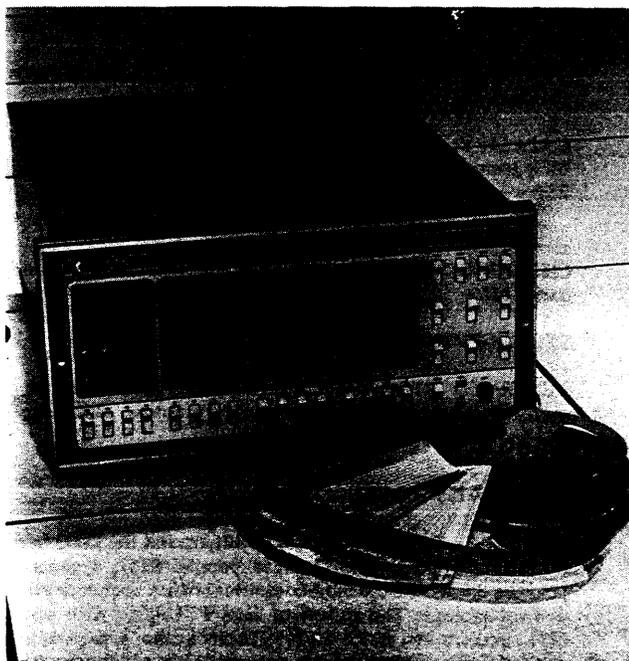


Cincinnati Milacron CIP 2200



The 8-bit byte-oriented CIP/2200 Minicomputer has up to 32KB of 1.1 microsecond core main memory and up to 2K 16-bit words of 220 nanosecond control memory. The front panel has a matrix of indicator lights showing the status of key locations/registers during processing. Often used in a computer numerical control environment (indicated by the paper tape/punched card input media), the CIP/2200 is supported by a general-purpose disk operating system.

MANAGEMENT SUMMARY

The CIP/2000 series of minicomputers was announced in January 1970 with the Model 2100 at the same time that its vendor, The Cincinnati Milling Machine Company ("the Mill") changed its name to Cincinnati Milacron ("mil" a unit of precise measurement, "acron", from the Greek word meaning highest). At least part of the reason for the name change was to reflect the fact that this leading producer of machine tools and process controls since 1884 had become diversified into the computer business as well as into numerous abrasive, chemical, plastic, and cutting fluid markets. The growth into minicomputers arose naturally as its own extensive computer controlled automation of large lathes, turning centers, profiling and milling machines, etc., reached greater heights each year.

In this respect, Cincinnati Milacron's approach toward turning the machine tool industry's increasing involvement with minicomputers to its maximum advantage differed from that of its competitors. While firms such as Gardner-Denver incorporated off-the-shelf OEM mini's from DEC and others into their end-user machine tool systems, Cincinnati Milacron decided to produce its own ➤

Cincinnati Milacron's CIP/2000 series is a little known family of byte-oriented minicomputers designed for numerical control and factory automation requirements. Many of these systems are used by the vendor in their own machine tools as flexible system controllers. A general-purpose disk operating system and decimal arithmetic for the CIP/2200 gives evidence that these real-time systems may prove to have a more general commercial marketability.

CHARACTERISTICS

MANUFACTURER: Process Controls Division of Cincinnati Milacron, Lebanon, Ohio 45036. Telephone (513) 494-1200.

MODELS: CIP/2200.

DATA FORMATS

BASIC UNIT: 8-bit byte.

FIXED-POINT OPERANDS: 16-bits (full word), with 8-bit (half-word) 24-bit (extended word), and 32-bit (double-word) lengths. Byte-string manipulation up to 256 bytes is also available. Decimal numbers appear in memory as byte strings up to 16 digits in length.

FLOATING POINT OPERANDS: Provided for RPG by software subroutine (up to 15 decimal digits).

INSTRUCTIONS: Variable-length instructions in halfwords (8 bits), full words (16 bits), extended words (24 bits) or double words (32 bits). Control and Register-Operate instructions have an eight-bit operation code only. Conditional Skips and Shift instructions have an eight-bit operation code and signed seven-bit displacement or shift count field. Register type I/O instructions have an eight-bit operation code, a three-bit device function indicator, and a five-bit I/O device identifier.

Memory-type I/O instructions have the first 16 bits in common with the register-type I/O instructions, plus eight-bit data transfer addresses. Memory-immediate instructions have an eight-bit operation code, an eight-bit literal field, and an eight-bit data transfer address. Memory-to-memory instructions are like the memory-immediate with a data string length in place of the literal field, and an eight-bit start address and eight-bit stop address. Extended memory-to-memory data transfer instructions are similar to the memory-to-memory types plus an eight-bit data string length field. Memory reference instructions have an eight-bit operation code, and an eight-bit address field. Extended memory references have a 16-bit address field. Literal instructions have an eight-bit operation code and from one to four eight-bit bytes. Eight addressing modes are provided, including relative, indexed, indirect, and literal. All of main memory can be directly addressed.

INTERNAL CODE: ASCII ➤

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▷ minicomputer, and make it available for direct purchase as well as build it into their finished end-user tool systems to replace earlier hard-wired (direct) controllers. This then, is the *raison d'être* for the CIP/2000 Series, and, as can well be imagined, the CIP systems are designed to function well in a factory automation environment.

Surprisingly enough, the earliest uses of the CIP/2000's were in a variety of special applications (the "Comp-acct" point-of-sale terminal for McDonald hamburger stands, the Mergenthaler typesetting system, the Asyst Insurance proposal service, and the Hardy concrete mixing control system), although it was always intended that the CIP's be amenable to incorporation in numerical control systems produced by "The Mill".

The CIP/2200, announced in January 1972 differs from the earlier CIP/2100 primarily in having a more sophisticated instruction set that is better suited to more generalized applications (list/word/data processing). Both systems are produced by Cincinnati Milacron from an initial license granted by Micro Systems, Inc. of Santa Ana California.

Most of the more than 450 systems that have been delivered to date (310 Model 2100's plus about 140 Model 2200's) are used in Cincinnati Milacron's own products or in the products of one major customer (about 40-50 CIP's used in Eldorado Electrodata's Model 125 computerized data terminal and Model 140 small office computer). But the growing number of sophisticated process-control end-users and systems houses augurs well for the vendor's hopes that the CIP/2200's will become one of the industry's popular OEM minicomputers.

The CIP/2000 systems were developed with a strong emphasis on the use of read-only-memory (ROM) control storage to hold up to 2K bytes of selected user programs for the purpose of producing high-speed program execution for non-alterable, often-performed operations. In view of Cincinnati Milacron's Process Control Division background in computer numerical control (CNC), the presence of an effective, high-speed I/O control system and flexible external interrupt structure is understandable. ▷

▶ MAIN STORAGE

STORAGE TYPE: Core main memory; semiconductor ROM control storage.

CYCLE TIME: 1.1 microseconds for core; 220 nanoseconds for semiconductor.

CAPACITY: 8K to 32K eight-bit bytes of main memory in 8KB increments, plus 2K 16-bit words of control storage in 256-word increments.

CHECKING: Optional 9-bit/byte memory includes one parity bit.

STORAGE PROTECTION: None.

RESERVED STORAGE: Approximately 256 bytes for vectored interrupts and DMC buffer pointers, plus about 144 bytes for system save areas, etc.

CENTRAL PROCESSOR

GENERAL: The CIP 2000's are built around the 2003 bare bones ("strippable mini") OEM parallel CPU, a general-purpose byte-oriented minicomputer with a user-accessible control storage. The processor uses TTL logic with some MSI circuitry and has a 4.55 MHz clock rate. A push-down control stack is standard for automatic state switching (the control stack occupies the 256-byte memory page indicated by the control stack pointer). Options include power fail/automatic restart, 2 DMA channels, interrupt enable/disable, real-time clock, and memory parity.

REGISTERS: Three programmable 16-bit registers. Accumulator (A), Accumulator Extension (B), and index register (X). The A register is the operand source for all binary arithmetic and logical instructions. The B register extends the accumulator for variable-length binary arithmetic and logical operations. Byte mode I/O operations may transfer data to or from the low-order eight bits of the A or B register. The X register is used for address modification and base relative addressing, (several specialized instructions are provided for index value modification). In addition there are two other registers, P and S. The P Register (Program Counter) contains the address of the next machine instruction to be executed. The contents of the P register are stored by the return jump instruction. The S Register (Status) is an eight-bit register containing the CPU internal status indicators. The contents of all registers may be stored in a control stack. ▶

SUMMARY DATA FOR CIP 2100/2200 MODELS

	Model 2100	Model 2200
Announced	1Q 1970	1Q 1972
First Delivery	1970	2/72
Typical Purchase*	\$2,840	\$3,020
Number Installed**	310	139

*CPU plus main memory.
**As of September 1973.

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PERIPHERALS/TERMINALS

DEVICE	DESCRIPTION	SPEED
MAGNETIC TAPE EQUIPMENT		
3016	Industry-compatible, 25 ips, 9-track, 800 bpi (1 slot for 4 drives)	20 KBS
3005	Cartrifile Model 20, 10 ips, 1/4-inch continuous loop	1.8 KBS
LINE PRINTERS		
3003 (Centronics 101A)	132-position, 64-character	60 lpm
3015 (Centronics 102A)	132-position, 64-character	125 lpm
PAPER TAPE EQUIPMENT		
Remex Interfaces only		
PUNCHED CARD EQUIPMENT		
Mohawk, GDI Interfaces available		
3013 (True Data 80C)	Reader, 80-column	600 cpm
3018 (Decision Data 9635)	Reader/Punch, 96-column	300/60-120 cpm
3019 (Decision Data 9645)	Data Recorder, 96-column	300/60-120 cpm
TERMINALS		
3000 (ASR 33)	Hardcopy	10 cps
3007 (RO 33)	Hardcopy	10 cps

> What is not as readily attributable to the CNC heritage of the CIP/2200 is the comprehensive CiMOS operating system — a powerful general-purpose disk-based system with good sort capability and file handlers. The availability of CiMOS at no additional charge must be viewed as a measure intended to increase the commercial attractiveness of the CIP's for stand-alone processing, and remote terminal use, in addition to the use of the systems as dedicated processors. A separately-licensed cross-assembler for use on most third-generation systems with FORTRAN support is also provided.

Further, the availability of powerful decimal add/subtract instructions seems intended to make the systems more readily suited to commercial applications, while the absence of a simple multiply/divide instruction furthers neither the CNC nor general-purpose applications of the CIP/2200. (Multiply/divide "step" instructions for both binary and decimal arithmetic are provided. These latter function like a combined add/add-complement and shift to produce a functional, if rather inelegant multiply/divide subroutine instead of a single clean instruction for this purpose.)

Competition for the CIP/2200 in Cincinnati Milacron's primary CNC marketplace consists of the OEM products of most major minicomputer vendors including DEC, Data General, Varian, Hewlett-Packard, etc. In this application area, however, Cincinnati Milacron has placed about 225 CIP 2000 type systems, and the current users are generally >

▶ **INDIRECT ADDRESSING:** Yes, to one level.

INSTRUCTION REPERTOIRE: 119 instructions are standard with the CIP/2200. Of these, 14 are arithmetic, 3 are moves, 41 are register-operate, 12 are shifts, 8 are I/O, 19 are transfer of control, 16 are character string, 13 are control, and 7 are memory-immediate. The basic repertoire is extensible through microcode and an increment (page) of ROM Control storage. Decimal instructions are standard.

INSTRUCTION TIMING: All times are for full-word, fixed-point operands in microseconds.

Load/Store	12.1/11.2
Add/Subtract	11.7
Add/Subtract (Decimal)	84.5 + 7.5/digit
Multiply/Divide	*
Compare/Branch	25.1

*Subroutine only

INTERRUPTS: Two levels with up to 70 lines having an average interrupt delay time of 25 microseconds. The internal level provides six interrupts for power failure, real-time clock, and memory parity error. The external level provides up to 32 interrupt signals over the byte I/O Bus.

CONTROL STORAGE: The standard ROM control storage can be used to hold a bootstrap loader and a disc IPL routine, as well as often-used reentrant (non-altered) program segments for higher execution speeds. Extensions to the basic instruction repertoire can be made in control storage with the addition of one or two 256-word control storage increments (control storage is divided into two 1K segments referred to as pages). ▶

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➤ satisfied not only with the minicomputers, but also with the numerical control/factory automation systems for which many of the CIP's form the nucleus. Users with factory automation applications should investigate the CIP 2200 as potential solutions to their minicomputer control requirements. □

► INPUT/OUTPUT CONTROL

I/O BUS: The I/O Bus allows a microprogram - controlled Direct Memory Channel (DMC) to transfer data at up to 25K bytes/second (eight-bit parallel transfer) for a single synchronous device concurrently with program execution without affecting response to internal interrupts. Data transfer rates up to an aggregate of 86K bytes/second for 32 devices can proceed over the DMC from buffered I/O devices with some delay to internal interrupts. One or two optional Direct Memory Access (DMA) channels can be attached to handle data transfers at 910K bytes/second with each DMA channel providing interface for up to ten external devices. Programmed I/O data transfer as well as fully automatic data transfer can occur at 25K bytes/second.

SIMULTANEOUS OPERATIONS: Data transfer can proceed concurrently with program execution.

CONFIGURATION RULES: The basic chassis provides 17 slots, with a 17-slot expander chassis available if required. Each peripheral controller and 8K memory board uses one chassis slot. The maximum configurability of the system is 32K words of memory, 32 I/O devices, and two DMA channels.

MASS STORAGE

MOVABLE-HEAD DISK STORAGE: Provides direct access storage for 4,915,200 bytes on one fixed and one removable disc mounted one above the other on a single spindle. Average access time is 95 milliseconds (includes average rotation delay of 20 milliseconds) and data transfer rate is 1.56 million bits/second. The disc cartridge is formatted for 24-sector/track modes (200 cylinders plus three spares per disc). Two spindles can be attached to a controller for a maximum subsystem capacity 9,830,400 bytes. The controller interface to the DMA requires one slot position.

INPUT/OUTPUT UNITS

See Peripherals/Terminals table.

COMMUNICATIONS CONTROL

ASYNCHRONOUS COMMUNICATIONS CONTROLLER: Provides interface for six full-duplex lines (RS-232) with odd or even parity at 110-4800 bps. Word length is selectable (five-eight bits).

SYNCHRONOUS COMMUNICATIONS CONTROLLER: Provides interface for one half- or full-duplex (dedicated or dial-up) line at 1200 - 9600 bps. Complete error checking capabilities are standard. More than one controller may be installed per system.

SOFTWARE

OPERATING SYSTEMS: Two operating systems are provided with the CIP 2200 minicomputer; Paper Tape Operating System (PTOS) and Cincinnati Milacron Operating System (CiMOS-22). PTOS is the basic operating system, and can be run on an 8K CIP/2200 model with program development support for a two-pass relocating assembler. Utility support is provided for system generation, as well as a dynamic debug facility and a system library.

CiMOS is the main batch-oriented, disk-based operating system for use on a 16K minimum CIP/2200 system (8K for CiMOS plus 8K for language processors). In addition to assembler and RPG program development support, CiMOS has an extensive range of utility packages including a sort program (requires 24KB when sorting 4KB records), a linkage editor, text editor, library maintenance program, disc initializer program, disc reorganization program, a volume/catalog list program, and file copy utilities. No multiprogramming support is provided (interactive, single-user mode only).

PROGRAMMING: The most efficient language available is an assembler (8KB or 12KB versions) with an easier to use RPG available for most commercial end-users.

APPLICATIONS: No applications programs are provided directly by Cincinnati Milacron, and the user must develop his own programs using the Assembler or RPG.

PRICING

POLICY: Cincinnati Milacron provides the CIP minicomputers on either a purchase or lease basis with an OEM discount available. An appropriate level of operating system support (disk or paper tape) is provided at no additional charge. A 90-day warranty on all equipment is made; system installation is at no additional charge.

SUPPORT: Maintenance is separately priced with field support available from any of ten Cincinnati Milacron Process Control Division offices in the U S only. Two man-weeks of training are allowed with the purchase of each system. Additional training is available at the rate of \$265 per man-week. All training classes are in Lebanon, Ohio.

EQUIPMENT: The following typical purchase and rental prices include controllers and adapters.

SMALL OEM SYSTEM: Consists of 8KB processor (open frame; no power supply), ROM, system control panel, DMA, and 32 priority interrupts. Purchase and monthly lease charges are \$7,175 and \$243, respectively.

PAPER TAPE OPERATING SYSTEM: Consists of 16 KB processor, ROM, teletype console, 80-column card reader, and line printer. Purchase and monthly lease charges are \$20,560 and \$678, respectively.

LARGE-SCALE DISK OPERATING SYSTEM: Consists of 32KB processor, ROM, teletype console, DMA, 10MB Disk, line printer, 96-column card reader/punch, and six-channel communication subsystem. Purchase and monthly lease charges are \$52,450 and \$1,748, respectively. ■

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EQUIPMENT PRICES

		<u>Purchase Price</u>	<u>Monthly Maint.</u>	<u>Rental (1-Year Lease)</u>
PROCESSOR				
2001	Basic CIP 2200 Processor (requires ROM)	\$2,165	\$15	\$72
2003	Open Frame Processor with power supply and all options	2,195	15	73
MEMORY/PROCESSOR OPTIONS				
2214	8KB	1,800	12	60
2215	8KB with parity	2,000	14	67
2310	CIP/2100 ROM (768 16-bit words)	675	5	23
2316	CIP/2200 ROM (1,536 16-bit words)	825	6	28
2317	Basic ROM (unprogrammed); can hold eight 256-word ROM's)	375	3	13
2318	CIP/2200 ROM (2,316 16-bit words)	900	6	30
2402	Processor Option (Type I), includes power/fail automatic restart and interrupt enable/disable.	200	2	9
2410	Processor Option (Type II), includes Type I plus real-time clock.	355	3	12
2412	Processor Option (Type III), includes Type II plus parity check.	400	3	13
2514	Basic Control Panel	375	3	13
2515	System Control Panel	495	5	17
2517	System Control Panel Interface (for 2002)	200	2	7
2590-4	System Control Panel Cable (for 2517)	355	3	12
2516	Blank Control Panel	100	-	3
2592-6	Basic Control Panel Interface	180	2	6
2600	Expansion Enclosure (12 I/O interfaces only)	1,255	0	42
2604	DMA Cable	200	0	7
2605	Expansion Enclosure Cable	335	3	11
2606	Expansion Enclosure Power Supply	450	3	15
2701	Parallel TTY Control	375	3	13
2702	Parallel TTY and I/O Control	470	4	16
2703	Priority Interrupt Group (8 lines)	500	4	17
2704	DMA	500	4	17
2705	4-byte I/O Multiplexor	540	4	18
3021	30-inch cabinet	650	-	22
3022	30-inch cabinet with desk top	800	-	27
3023	60-inch cabinet	700	-	23
MASS STORAGE				
3001	IOMEC* 2002 Disk Drive (5MB) with control, cabinet	11,300	128	377
3009	Control for 3001 (IOMEC* 2002-R)	1,500	10	50
3002	IOMEC* 2002 Disk Drive (10MB) with control, cabinet	15,800	146	527
3010	Control for 3002	2,000	14	67
3011	Add-on (5MB) drive for 3001 (requires 3009 control)	6,750	62	225
3004	Disk Pack (IBM 2315 type for 3001/3002)	170	0	6
MAGNETIC TAPE EQUIPMENT				
2907	Cartrifile Controller (Model 20/40)	485	4	16
2994	Cartrifile Cable	150	0	5
3005	Cartrifile Model 20 Drive, 1.8 KBS	3,575	33	119
3006, 10-, 25-, 50	Cartridge (10 feet to 50 feet)	25	0	-
3016	Magnetic Tape Unit, 9-trk, 800 bpi, 20 KBS	5,200	58	173
3017	Magnetic tape control	2,800	15	93
LINE PRINTERS				
2707	Composite Printer Control (Centronics 101, 101A, 102, 102A)	425	3	14
3003	Centronics 101A Printer, 60 lpm	4,635	43	155
3014	Centronics 101A Printer with interface and cable	5,210	52	174
3015	Centronics 102A Printer with interface and cable	6,500	62	217
PAPER TAPE EQUIPMENT				
2904	Controller for Reader/Punch (Teletype DRPE 240 punch, Remex 300 reader)	575	4	19
2991	Reader Cable for 2904	150	0	5
PUNCHED CARD EQUIPMENT				
2990	Reader Cable	150	0	5
3013	True Data 80C Reader with interface	3,800	45	127
3018	96-column Reader/Punch, 300/120 cpm	9,250	85	308
3019	96-column Data Recorder with keyboard and interface	11,300	104	377
3020	96-column Data Recorder with keyboard	9,300	86	310
2901	Reader controller	500	4	17
INTERFACES				
2906	I/O Extender Card	300	2	10
COMMUNICATIONS				
2908	103-type modem (300 bps)	845	6	28
2909	202-type modem (1200 bps)	1,400	10	47
2910	Modem-to-DAA Cable	150	0	5
3000	ASR 33 Teletype, 10 cps	1,700	30	57
3007	RO 33 Teletype, 10 cps	1,200	22	40
2708/2708	Serial Controller 1760/2400 bps (RS232)	425	3	14
2706	6-channel Asynchronous Controller	755	5	25
2801	201 Synchronous Modem controller (1200-9600 bps)	465	4	15
2802	Multi-Asynchronous TTY Controller	325	3	11
2803	8-line RS-232 Controller (300 bps)	300	2	10
2804	Asynchronous Modem Controller (103/202) 85-10.8 bps)	495	4	17
2890/2891/2892	Modem/External DAA Cable	100	0	4