CS
CS/386 Turbo

OVERVIEW

The Wang CS/386 Turbo is the newest addition to the CS Series of computer systems. The CS/386 Turbo consists of a central processing unit (CPU) that includes a new mother board, a high-speed 16-port terminal controller, a high-speed printer, and disk controller. The CS/386 Turbo requires a data storage (DS) cabinet. The CS/386 Turbo can also reside in a CS-D or CS/386-D chassis that supports up to three storage devices, including a disk processing unit (DPU) in one cabinet resulting in a compact and cost-effective minicomputer system. The CPU (a high-performance Intel 80386-33 MHz processor) can support up to 64 terminals with 64 jobs running concurrently in a multiprogramming environment. The CS/386 Turbo is available in four versions: 4 MB, 8 MB, 16 MB, and 32 MB. All are programmable in the popular BASIC-2 language.

The chassis contains nine input/output (I/O) slots and two I/O busses (the standard 8-byte and the new 32-byte, high-speed) that support a wide range of peripheral devices. Each slot can support a controller for one or more peripheral devices. These devices include a selection of flexible and hard external disk drives and an extensive array of printers. The CS/386 Turbo supports the standard CS controllers as well as the two new I/O controllers for the high-speed bus: the MXF for 16-port terminal/modem processing and the 22C11-HS for printer/disk processing.

The CS/386 Turbo system offers data communications capabilities and an operating system with extremely low overhead. Designed for simplicity of operation and flexibility in system configuration, the CS/386 Turbo can be easily adapted to meet each user's unique processing requirements.

System users can communicate directly with the CS/386 Turbo through the new high-speed 16-port terminal controller by using any Wang 2236, 2336, 2436, or 2536 terminal, or any PC terminal emulator (supported on most AT-compatibles). Each terminal consists of a large, easy-to-read, 24 or 25 by 80 (24 or 25 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, users can perform screen dumps and standard printing operations. All CS Series terminals can generate extensive bar and line graphics, providing the user with valuable displays for business applications.

Wang 2436 DW and 2536 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, with modems and telephone lines. The CS/386 Turbo can also have communications controllers that allow remote devices to be attached directly to the CPU and accessed by a user at the terminal. In addition, the CS/386 Turbo system supports synchronous, asynchronous, and advanced bit-oriented protocols.

The CS/386 Turbo uses a fixed-partition memory configuration defined by the user 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 containing 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.

High-Speed Performance

The CS/386 Turbo central processor is a high-performance, industry-standard 80386 33-MHz processor built with fast, reliable components. CPU memory cycle time is 60 nanoseconds – usually sufficient to execute and retrieve a control memory instruction, as well as read two bytes of user memory. When combined with the low-overhead operating system and the incremental compiler, the CS/386 Turbo provides exceptional response time for all system users.

To illustrate the speed of the CPU, Table 1 lists several BASIC-2 performance operations with the times required for each computation. (These times represent average execution times and asume full 11-digit precision for each operation.)

Table 1. CS, CS/386, and CS/Turbo Performance

Module and Number of Repetitions	CS Seconds	CS/386 Seconds	CS/Turbo Seconds
Expressions/1,000	5.00	2.00	Less than 1.00
Array Elements/1,000	8.00	3.00	1.00
Array as a Parameter/500	25.00	10.00	5.00
Conditional Jumps/3,000	7.00	4.00	2.00
Integer Arithmetic/1,000	5.00	2.00	1.00
Trigonometric Functions/500	29.00	12.00	5.00
Subroutine Calls/2,000	7.00	3.00	1.00
Array References/2,000	4.00	2.00	1.00
Integer Arithmetic/3,000	6.00	3.00	2.00
Standard Functions/500	4.00	4.00	2.00
Total Seconds	**100.00**	**45.00**	**21.00**

Benefits

The main benefits of the CS/386 Turbo are its high-speed I/O bus and two new controllers. The bus provides a short response time for all users through its high-speed terminal controller; its easy operation lets beginners quickly learn how to use the system.

The 16-port terminal controller is an 80286 12-MHz coprocessor that runs on the 32-byte high-speed data bus. The shared memory concept allows the 256 KB of terminal controller memory to be directly accessible by the CPU through the high-speed bus.

The new high-speed printer/disk controller also uses an 80286 12-MHz coprocessor on the 32-byte I/O bus. The 256 KB of controller memory allows faster disk tranfers with more users on the system.

The CS/386 Turbo also provides high-speed, alphanumeric string processing capabilities. For example, Table 2 lists the times measured when the specified BASIC-2 operations were performed on an alpha array with 1,000 8-character elements.

Table 2. BASIC-2 Alpha Array Operation Times

Operation	Central Processing Time
Search for a specified value	0.01 sec (maximum)
Memory sort of random data	0.84 sec

Easy Operation

The CS/386 Turbo is simple to operate and easy to program. No special job-control languages or elaborate operating procedures are involved. 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. Partition sizes can range from 1 KB to the maximum size of data memory. 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/386 Turbo 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/386 Turbo operating system and incremental compiler reside in 256 KB of control storage memory 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 CPU and I/O processing to overlap; thus, the CPU is not responsible for controlling peripherals that would otherwise require frequent or dedicated CPU attention.
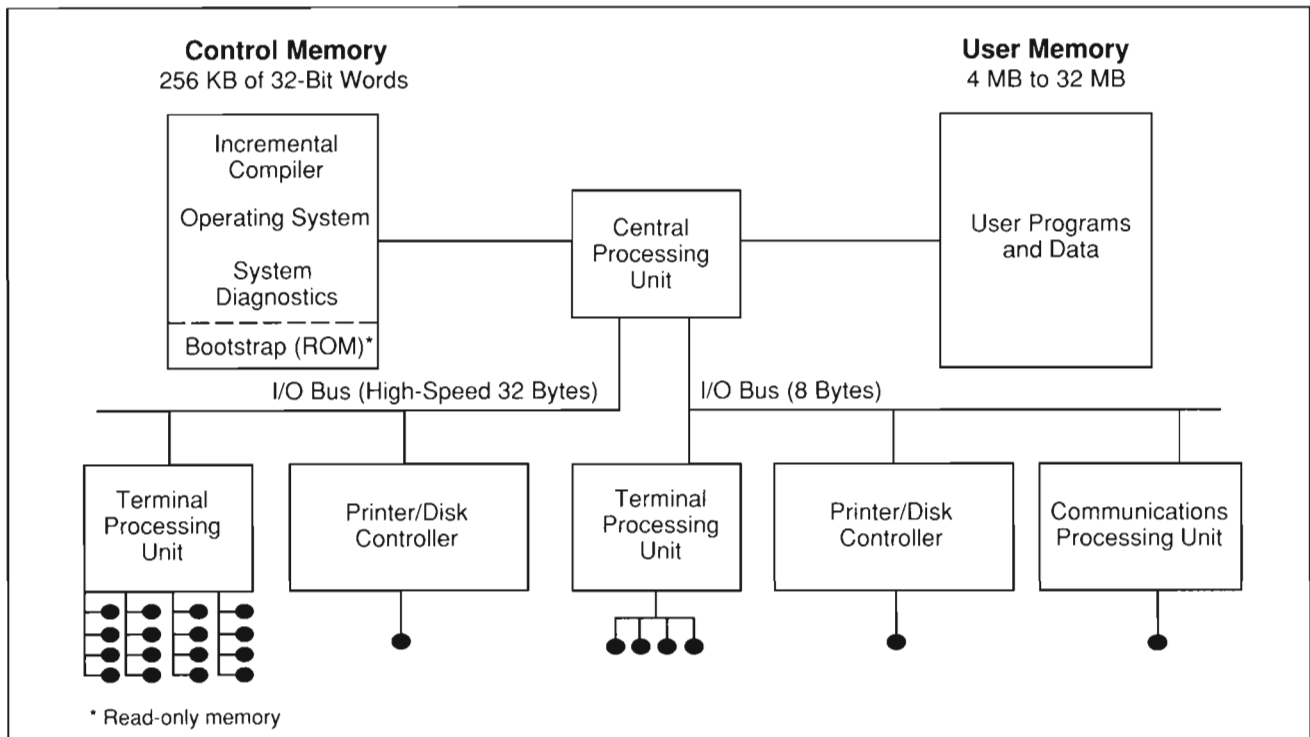
The CS/386 Turbo is an open-slotted system that can be ordered with a data storage (DS) cabinet that supports a 1.2-MB diskette drive, a 150-MB streaming tape drive, and several fixed 20-, 32-, 64-, or 140-MB Winchester drives. The CS/386 Turbo storage can be easily upgraded by adding one or two additional DS cabinets. Each DS can store up to 570 MB of data in 2-byte addressing mode.

The CS/386 Turbo also functions in 3-byte addressing mode where the disk platter can be the same size as the hard disk, eliminating the 16 MB per disk address restriction. Functioning in this mode, the CS/386 Turbo with a 64-MB hard disk in the DS and a Revision 4 PROM can have a single disk platter address of 64 MB.

The combination of the removable diskette, the fixed Winchester drives, and the streaming tape drive makes the CS/386 Turbo's off-line storage capacity virtually unlimited. These storage devices are easy to unload and store, and are less susceptible to destruction from operator errors, program errors, or hardware malfunctions.

Up to 16 CPUs can share the CS/386 Turbo's fixed disk drive by using the 2275 MUX and 2275 MUXE extenders. Once the 2275 MUX has been connected, three 2275 MUXE extenders can be added to the CS/386 Turbo. Each 2275 MUXE extender allows four additional CPUs to connect to the same fixed disk. The additional CPUs can be CS/386 Turbos or any other type of CS/2200 CPU.

Figure 1 illustrates the CS/386 Turbo architecture.

Control Memory
256 KB of 32-Bit Words

User Memory
4 MB to 32 MB

Incremental Compiler

Operating System

System Diagnostics

Bootstrap (ROM)*

Central Processing Unit

User Programs and Data

I/O Bus (High-Speed 32 Bytes)

I/O Bus (8 Bytes)

Terminal Processing Unit

Printer/Disk Controller

Terminal Processing Unit

Printer/Disk Controller

Communications Processing Unit

* Read-only memory

CPU MEMORY ORGANIZATION

The following CPU features contribute to its highly efficient use of memory:

- Dedicated control memory for storage of the incremental compiler and operating system

- Partitioned user memory for user programs and data

- Unique "atomization" technique for storing program text

- Unpartitioned user memory for the CPU RAMdisk

The following sections describe these features in more detail.

Dedicated Control Memory

The CS/386 Turbo control memory contains 256 KB of 32-bit words. When the system is powered on, the 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

User memory is the area of memory available to the user's programs and data. It is divided into a number of partitions of fixed size, each of which can execute a separate program. Partitions can be any memory size up to a maxium of data memory. A fixed amount of memory is reserved for system control information.

Memory can be allocated to as many as 64 partitions. Unused memory may be allocated to the CPU RAMdisk. Table 3 lists the amount of user memory for each version of the CS/386 Turbo.

Table 3. User Memory

System Version	User Memory
CS/386 – 400	4 MB
CS/386 – 800	8 MB
CS/386 – 1600	16 MB
CS/386 – 3200	32 MB

Atomization

The CS/386 Turbo uses an atomization technique to automatically condense each program line. This condensed format conserves the memory needed for program storage and enables programs to execute faster.

CPU RAMdisk

RAMdisk allows a portion of user memory to be used as a high-speed disk. 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 actual disk access. RAMdisk, however, provides only temporary storage; all information is lost when the system is powered off.

Table 4 lists the maximum number and types of Wang storage devices for a DS and/or single CS/386 Turbo.

DS RAMdisk

The DS allows users to set aside a portion of its cache memory for use as RAM. Once the RAMdisk has been established, it is accessed as a standard disk platter and supports all standard disk commands. The RAMdisk is not permanent storage; its contents are lost if the RAMdisk is deallocated or if power to the CS/386 Turbo is lost. RAM is best suited for frequently accessed programs or data files whose contents remain constant. As many as 900 sectors (256 bytes/sector) of cache memory may be allocated for use as a RAMdisk. If the number of sectors to allocate is specified as 0, the RAMdisk is deallocated.

Table 4. Maximum Number of Storage Devices Allowed for a DS

320-KB or 1-MB Diskette*	10-MB Removable Hard Disk	20-MB Fixed Hard Disk		32- or 64-MB Fixed Hard Disk		140-MB Fixed Hard Disk	Streaming Tape Cassette
1	0	3	or	3	or	2	0
1	0	1		2		0	0
1	0	3		0		0	0
1	1	0		0		2	0
1	0	1		2		0	1
1	0	3	or	3	or	2	1
1	1	1		2		0	1
1	1	0		0		2	1

* A diskette is mandatory.

Diskette Drive for DS

The diskette drive uses a 5 1/4-inch double-sided double-density (DSDD), 1.2-MB diskette drive for removable storage. DSDD diskette formats are supported on each of the possible diskette drives: 256 bytes per sector (bps) and 512 bps. All CS systems data and word processing applications use the standard 256-bps format.

The 512-bps format, the Wang Professional Computer (PC) format, is used for interchange purposes. The 512-byte sectoring is transparent to the CS/386 Turbo Operating System. The Disk Storage Printer Controller (DSPC) maps one 512-byte physical sector into two 256-byte logical sectors.

The 1.2-MB diskette drive can read and write to 320-KB diskettes. However, not all 320-KB diskette drives can read media written by the 1.2-MB diskette drive.

The BASIC-2 programming language accesses diskettes with the 512-bps format as if the platter were formatted with 256-byte sectors. All BASIC-2 disk operations can be performed.

Fixed Disk Drive for DS

Fixed hard disks provide fast access to a large amount of disk storage. Information stored on fixed disks should be periodically backed up onto other devices with removable storage for off-line storage. The fixed hard disk (Winchester) drives are formatted to 256 bps.

Streaming Tape Drive for DS

The streaming tape cassette drive is a mass storage and recovery device with a capacity of 150 MB at 8,000 bits per inch (bpi). The drive uses a new Backup/Recovery utility that works on a platter image basis. The drive supports backup by way of reference files; it can run without constant user interaction and while the disk is in regular use.

Table 5 compares the various diskette drives and hard disk drives used by the CS/386 Turbo in 2-byte addressing mode.

22C03-SCSI Disk Controller

The 22C03-SCSI (small computer system interface) controller supports up to seven SCSI disk drives. The SCSI disk drives range from 30 MB to 800 MB, providing the user with a wide range of storage in one cabinet.

Wang offers two SCSI cabinets:

- A 2-slot half-height model, ideal for one half-height SCSI drive and one 150-MB streaming tape drive (for backups)

- A 7-slot SCSI drive model

The controller supports the 2275 MUX, which provides access to the SCSI system for up to 16 CPUs. Table 6 lists the SCSI drives that Wang offers.

Table 5. Comparison of Drives in 2-Byte Addressing Mode

	1-MB Diskette	20-MB Hard Disk	32-MB Hard Disk	64-MB Hard Disk	140-MB Hard Disk
Disk Platters	1	2	2	4	7 or 14
Capacity/Platter	1 MB (1.2 MB for PC)	10 MB	16 MB	16 MB	10 MB or 16 MB
Sectors/Platter	4,160 (4,800 for PC)	38,912	65,024	65,024	38,912 or 65,024
Bytes/Sector	256 (512 for PC)	256	256	256	256
Average Access Time	100 ms	68 ms	45 ms	27 ms	27 ms
Data Transfer Rate	500 KB/sec	5 MB/sec	5 MB/sec	5 MB/sec	5 MB/sec

Table 6. Comparison of SCSI Drives in 2-Byte Addressing Mode

	145-MB Hard Disk	320-MB Hard Disk	650-MB Hard Disk
Disk Platter	9	20	40
Capacity/Platter	16 MB	16 MB	16 MB
Bytes/Sector	256	256	256
Average Access Time	23 ms	16 ms	11 ms

FEATURES

Foreground/Background Operation

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

The BASIC-2 Programming Language

The CS/386 CPU supports BASIC-2, a high-level language designed for interactive programming on the CS/386 Turbo. Beginning programmers can learn BASIC-2 easily. Wang Laboratories, Inc., has developed a variety of extensions and enhancements to BASIC-2 to make it easy to write, document, and debug programs, as well as 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 up to 11 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 control system operations in each partition from the keyboard. 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, read/write MS-DOS files, and customized I/O control. Language enhancements within BASIC-2 also include statements that let the user share program text, manage shared resources, use the MS-DOS file server, and define system configurations.

Multiuser BASIC-2/Turbo Operating System

The Multiuser BASIC-2/Turbo Operating System, which runs on the CS/386 Turbo, supports the BASIC-2 language and 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 cannot enter or modify program text, or directly access disk files from the specified terminal.

The Multiuser BASIC-2/Turbo 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 (the system automatically performs the tasks associated with disk maintenance) and Absolute Sector Addressing mode (the programmer can directly access any sector on the disk).

Communications Capabilities

The CS/386 Turbo supports a full range of communications capabilities between the CPU and remote terminals, and between the CS/386 Turbo and other computer systems. Wang Laboratories, Inc., also offers a number of software packages to emulate common communications protocols.

Each terminal is connected to the CS/386 Turbo by a Wang Model 22C32 triple controller, a Model 2236 MXE terminal processor, or an MXF 16-port high-speed terminal controller. The MXF performs as fast on the new 32-byte bus as the MXE performs on the 8-byte bus. 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 38,400 bits per second (bps). In addition, ports of the Model 2236 MXE can support asynchronous communication in half- or full-duplex at line speeds ranging from 110 to 9,600 bps.

For remote connection, two fully equipped RS-232 modem ports are available for each MXF controller. 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 support their own local printers and produce hard copy at the terminal site.

For communicating with other computer systems, the CS/386 Turbo can be configured with Wang Communications Controller Model 2227B, 2228B, 2228C, or 2228D-4:

- Model 2227B supports asynchronous-only communications in half- or full-duplex, at line speeds ranging from 110 to 9,600 bps.

- Models 2228B and 2228C offer a choice of synchronous or asynchronous communications at speeds ranging from 0 to 4800 bps. In addition, Model 2228C supports 3275 Emulation.

- Model 2228D-4 offers synchronous communications at speeds ranging from 0 to 9,600 bps and supports the 2200/VS Local Communications Option (LCO).

The LCO is a hardware and software package that enables a Wang CS/386 Turbo to communicate with the Wang VS computer system. Communications between the CS/386 Turbo and the VS system occur at speeds of 4.27 megabits per second over dual coaxial cable facilities.

Table 7 compares the various communication controllers available for the CS/386 Turbo; Table 8 lists their line speeds.

Table 7. Communication Controllers

Emulation	MXE	2227B	2228B	2228C	2228D D-4	2258 LCO
Asynchronous						
RCM	Yes	Yes	Yes	Yes	-	-
ASC	Yes	Yes	Yes	Yes	-	-
ASC with Flow Control	Yes	-	-	-	-	-
Asynchronous/Synchronous						
Burroughs Poll Select	Yes	Yes	Yes	Yes	-	-
Synchronous						
2780/3780/3741	-	-	Yes	Yes	-	-
2200-2200	-	-	Yes	Yes	-	-
2200/WP	-	-	Yes	Yes	-	-
2200/VS TCCopy	-	-	Yes	Yes	-	-
IBM 3275	-	-	-	Yes	-	-
IBM 3271 BSC	-	-	-	-	Yes	-
2200/VS	-	-	-	-	-	Yes

Table 8. Line Speeds of the Communication Controllers

Device	Line Speed (bps)	Mode
MXE	300 - 38,400	Terminal
	110 - 9,600	Asynchronous TC
2227B/28B/28C	110 - 9,600	Asynchronous
2228B/28C	0 - 4,800	Synchronous
2228D-4	0 - 9,600	Synchronous

Compatibility With 2200 Systems

The CS/386 Turbo has been designed to preserve maximum compatibility with single-user and multiuser 2200 or CS Series systems. Since the CS/386 CPU is compatible with the 2200MVP, the MicroVP, and the CS, multiuser software written for these systems functions on the CS/386 Turbo.

BASIC-2 supported on the CS/386 Turbo CPU is identical to the BASIC-2 language on the 2200VP, SVP, LVP, MVP, MicroVP, and CS/386. The CS/386 Turbo also supports Wang BASIC syntax, providing a significant degree of compatibility with earlier Wang 2200 systems. Since each interactive terminal functions like a single-user CS or 2200 system for program development purposes, language compatibility ensures that programmers familiar with CS or 2200 systems can quickly become productive on the CS/386 Turbo.

The CS/386 Turbo lets programmers use the memory available for multiuser programs with maximum efficiency. If programmers must adapt a single-user program for multiuser operations on a CS/386 Turbo, they may want to modify the program to take advantage of these multiprogramming features. In general, such modification is not extensive. As long as memory space is not a problem, the program can be loaded and run in each partition with little or no modification.

Note: The CS/386 Turbo requires 80 percent more partition space to run a program than does a CS CPU.

SPECIFICATIONS

Cabinet

Size
Height
  23.1 in. (58.6 cm)
Width
  13.6 in. (34.6 cm)
Depth
  20.3 in. (51.5 cm)
Weight (standard unit without storage devices)
  66 lbs. (30 kg)

Available I/O Slots
  9

Memory
Control Memory Size
  256 KB of 32-bit words
User Memory Size
  CS/386 4 MB
  CS/386 8 MB
  CS/386 16 MB
  CS/386 32 MB
Memory Cycle Time
  125 nsec

System Compatibility
  Wang CS-D/N, 2200 Micro VP, 2200 LVP,
  2200 SVP, and 2200 MVP-type systems

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

Operating Environment
Temperature
  50°F to 90°F (10°C to 32°C)
Relative humidity, noncondensing
  35% to 65% recommended
  20% to 80% allowable
Noise Level (Running continuously)
  35 db (A)
Heat Output
  1,020 Btu/hr

Operating System

Partitions
Maximum number
  64
Minimum size
  1.25 KB (1,280) bytes
Maximum size
  32 MB

Maximum number of terminals
  64

Ordering

The interactive multiuser central processing unit (CPU) must include the BASIC-2/386 Turbo incremental compiler, the latest release of the BASIC-2/386 Turbo Multiuser Operating System, and extensive system diagnostics. The CPU must contain approximately 256 KB of 32-bit words of control memory and nine I/O slots, and must be provided with 1 MB of user memory and be expandable to 32 MB. User memory must be divisible into a maximum of 64 separate partitions. The multiuser operating system and the BASIC-2/386 Turbo incremental compiler must reside in separate control memory. The memory cycle time must be a minimum of 125 nanoseconds. Full memory parity must be provided throughout both control and user memory. The CPU must be able to support up to 64 interactive terminals concurrently. The system must support the BASIC-2 language, provide a complete set of I/O instructions to control system peripherals, and 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.

The MXF Terminal Controller can support up to 16 terminals running per controller and up to 4 controllers per system. The MXF has an 80286 12-MHz coprocessor and 256 KB of system random access memory (SRAM) that it shares with the CPU. The MXF uses only the high-speed bus.

The 22C11-HS is the printer/disk controller, an 80286 12-MHz coprocessor with 256 KB of SRAM. It tranfers data between the printer or disk and the CPU faster under heavy I/O loads than the MVP or CS/386. The 22C11-HS also has a 22C80 port so that it can tie into a 2275 MUX.

Standard Warranty Applies

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