two Space keys are provided to move the cursor a single space to the left or right. The INSERT key is used to expand a line to allow for additional text or data. When the DELETE key is depressed, the character at the current cursor position is deleted. A program or data line can be erased from the current cursor position to the end of the line by touching the ERASE key.

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
X^{y^e}	45.4
Integer Value	0.24
Absolute Value	0.02
Sign	0.25
SINE	38.3
COSINE	38.9
TANGENT	78.5
ARCTANGENT	72.5
Read/Write Cycle	1.6 μ 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.

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

Subroutine Stacking — 50

WCS/20 Flexible Disk 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

Raw Transfer Rate
31,000 bytes/sec

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 ± ½ cps

Operating Environment
50° F - 90° F (10° C - 32° C)
20% - 80% Relative Humidity
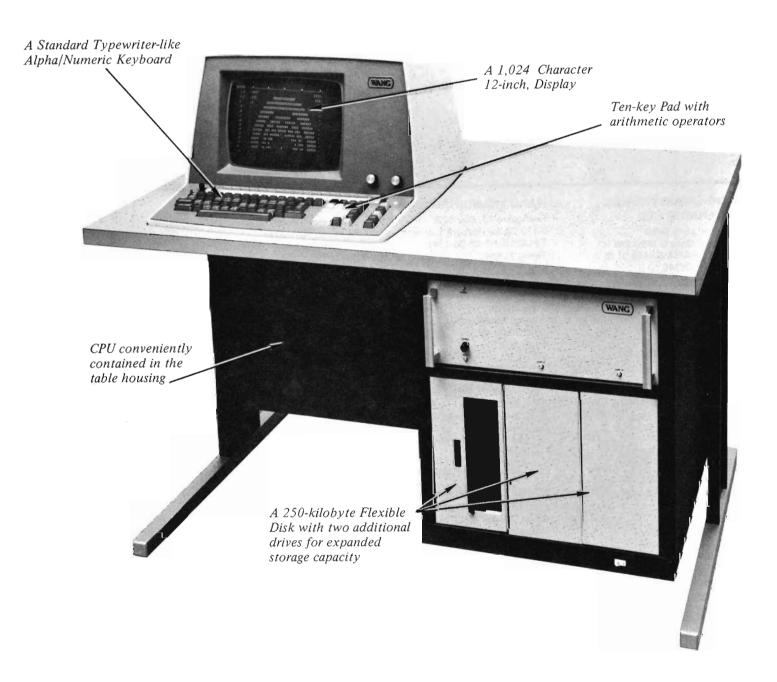Recommended Relative Humidity 35% to 65%

ORDERING SPECIFICATIONS

A Keyboard Programmable Central Processing Unit (CPU) with hardwired BASIC language. The CPU must have at least 8,192 bytes of memory, expandable in 8,192 byte increments to 32,768 bytes. An EDIT feature must be hardwired into the CPU. The CPU must be capable of supporting any or all of a number of peripheral devices: Cathode Ray Tube display (16 lines by 64 characters per line); a Selectric Output Typewriter; an Input Keyboard of typewriter characters and single keystroke BASIC language verbs; an 80 or 132 column Line Printer; a 132 column High Speed Printer; 2207A I/O Interface-Controller; Models 2234A and 2244A Card Readers; Model 2227 Telecommunications Controller; Model 2250 I/O and Model 2252A Input Interface Controllers; and the Model 2262 Digitizer.

A removable flexible disk drive capable of storing programs and data for the Wang Computer System/20. The disk drive must provide a storage capacity of at least 262,144 bytes. Disk platters must be easily inserted in and removed from the unit; individual platters must be formatted automatically by the unit. The System must provide the capability to read and write multi-sector records of any length, and to use entire arrays as arguments. The system also must provide a hard-wired internal data management system, as well as a number of BASIC statements and commands which permit the programmer to design his own disk management system. Finally, the system must provide a rapid platter-to-platter backup capability for at least two of the three disk drives in the disk unit. All of these features, as well as all interface and control electronics, must be included in the price quoted for the disk drive; none should be considered optional extras. Also must drive a Model 2292 CRT Auxiliary Display.

Standard Warranty Applies.

Maintenance Contract Available.

Wang Computer Systems WCS/20

A Standard Typewriter-like Alpha/Numeric Keyboard

A 1,024 Character 12-inch, Display

Ten-key Pad with arithmetic operators

CPU conveniently contained in the table housing

A 250-kilobyte Flexible Disk with two additional drives for expanded storage capacity