SYSTEM OVERVIEW

The Wang CS central processing unit (CPU) is a high-performance VLSI processor that supports up to 16 terminals and 16 jobs concurrently in a multiprogramming environment. The system offers data communications capabilities and an extremely low-overhead operating system. Designed for simplicity of operation and flexibility in system configuration, the CS can be easily adapted to meet each user's unique processing requirements.

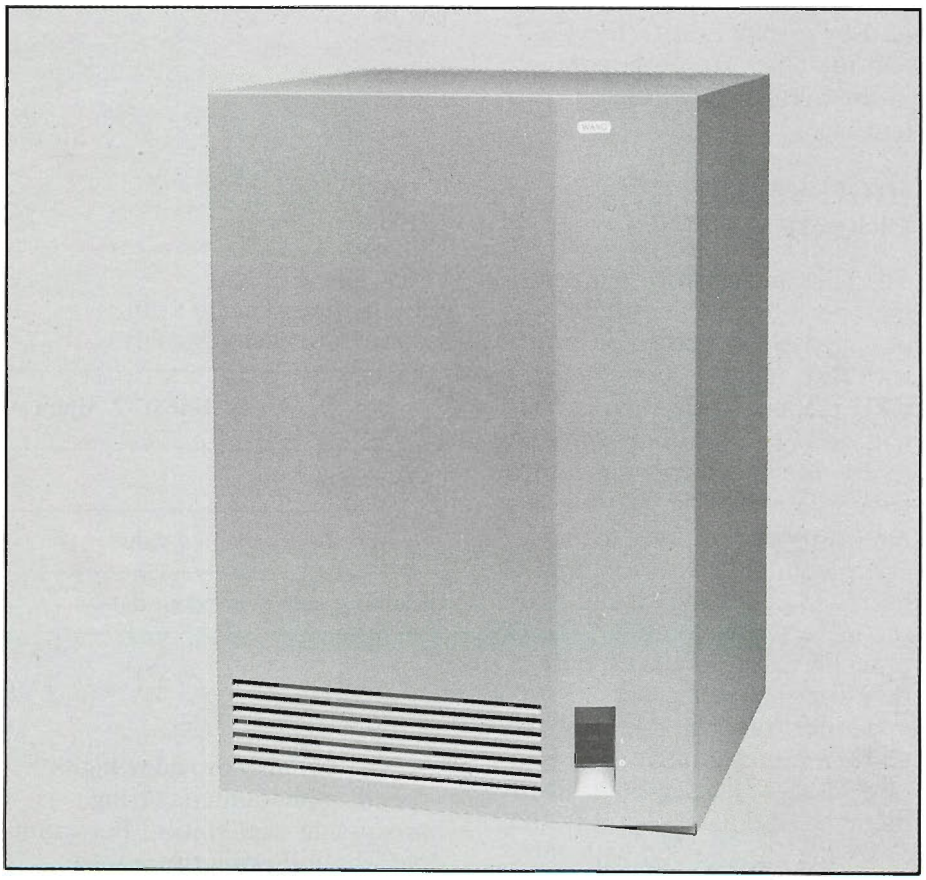
The CS utilizes a user-defined, fixed-partition memory configuration and a fast, efficient central processor to extend multiprogramming capabilities to system users. In a fixed-partition memory scheme, user memory is divided into a number of distinct areas called *partitions*, each of which can contain a separate program. The central processor allocates intervals of processing time to each partition in turn. Thus, the program in an individual partition executes for a brief time before the CPU services the next partition. Response time is fast for all users, regardless of the number of partitions or types of programs being executed.

System users can communicate directly with the CS by using any 2236, 2336, or 2436 terminal. Each terminal consists of a large, easy-to-read, 24 by 80 (24 lines, 80 characters per line) CRT screen display with a typewriter-style keyboard. The system performs automatic data compression on information transmitted to each terminal to accelerate communication and increase response time.

Since each terminal can support its own local printer, screen dumps and standard printing operations can be performed. All 2200, MicroVP, and CS terminals generate extensive bar and line graphics by using standard program statements to provide the user with valuable displays for business applications.

Wang 2436 DW Series terminals support an optional Word Processing software package. This package enables users to perform both word processing and data processing applications at the same terminal.

Terminals can be attached to the CPU either locally, at distances up to 2,000 feet (609.6 meters), or remotely, through the use of modems and telephone lines. Optionally, the CS can be equipped with communications controllers that allow remote devices to be attached directly to the CPU and accessed by a user at the terminal. Asynchronous,



The Wang CS

synchronous, and advanced bit-oriented protocols are supported by the CS processor.

Additionally, the CS chassis contains nine input/output (I/O) slots to support a wide range of other peripheral devices. Each I/O slot can contain a controller that is capable of controlling one or more peripheral devices. These devices include a selection of flexible and hard disk drives and an extensive array of printers and plotters.

The CS is available in two versions: the CS-2, which has 128K bytes of user memory, and the CS-5, which has 512K bytes of user memory. Both the CS-2 and the CS-5 are programmable in the popular BASIC-2 language.

HIGH-SPEED PERFORMANCE

The CS central processor is a high-performance, custom-designed VLSI processor built with fast, reliable components. CPU memory cycle time is 600 nanoseconds — usually sufficient to execute and retrieve a control memory instruction, as well as to read two bytes of user memory. When combined with the low-overhead operating system and the incremental compiler, the CS provides exceptional response time for all system users.

To illustrate the speed of the CPU, a representative selection of BASIC-2 floating-point arithmetic operations is listed in the following table, along with the times required for each computation. These times represent average execution times and assume full 13-digit precision for each operation.

Floating-Point Arithmetic Operation Times

Operation	Central Processing Time
Addition (+) 0.11 msec	0.11 msec
Subtraction (-)	0.11 msec
Multiplication (*)	0.39 msec
Division (/)	0.79 msec
Exponentiation	6.40 msec
LOG	3.30 msec
LGT	2.90 msec
EXP	3.40 msec
SQR	1.80 msec
SIN	4.60 msec
COS	4.70 msec
TAN	8.00 msec
ARCSIN	12.90 msec
ARCCOS	13.00 msec
ARCTAN	10.20 msec
RND	0.28 msec
MOD	1.10 msec
ROUND	0.12 msec
Matrix Inversion (10 x 10)	0.57 sec
Matrix Inversion (20 x 20)	4.30 sec

The CS also provides high-speed, alphanumeric string processing capabilities. For example, the following times were measured when the specified BASIC-2 operations were performed upon an alpha array consisting of 1000 8-character elements.

BASIC-2 Alpha Array Operation Times

Operation	Central Processing Time
Search for a specified value	0.02 sec (maximum)
Memory sort of random data	1.68 sec

EASY OPERATION

The CS is simple to operate and easy to program. There are no special job-control languages or elaborate operating procedures.

System resources are allocated through a supplied partition-generation program that guides the user through the process of configuring user memory. By running this program, the user creates partitions and assigns them to terminals. Each terminal can control one or more partitions.

Once the system has been configured, each partition functions independently. Within each partition, a user can develop and execute a program as if the partition were on a single-user system.

Because each user communicates with the system interactively, the program requests required information with clear, nontechnical prompts. For the programmer, interactive operation greatly simplifies program development and maintenance. Programs can be entered, edited, and run directly from the terminal keyboard. In addition, the CS processor performs a range of error checks to detect and identify various types of errors. It also provides an extensive set of edit functions to facilitate error correction.

FUNCTIONAL ORGANIZATION

The CS consists of a microprogrammed VLSI processor coupled with a number of special-purpose LSI I/O processors and controllers. The operating system and incremental compiler reside in 32 KB of control storage memory that is independent from user data memory.

The microprogram, comprised of the operating system and incremental compiler, directs the execution of the CPU and coordinates communication with the I/O processors. The independent I/O processors permit the overlap of CPU and I/O processing; thus, the CPU is relieved of responsibility for controlling peripherals that would otherwise require frequent or dedicated CPU attention.

Refer to the figure, "Logical Organization of the CS" for an illustration of the CS architecture.

MEMORY ORGANIZATION

Among the most significant features of the CS are those that contribute to its highly efficient use of memory. These features include the following two characteristics:

1. Use of a dedicated control memory for storage of the incremental compiler and the operating system

2. Use of a unique "atomization" technique for storing program text

3. Use of unpartitioned user memory for RAMDISK

Dedicated Control Memory

The CS control memory contains 32K of 24-bit words. When the system is powered on, the system programs are loaded into control memory from the system disk and remain resident in memory until the system is either powered off or reinitialized. Since the contents of control memory are inaccessible to the user or the user's programs, the system programs are always protected against accidental interference or destruction.

User memory is the area of memory available to the user's programs and data. The CS-2 has 128K bytes of user memory; the CS-5 has 512K bytes of user memory. All user memory, except for a small portion used for system control, is available for user programs and data.

User memory is divided into areas, or *banks*, of 64K bytes each. The CS-2 can contain a maximum of two banks of user memory; the CS-5 can be organized into a maximum of eight banks. The user can subdivide each bank into a number of partitions of fixed size, each of which is capable of executing a separate program. Partitions cannot span bank boundaries. Within each bank, a fixed amount of memory is reserved for system control information.

The operating system and incremental compiler require 3K bytes of user memory in the first bank for storage of control information; the system requires 8K bytes of user memory in each subsequent bank. Thus, a total of 61K bytes in Bank 1 and 56K bytes in Banks 2 through 8 is available for partitioning. In addition, the system reserves 1K byte of memory in each user partition for tracking the state of the partition, e.g., which files the partition has open. All remaining memory

is available for user programs and data.

Atomization

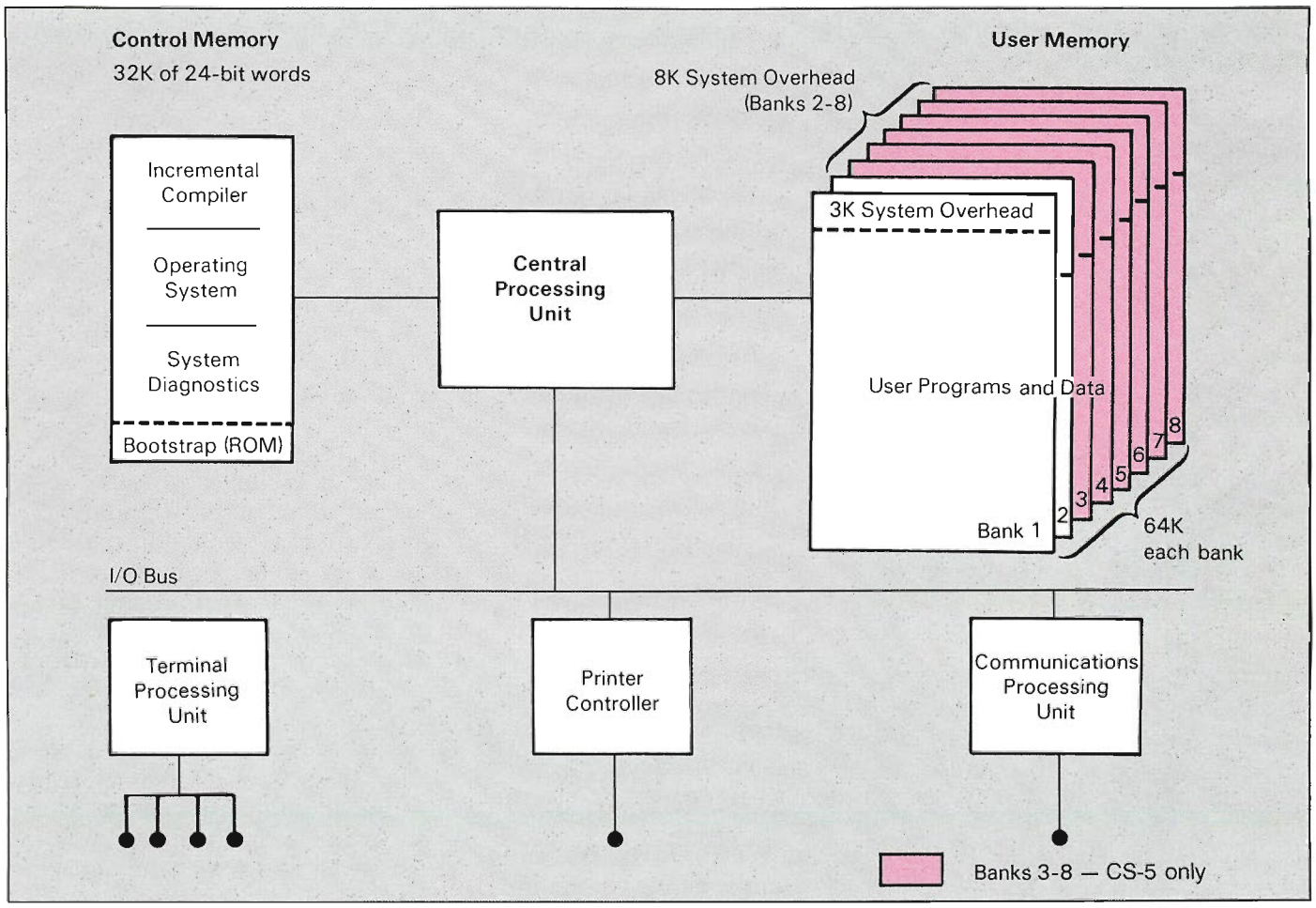
The CS uses an atomization technique to automatically condense each program line. The condensed format conserves the memory needed for program storage and, additionally, contributes to fast program execution.

RAMDISK

RAMDISK allows a portion of user memory to be used as a high-speed disk. All of the BASIC-2 disk statements can be used with the RAMDISK logical platter. Since user memory is used to emulate disk storage and there is no physical disk address, RAMDISK access is considerably faster than access to an actual disk. RAMDISK, however, provides only temporary storage; all information stored is lost when the system is powered off.

FOREGROUND/ BACKGROUND OPERATION

Since each terminal on the system can be assigned more than one memory partition, each terminal is capable of running several jobs concurrently. The job that is in the process of communicating with the terminal at a given time is said to be running in the *foreground*. The job or jobs associated with the terminal, but



Logical Organization of the CS

not communicating with it, are said to be running in the *background*.

The terminal's attention can be transferred from one partition to another to shift the current foreground job into the background and a particular background job into the foreground. Thus, the operator can interact with each program as needed. A typical example of foreground/background operation would be running a batch-type job requiring minimal operator interaction (such as payroll processing) in the background, while running an interactive job (such as word processing) in the foreground.

MULTIUSER BASIC-2 OPERATING SYSTEM

The Multiuser BASIC-2 Operating System supports the BASIC-2 language and runs on the CS. The Multiuser BASIC-2 Operating System provides facilities for program coordination and the sharing of system resources. The operating system protects multiple users from disk and printer conflicts by using BASIC-2 language features that enable a program to seize temporary control of a device and, subsequently, to release it.

Users can select Disabled Programming mode to prevent unauthorized access to important files and unauthorized execution of critical programs. In Disabled Programming mode, a terminal functions exclusively under program control; an operator is prevented from entering or modifying program text, as well as from directly accessing disk files from the specified terminal.

The Multiuser BASIC-2 Operating System includes a set of BASIC-2 instructions for handling disk operations. These instructions allow the programmer to choose between Automatic File Cataloging mode, in which the system automatically performs the tasks associated with disk maintenance, and Absolute Sector Addressing mode, in which the programmer can directly access any sector on the disk.

SINGLE-USER OPERATION

The CS can be configured as a single-user, stand-alone system with the same features and language capabilities as the multiuser arrangement. Unlike most single-user systems, the CS enables a single terminal to control several programs executing concurrently, while maintaining fast execution speeds. Thus, the CS is an excellent choice for the first-time user because it combines high-performance computing with the capacity for expansion from a single-user system to a multiuser system.

COMMUNICATIONS CAPABILITIES

The CS supports a full range of communications capabilities between remote terminals and the CPU and between the CS and other computer systems. Wang also offers a number of software packages to emulate common communications protocols.

Each terminal is connected to the CS by a Wang Model 22C32 Triple Controller or a Model 2236MXE Terminal Processor. These devices control I/O operations between the CPU and the terminals. Line handling between the CPU and each terminal is asynchronous and full-duplex, with selectable line speeds ranging from 300 to 19,200 bits per second (bps).

For remote connection, two RS-232-C-compatible modems (e.g., Wang WA3451) are required to provide the communication link. Remote terminals, located miles from the CPU, can function as local terminals, communicating directly with the system to perform operations within their assigned partitions.

Both remote and local terminals can have their own local printers to produce hard copy at the terminal site.

For communicating with other computer systems, the CS can be configured with Wang Communications Controller Model 2227B, 2228B, 2228C, or 2228D. Model 2227B supports asynchronous-only communications in half- or full-duplex, at line speeds ranging from 300 to 9600 bps. Models 2228B and 2228C offer a choice of synchronous or asynchronous communications at speeds ranging from 300 to 4800 bps. Additionally, Model 2228C supports 3275 Emulation. Model 2228D offers synchronous communications at speeds ranging from 300

to 19,200 bps and supports the following protocols:

- MAILWAY®
- 2780/3780
- 3274 SNA
- Remote WangNet
- X.25 Packet Network Access
- 3274 BSC (3271)
- ASYNC - Teletypewriter Emulation
- TELETEX

For communicating with the Wang VS, the 2200/VS Local Communications Option (LCO) is supported. This hardware and software package enables a Wang MicroVP, 2200MVP, -LVP, or CS to communicate with the Wang VS computer system. Communication between the CS and the VS system occur at speeds of 4.27 megabits per second over dual coaxial cable facilities.

THE BASIC-2 PROGRAMMING LANGUAGE

The CS supports the BASIC-2 language, which is a high-level programming language designed for interactive programming on the CS. Beginning programmers can learn BASIC-2 easily. Wang Laboratories, Inc., has developed a variety of extensions and enhancements that have been added to BASIC-2 to facilitate writing, documenting, and debugging programs, as well as to provide flexible language capabilities for a wide range of applications.

The BASIC-2 instruction set is comprehensive and extremely powerful. A math package includes numerous system-defined mathematical and trigonometric functions. The results obtained are accurate to 13 digits and can be either rounded or truncated.

Alphanumeric data can be compared, analyzed, and modified with a variety of data manipulation statements. These statements permit the programmer to manipulate characters at the bit and byte levels and to perform various Boolean and binary arithmetic operations.

System commands let the user use the terminal keyboard to control system operations in each partition. System commands also serve as useful debugging tools.

In addition to the standard general-purpose BASIC statements, BASIC-2 provides several groups of special-purpose statements that perform such specialized operations as code conversion, sorting, matrix arithmetic, and customized I/O control. Language enhancements within BASIC-2 also include statements that enable the user to share program text, manage shared resources, and define system configurations.

COMPATIBILITY WITH 2200 SYSTEMS

Software compatibility is an important consideration in the selection of a new system. The CS has been designed to preserve maximum compatibility with single-user and multiuser 2200 Series systems. Since the CS is compatible with the 2200MVP and the MicroVP, multiuser software written for the 2200MVP and MicroVP functions correctly on the CS.

The BASIC-2 language supported on the CS is identical to the BASIC-2 language on the 2200VP, SVP, LVP, MVP, and MicroVP. The CS also supports Wang BASIC syntax, providing a significant degree of compatibility with earlier Wang 2200 systems. Since each interactive terminal functions similar to single-user 2200 system for program development purposes, language compatibility ensures that programmers familiar with 2200 systems can quickly become productive on the CS.

The CS enables the programmer to use the memory available for multiuser programs with maximum efficiency. If a programmer must adapt a single-user program for multiuser operations on a CS, the programmer may want to modify the program to capitalize on these multiprogramming features. In general, such modification is not extensive. When memory space is not a problem, however, the program can be loaded and run in each partition with little or no modification.

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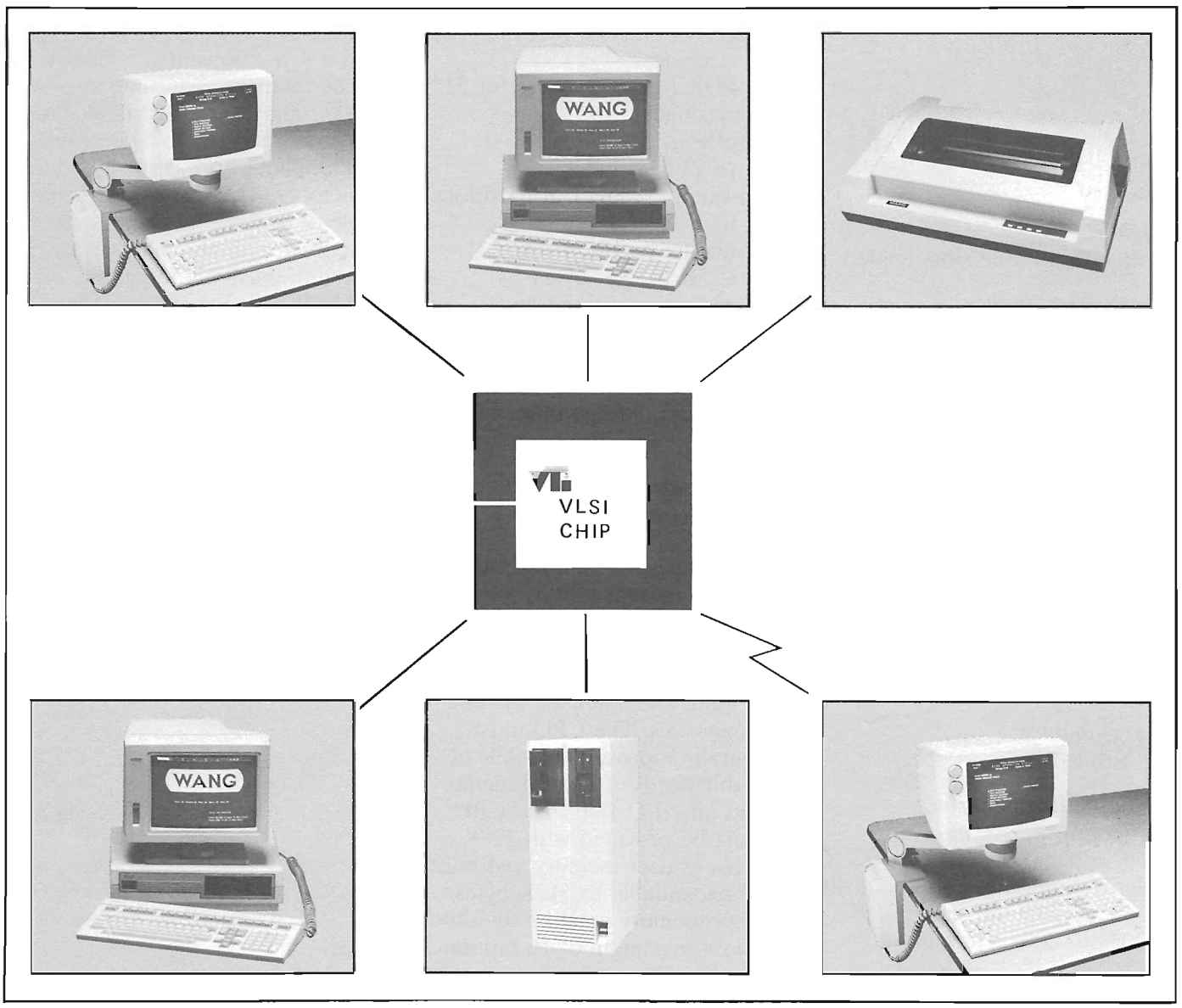
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CPU SPECIFICATIONS

Size
Height
22.75 in.
Width
15 in.
Depth
5.75 in.

Weight
70 lb with all nine slots loaded

Control Memory Size
32K bytes of 24-bit words

User Memory Size
CS-2: 128K bytes
CS-5: 512K bytes

I/O Slots
9

Memory Cycle Time
600 nsec

Power Requirements
115 Vac ± 10%, 60Hz ± 1 Hz
230 Vac ± 10%, 50Hz ± 1 Hz
230 W

Heat Output
745 Btu/hr

Operating Environment
Temperature
50° F to 90° F (10° C to 32° C)
Relative humidity, noncondensing
35% to 65% recommended
20% to 80% allowable

Operating System Specifications
Memory available for partitions
117K (119,808) bytes for 128K machines
483K (463,872) bytes for 512K machines
Overhead per partition
1K (1,024) bytes
Maximum number of partitions
16
Minimum partition size
1.25K (1,280) bytes
Maximum partition size
Bank 1: 61K (62,464) bytes
Banks 2 - 8: 56K (57,344) bytes
Maximum number of terminals
16

ORDERING SPECIFICATIONS

The interactive multiuser central processing unit (CPU) must include the BASIC-2 incremental compiler, the latest release of the BASIC-2 Multiuser Operating System, and extensive system diagnostics. The CPU must contain approximately 32K of 24-bit words of control memory and nine I/O slots. The CPU must be provided with 128K bytes of user memory and must be expandable to 512K bytes. User memory must be divisible into a maximum of 16 separate partitions. The multiuser operating system and the BASIC-2 incremental compiler must reside in a separate control memory. The memory cycle time must be 600 nanoseconds nominal. Full memory parity must be provided throughout both control and user memory. The CPU must be capable of supporting up to 16 interactive terminals concurrently. The system must support the BASIC-2 language, provide a complete set of I/O instructions to control system peripherals, and it must include both automatic cataloging and direct addressing instructions for disk I/O operations. Both synchronous and asynchronous communications hardware, on a single board, must be available for installation directly within the processor.

Standard Warranty Applies

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

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