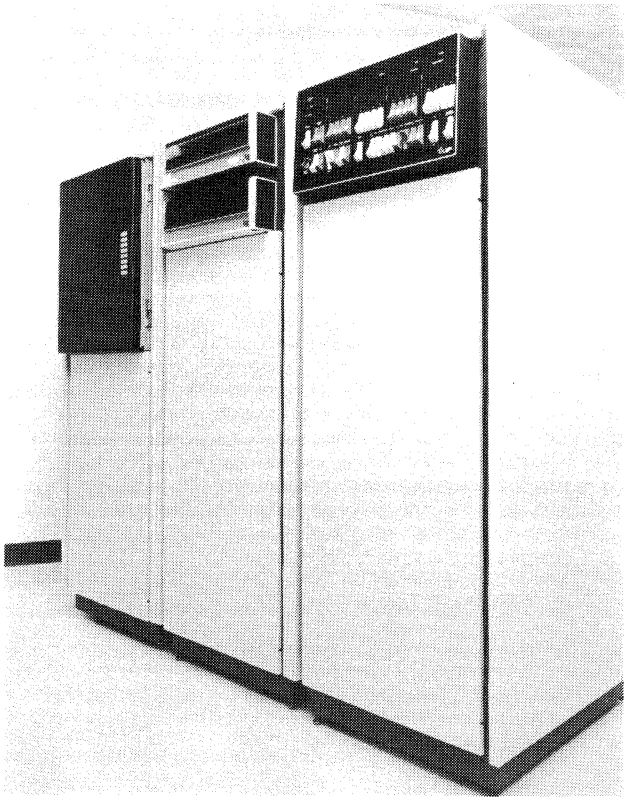
Modular Computer Systems Modcomp II and IV Communications Processors



The Modcomp IV minicomputer system shown above represents the largest member of the Modcomp computer family.

A family of computer systems offering extensive communications handling capabilities.

Each system can support up to 256 full-duplex lines and interface with either CDC, IBM, or other Modcomp computers. The MAXNET system enables Modcomp networks to be operated in a distributed data processing mode. The MAXCOM Communications Executive is the basis for front ending and message switching. A full complement of peripherals is offered, along with a bulk core memory system, Memory+.

A Modcomp II/45/CP2 with 32K bytes of 800 nanosecond core, 4-port memory interface, a 32-line Universal Communications Controller with asynchronous Line Interfaces, a parallel link to another Modcomp system, and a 12-megaword disk drive can be purchased for $58,890; the monthly maintenance charge is $651.

MANAGEMENT SUMMARY

Modular Computer Systems (Modcomp), founded in 1970, manufactures computer products based on "macro-modular" design architecture, achieving the goal of most computer manufacturers. The term modularity, as applied to the Modcomp CPU's, means that all elements of the processor-arithmetic logical unit, I/O control section, etc., are implemented in isolatable, asynchronous blocks, or modules, which are largely independent of each other and can be removed and replaced quite easily permit upgrading without total redesign or extensive engineering changes.

Modcomp's major market areas are Manufacturing Industries, Power Industries, Process Control and Energy Management. They enjoy strong representation in Communications applications such as Front Ends, Message Switching and time sharing networks.

Modcomp offers a series of packaged computer systems based on its Modcomp II and Modcomp IV computer systems. This report discusses the communications processors of this series, which include ROM with specialized communications macro routines.

The modular hardware architecture allows for a variety of asynchronous internal data transfer arrangements to ➢

CHARACTERISTICS

VENDOR: Modular Computer Systems, 1650 West McNab Road, Fort Lauderdale, Florida 33309. Telephone (305) 974-1380.

DATE OF FIRST ANNOUNCEMENT: Modcomp II, October 1971; Modcomp IV, June 1973.

DATE OF FIRST DELIVERY: Modcomp II, December 1972; Modcomp IV, September 1974.

NUMBER INSTALLED TO DATE: 3000 (all models).

SERVICED BY: Modular Computer Systems.

CONFIGURATION

Modcomp offers four basic communications processor configurations. Common to each system are a direct memory interface, a communications ROM, and a control console. The direct memory interface enables attachment of a Universal Communications subsystem that will support up to 256 full-duplex communications lines. The communications ROM provides storage for specialized communications macro routines necessary for control of the lines.

The II/26/CP2 communications processor is based on the Modcomp II, a 16-bit computer. Standard with this system are 64K bytes of 1.06 microsecond, parity core memory.

The II/233 Communications System contains a II/26/CP2 with all of the CPU options to support the MAXCOM software system, a 4903 PCI, and a Universal Communications Subsystem.

The II/45/CP2 communications processor is basically the II/26/CP2 with a four-port memory access interface with 800 nanosecond cycle time. The main processor and the I/O bus are each assigned a memory access port. The two remaining ➢

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maximize throughput. Communications lines and mass storage devices can be attached so that internal data transfer is via either processor interrupt or direct memory access. For communications lines, a special direct memory access (Direct Memory Interface) is available that does not have to contend with other devices for memory access or steal processor cycles. Alternatively, a low volume/speed communications line can be attached to the Direct Memory Processor along with other devices contending for use of a common direct memory access port. A memory interface option enables attachment of two out of the four possible memory port accesses to favored internal units such as the Direct Memory Processor.

For a network of Modcomp systems, the company offers MAXNET, a network control system. This software permits each computer system to operate in a distributed data processing mode. The applications programs without effort, can freely employ the I/O resources resident anywhere in the network. In true distributed fashion, each computer can trigger events and actions in other network computers. Downline loading of programs is supported along with remote initial program loading.

For a dedicated communications application, Modcomp offers MAXCOM, a specialized system executive. This software is designed to minimize system overhead and memory, and is optimized for high throughput applications. It contains as standard, handlers for IBM 2780/3780 and CDC UT-200 Emulators.

When the Direct Memory Interface option is used for communications lines, 256 lines can be physically attached. This is practical from a throughput standpoint, if each line accommodates line speeds up to 1800 bps. However, if all the lines have to handle heavy traffic operating in excess of 9600 bps for prolonged periods, more than 48 lines may cause too great a load on the system.

The Memory+ System is an I/O feature not common to many other communications processors. Up to 16.8 megabytes of core memory can be attached to one system for use as a mass storage device. Memory+, offering a cross between the advantages of extended memory and the control of an I/O handler, was developed jointly by Modcomp and Dataram.

USER REACTION

In October 1979, Datapro interviewed three users of Modcomp Communications Processors with a total of five units in use. These users were selected at random from a list provided by the vendor. All of the installations had been operating for a period of two to five years, and in all cases the Modcomp system was being used as a front-end processor. Four of the five units were front-ending CDC hosts (6000, 6600, Cyber 76, and Cyber 170) and the fifth was front-ending an IBM 360. The users' ratings are as follows:

ports can either be assigned to the main processor or to the optional Direct Memory Processor (DMP). The DMP enables up to eight peripheral devices to have direct memory access.

The IV/35/CP-B system is based on the Modcomp IV/35-B, a 32-bit computer system that can process data internally in multiples of 16 bits. Standard with this system are 128K bytes of 1.06 microsecond, interleaved, parity core memory with four-port memory access. Interleaving of memory modules produces an effective memory access rate of 600 nanoseconds. The Direct Memory Processor is standard with the IV/35/CP-B and enables up to 16 peripheral devices to have direct memory access.

Peripheral Controller Interface

Each system has an I/O Bus with the capability of handling eight electrical loads. Each electrical load will accommodate attachment of either a 4903 or a 4905 Peripheral Controller Interface. Either Peripheral Controller Interface supports up to four peripheral devices or communications controllers. The 4905, additionally, includes a controller for attachment of a console. Each system can, therefore, physically support up to 32 communications or peripheral attachments, plus a console. Optionally, a direct memory processor can be added to the Modcomp II system to enable up to eight of the attachments to transfer data via direct memory access. This feature is standard on the Modcomp IV system and enables up to 16 attachments to enjoy direct memory access.

Asynchronous and synchronous interfaces are available for direct attachment of communications lines to the Peripheral Controller Interface. Data transfer for lines so attached is under main processor (interrupt) control. Each interface supports two full-duplex lines.

A 128-line Asynchronous Multiplexer Controller can also be attached to the Peripheral Controller Interface. Up to four 32-line Asynchronous Multiplexers can be attached. Each multiplexer requires a Line Interface for every two full-duplex lines attached to the multiplexer. Data transfer for lines attached to the multiplexer is on an interrupt basis.

Communications lines can have direct memory access for data transfer via attachment of a Universal Communications Controller to a Peripheral Controller Interface. This device is also attached to the Direct Memory Interface feature that is standard in each of the communications processor systems. It is this feature that enables up to 256 communications lines attached to the Universal Communications Controller to transfer data to and from the memory without main processor intervention. Universal Communications Chassis are required to house the Line Interfaces that are attached to the Universal Communications Controller. The Chassis come in two versions, each accommodating interfaces for 32 lines. One version has single port access, and the other has dual port access. The latter version is used in redundant configurations to attach the communications lines to another system. Each Line Interface supports two full-duplex lines.

Adapters for attachment to Control Data, IBM, and other Modcomp processors are offered for attachment to the Peripheral Controller Interface.

Peripherals

Most peripheral devices are offered with an integral controller for attachment to the Peripheral Controller Interface. Peripheral devices include: printers with speeds up to 600 lpm, 7 and 9-track magnetic tape drives, fixed head disk drives with up to one-megaword capacity, movable head disk drives with up to an 168-megabyte capacity, floppy disks with up to 300K words capacity, and bulk core storage units of up to 2 megabyte capacity. A 300-cpm or a 1000 cpm card reader and a 100 cpm punch can be attached to the Peripheral Controller.

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	Excellent	Good	Fair	Poor	WA*
Overall satisfaction	0	3	0	0	3.0
Throughput	1	2	0	0	3.3
Hardware reliability	1	2	0	0	3.3
Promptness of maintenance	0	2	1	0	2.7
Quality of maintenance	0	1	2	0	2.3
Technical support	0	1	2	0	2.3

*Weighted average on a scale of 4.0 for Excellent.

No major difficulties were prevalent among the three sites polled. One user mentioned that he had problems with the system's modems and terminals, but said that these problems were "nothing out of the ordinary", and were unrelated to the operation of the Modcomp processors.

The ratings show a high degree of satisfaction with throughput and hardware reliability. We were unable to get three ratings on ease of installation and vendor software so these factors are excluded from the above table. Three is the minimum number of responses for which Datapro will calculate a weighted average.□

CRT's can be attached to the system over communications lines. The Hazeltine 1500 and 1510 are offered by Modcomp.

Memory

The Modcomp II systems have either 32K bytes of 800-nanosecond core memory or 64K bytes of 1.06 microsecond core memory as standard. The 800-nanosecond memory can be expanded in increments of 8K or 16K bytes. The 1.06 microsecond memory can be expanded in increments of 64K bytes. Maximum allowable memory on any of the Modcomp II systems is 128K bytes. Standard memory on the Modcomp IV is 128K bytes of 1.06 microsecond memory. Expansion is in 128K byte increments up to 1024K bytes. The second 512K bytes requires a Memory Expansion Unit. The first 512K bytes and the second 512K bytes each have a four-port interface. Two of the ports on each interface are available for direct attachment to other computers.

CONNECTION TO HOST COMPUTER

Adapters for local attachment of the Modcomp communications systems to host computers are available for Control Data, IBM, and other Modcomp computer systems. Modcomp will custom build adapters for other host computers. The adapters are attached to the Peripheral Controller Interface and, when direct memory access is required, to the Direct Memory Processor.

The 4820 Parallel Computer Link is used to attach the communications processor to another Modcomp system. Parallel direct memory transfer of 200K bytes per second is possible with systems spaced within 150 feet of each other. A Serial Link is available between two Modcomp processors with the 4824 feature. Serial transfer is over a pair of coaxial cables with data rates varying according to cable length; a rate of 250K bytes per second is possible up to 1000 feet, 62K bytes per second at up to 2500 feet, and 30K bytes per second at up to 5000 feet. Optional with the Serial Link is the capability for one computer to initialize (IPL) the other computer.

The 1941 Modcomp/CDC Satellite Coupler supports parallel transfer of data between the Modcomp processor and a Control Data 6000 or 3000 series computer system. Either byte transfer through program interrupt or word transfer through direct memory access is accommodated, with the latter transferring data at speeds of up to 600K bytes per second. An optional feature enables a Control Data processor to remotely load the Modcomp processor.

The 1950 Modcomp/IBM 360, 370 Interface supports attachment to either an IBM selector channel or a block multiplexer channel. Direct memory transfer rates of up to 250K bytes per second are possible and are limited to the burst mode when attachment is to the block multiplexer. Up to 256 device addresses are supported. Optionally, the IBM processor can initialize the Modcomp processor.

TRANSMISSION SPECIFICATIONS

Three dual channel interfaces are offered for direct attachment to one of the four slots of a Peripheral Controller Interface. Each of the interfaces will support two full-duplex communications lines. The 4810 Asynchronous Interface will support two 20 milliampere current loops with speeds between 75 and 9600 bps. The 4811 Asynchronous Interface will support two lines with an RS-232C interface at speeds between 75 and 9600 bps. The 4815 Synchronous Interface will support two lines with an RS-232C interface at speeds between 110 and 20K bps.

The attachment of the 1905 Asynchronous Multiplex Controller to a Peripheral Controller slot enables multiple 32-line Multiplexers (1910) to be attached to the Multiplexer Controller for support of up to 128 lines. Line Interfaces for the Multiplexer are offered to support either RS-232C or 20 mA current loop interfaces. Each Line Interface accommodates two lines. The lines can operate at speeds between 75 and 9600 bps.

Data transfer between the lines and memory for all of the above attachments is under processor interrupt control. Direct memory transfers, to support a greater number of communications lines and to operate lines at speeds in excess of 9600 bps, is available with the Universal Communications subsystem. This device attaches to a slot of the Peripheral Controller and to the Direct Memory Interface. The Controller is offered in several versions to support 32, 64, 128, 192, and 256 lines.

The Line Interfaces necessary for the supported lines require a 32-port Universal Communications Chassis for mounting. One asynchronous interface supports RS-232C and another supports either a 20 mA or a 60 mA current loop. Asynchronous line speeds can be between 75 and 19.2K bps. Synchronous interfaces are available in either byte mode for use with BSC like protocols or bit mode for use with HDLC like protocols. Both types are available in three models; (1) RS-232-C, (2) Bell 301/303, and (3) CCITT V.35 interfaces.

SOFTWARE

The Modular Application Executive (MAX) operating system provides three levels of system support: MAX II, MAX III, and MAX IV.

MAX II and MAX III are compatible operating systems for the Modcomp II computers; MAX III is a superset of MAX II. They share common executive services, peripheral handlers, and software.

MAX II is designed for batch processing with limited real-time requirements. It is a multiprogramming system that can execute multiple core-resident tasks concurrently with one batch job stream. MAX II is available in a core version and a batch version. The core version includes a taskmaster which allocates time slices to any number of core-resident tasks. It supports up to 256 unique execution priority levels. The batch version supports both moving-head and fixed-head discs and magnetic tape.

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The MAX II core version includes re-entrant floating-point simulation and re-entrant FORTRAN IV run-time packages; re-entrant executive services for I/O operations; execution control, byte string syntax analysis, code conversions, and utilities; and a device-independent I/O system. The batch version adds nonresident background and batch processing services to the real-time services of the core version.

MAX III is a real-time multiprogramming system with foreground/middleground/background capabilities. It is task-oriented and can have any number of tasks active in up to 256 priority levels.

MAX III exists in three versions: a core version, a batch version, and an extended version. The core version executes resident foreground tasks contained entirely within fixed areas of memory. It also includes a clock-driven CPU control executive, re-entrant executive services, queued I/O services that can be performed concurrently with task execution or with the calling task suspended, an off-line system generation program for configuring the resident elements and tasks of the system, and services for allocation of core not used by resident elements. Also included in the core version are a real-time clock for maintaining the time-of-day, timing task delays, and updating system watchdog timers; an option allowing the execution of more than one task at each priority level, and a feature allowing important or frequently used library subroutines to be declared resident at system generation time. Re-entrant library subroutines, memory tables, and variables may be made global. The system generation package permits generation of large core-resident systems in small core configurations.

The batch version of MAX III is a foreground/background system which adds the capabilities of a full-service loader for overlay programs catalogued on either sequential or direct-access devices. An optional background task may be added which uses a nonresident job control overlay to control batch processing operations. This version does not contain middleground or batch checkpointing capabilities.

The extended version of MAX III provides a full foreground/middleground/background system, which permits establishment of one or more core pools for foreground and middleground execution. Core is dynamically allocated to each task on a priority basis. The extended version also permits one or more background areas to support batch processing. These areas can be stored on a disk when higher-priority nonresident foreground programs require the memory space. The system allows background and middleground core area sizes to be changed by the operator, spooling of low-speed printing devices, and multiple-user BASIC which can be executed as either a foreground/middleground task or as a background overlay. Active tasks can request additional core blocks for use at run time. These blocks are automatically deallocated.

Foreground, middleground, and background tasks may be either privileged or unprivileged. The unprivileged mode is the user mode, where the task has absolute control within its own memory boundaries only. Round-robin task scheduling is an optional feature, allowing all tasks of equal priority to have their execution times shared on a cyclic basis.

MAX IV is a disk-oriented, real-time, communications-oriented multiprogramming system specifically designed for medium-to-large Modcomp IV systems. The operating system utilizes the Modcomp IV hardware relocation capabilities, map protection, memory allocation/deallocation instructions, multiple register sets, and multiported memories to reduce system overhead. In addition to most of the capabilities of MAX III, including a clock-driven CPU executive, MAX IV offers 256 task priority levels with the capability to execute multiple tasks at each level; re-entrant executive services for execution control, byte string syntax analysis, and code conversion; dynamic allocation of system resources; assigning privileged and unprivileged status to tasks; and the option of core residency or disk residency for tasks, if memory is to be conserved.

The basic executive services and functional capabilities of MAX II and III are included in MAX IV as a subset. Tasks and overlays developed under MAX II or III will operate normally under MAX IV provided that the interface to the operating system is via Modcomp macro calls, executive services, or standard FORTRAN call subroutines.

The MAX IV operating system generally makes more efficient use of disk-storage than MAX III, permitting such additional functions as rollin/rollout of tasks between core and disk as priorities dictate. MAX IV also has the same re-entrant FORTRAN run-time package and output spooling capabilities as MAX III.

A file manager system is available as an extension to the MAX IV operating system which can be used by any task concurrently with MAX IV's basic I/O system. The file manager organizes, maintains, and services multi-level files in any size and number. Nesting of named data files and file directories to any level while maintaining file security at each level is permitted. Up to four levels of volume and file access protection are provided using locks and keys. Both volume and file disposition functions based on user expiration dates are available. Volume and file access are device-independent. The file manager provides both direct and sequential access methods, as well as the ability for the user to develop his own access method through the MAX IV basic I/O system. File names may be of variable length, controlled by the user. File space may be contiguous or noncontiguous and is automatically allocated and deallocated.

The FORTRAN I/O Run-Time Package is written in a re-entrant format, allowing a single copy to be shared by all programs.

A comprehensive diagnostic capability provides assistance in the form of error printouts indicating the types and number of errors that exist in any line of coding.

The Modcomp *BASIC* interpreter supports an extended set of the elementary capabilities defined by the Dartmouth specification. A user can prepare and then CALL a set of subroutines which perform special real-time functions useful to him. The CALL statement enables BASIC to be used to conduct interactive, on-line experiments. In applications such as factory testing, test procedures for new devices to be tested by the system can be developed and checked out in an on-line interactive mode by the test engineer.

MAXCOM is a demand-driven operating system for dedicated communications applications. It does not support background system processors. MAXCOM can support up to 256 tasks, each with a separate priority level. Drivers are included for TTY, IBM Bisync, and CDC 200 UT terminals as well as for CDC 6000 and IBM 360/370 host processors. The operating system provides queued I/O services with the option of immediate return to interrupted tasks, deferred return to interrupted tasks, or no return. System generation is accomplished through the Modcomp macro assembler or the CDC and IBM cross assemblers. Generally, MAXCOM offers all the features of MAX II plus the enhancements gained through the addition of the communication macros to any Modcomp II CPU. The minimum configuration needed to run MAXCOM is any Modcomp II/CP processor with 8K words of core. To generate MAXCOM, however, a minimum of 16K words is required.

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MAXNET III is an operating system that permits linking multiple Modcomp II or IV processors to form a distributed network which operates an integrated system. Each system in the network has all the capabilities of the extended version of MAX III plus the capabilities of the designated host system to exercise control over all satellite systems.

In addition to handling the protocol, error checking and retries, MAXNET provides the following capabilities:

- Downline program loading of satellite computers by the Modcomp host.
- Initial program loading, or initialization, of remote satellites by the host.
- Control of one computer's tasks by another computer in the network.
- Selective use of local or remote peripherals by applications programs.

The internal MAXNET protocol is Modcomp designed, based on BSC protocol.

There are five specialized tasks to support network operations. These are the link task to interface the I/O system and allow device-independent I/O transfers through the network; a loader task for transferring other tasks from the host system disk to a satellite system; a linking loader that is specifically designed for network applications and will receive binary inputs from the host system, perform checksum validity checks, and request a predetermined number of retries under error conditions; and a software buffer management package which permits establishment of buffers in other systems' global or common areas.

The configuration needed for a MAXNET III host system is a Modcomp II or IV with 128K bytes of memory and all peripherals required by MAX III, extended version. Satellite systems require 48K bytes of memory as a minimum and any Modcomp communications interface to the host system.

MAXNET IV is a superset of MAX IV with all of its real-time multiprogramming capabilities and provision for communicating with MAXNET III. The MAXNET IV host system requires a Modcomp IV processor with 256K bytes of memory and the peripherals required by MAX IV. A satellite MAXNET IV system requires 128K bytes of memory.

The *CDC 200 User Terminal Emulator* provides a means for either a Modcomp II or IV to communicate with a remote Control Data 6000 or 7000 Series computer. The emulator operates under MAX II, III, or IV performing its task concurrently with other real-time or background tasks. The features of the CDC 200 User Terminal provided by the emulator include interleaved I/O transmissions, switched or dedicated point-to-point operation at 2000 to 9600 bps, space and zero character compression, external BCD transmission code, ANSI or IBM 26 punched card input codes, and full double-buffering. Input may be from cards, disk, or magnetic tape; output may be to printer, disk, magnetic tape, or spooler.

The emulator requires a Modcomp processor with at least 7K words above the resident systems or tasks; one duplex channel of a 4815 Interface; an appropriate dial or dedicated communications line and Bell 201A, 201B, 208, or 209-type modem; and access to a CDC 6000 or 7000 Series computer operating under Export/Import, Cybernet, etc.

The *IBM 2780/3780 Terminal Emulator* enables a Modcomp II or IV to communicate with a remote IBM System/360 or 370 computer. The emulator operates under MAX II or III as either a foreground or background task. Provided with the emulator are these features of the IBM 2780/3780; multiple record transmission, horizontal format control, EBCDIC transmission code, transparent text transmission, 3780 space compression, extended ENQ or error retry, variable-length records, and switched or dedicated point-to-point operation at 2000 to 9600 bps. Input may be from cards, disk, or magnetic tape; output may be to printer, disk, magnetic tape, punched cards, or spooler. The emulator may be non-resident and can perform its operations with other batch or foreground tasks.

Minimum requirements for operation of the emulator include a Modcomp processor with 5 to 8K words of memory above the resident tasks or systems; other requirements specified for the CDC 200 User Terminal Emulator above; and access to an IBM 360 or 370 computer under OS/VS, OS/HASP, DOS/VS, DOS/Power, etc.

The *IBM HASP Workstation Terminal Emulator* operates under MAX III or IV on either a Modcomp II or IV with 8K to 10K words of memory above the resident tasks or systems. Additional requirements include a duplex channel of a 4815 Interface; a dial or dedicated communications line, a Bell 201A, 201B, 208, or 209-type communications modem; and access to an IBM 360 or 370 computer under OS/VS, OS/HASP, or OS/ASP.

The HASP emulator includes these features of the workstation: multi-leaved I/O transmission, EBCDIC transmission code, transparent or nontransparent transmission, space and duplicate character transmission, switched or dedicated point-to-point operation at 2000 to 9600 bps; file insertion; input from punched cards, disk, or magnetic tape; and output to punched cards, disk, magnetic tape or printer. The emulator may be non-resident and can operate with other batch or real-time tasks.

LANGUAGES: For the Modcomp II or IV, a 4K assembler or 16K macro assembler (6K resident requirement) are available, as is a FORTRAN-coded cross assembler for use on an IBM System/360 or 370 (DOS, 65KB) or a Control Data 6000 Series system. Also available for the Modcomp II or IV are ANS FORTRAN IV and an extended BASIC.

The *Assembler* operates in two-pass fashion and requires a minimum batch processing area of 8K bytes, which can handle up to 200 symbol names. With additional available memory, the symbol table can be expanded at the rate of one symbol for every three words of memory.

Featured in the Assembler are both absolute and relocatable object format; free-field assembly format; a set of directives for aiding in expressing constants, allocating storage, interprogram communications, and listed output formatting; error diagnostics; an object listing including source and object code; symbolic addressing; the ability to define new instructions implemented in the ROM controller; and the capability to accept symbolic constants both as operands in an immediate instruction and in data statements.

The Macro Assembler is a free-format language processor that contains all of the assembler capabilities, plus additional features which include the generation of nested macros, recursive macro calls, assembly-time branches and macro exits.

The Macro Assembler is a two-pass processor that generates relocatable and absolute object format and requires a minimum batch processing area of 24K bytes. This language processor contains directives which allow the definition of macro prototypes, conditional assembly, custom hardware macros, symbol definition, plus local and global label processing. The user can define COMMON blocks for com-

munication between FORTRAN and assembly-language programs and subroutines.

The Modcomp *FORTRAN IV* compiler meets the specifications of the American National Standards Institute (X.39, 1966). Real-time extensions are provided which make FORTRAN a useful data acquisition and control language.

Modcomp FORTRAN IV is designed to produce efficient code through subscript optimization, block-level optimization, and the utilization of all Modcomp II or Modcomp IV machine capabilities, such as all general registers and the full instruction set.

Direct-access I/O to disk files is provided through DEFINE FILE statements. A file manager provides the utility functions for the creation and deletion of disk files to be used with the FORTRAN direct access I/O system. READ and WRITE may be free-format.

The programmer using the Modcomp FORTRAN IV compiler can write source code incorporating in-line assembly-language coding, including macro directives. The user can also call all the MAX executive services through in-line assembly-language coding for maximum run-time efficiency.

A set of CALL subroutines which are compatible with ISA Standard 61.1 has been added to the MAX IV System Library. They provide real-time capabilities for execution control of real-time tasks, status testing, and interrupt utilization. Array extensions provide the user with the freedom to use any arithmetic expression as an array subscript. Arithmetic capabilities include 16-bit and 32-bit (Modcomp IV) integers, plus 32-, 48-, and 64-bit (Modcomp IV) floating-point operations. The Modcomp floating-point hardware unit is fully supported by the compiler.

The FORTRAN I/O Run-Time Package is written in a re-entrant format, allowing a single copy to be shared by all programs.

A comprehensive diagnostic capability provides assistance in the form of error printouts indicating the types and number of errors that exist in any line of coding.

The Modcomp *BASIC* interpreter supports an extended set of the elementary capabilities defined by the Dartmouth specification. A user can prepare and then CALL a set of subroutines which perform special real-time functions useful to him. The CALL statement enables BASIC to be used to conduct interactive, on-line experiements. In applications such as factory testing, test procedures for new devices to be tested by the system can be developed and checked out in an on-line interactive mode by the test engineer.

UTILITIES: Modcomp provides a set of functions to maintain source, object, and load modules on disk storage; a file maintenance processor for files processed by the file manager; a direct-access maintenance processor for FORTRAN-defined direct access data files; and a sort/merge routine with a standard control language.

PERIPHERALS

Three fixed-head disk models, the 4103-1, 4104-1, and 4106-1, respectively provide storage capacities of 262,144 words (524,288 bytes), 524,288 words (1,048,576 bytes), and 1,048,576 words (2,097,152 bytes). Each disk drive has its own controller and contains 64, 128, or 256 tracks, 32 sectors per track, and 128 16-bit words per sector. Average rotational delay is 8.7 milliseconds, and the data transfer rate is 512K bytes (256K words) per second. The 4100 Series disk drives are manufactured by Digital Development Corp.

Models 4126/4127 *cartridge disk units* provide removable-cartridge storage for up to 1,299,200 16-bit words (2,598,400 bytes), while Models 4128/4129 provide storage for up to 2,598,400 16-bit words (5,196,800 bytes). Model 4126 consists of a controller for one to four drives and one 4127 drive. Model 4127 is the add-on drive for the 4126 subsystem. Model 4128 includes a controller for up to two drives; each drive includes two disk cartridges (IBM 1315-type), one of which is removable. Model 4129 is dual-cartridge add-on for Model 4128. Both units attach to the processor via the direct memory processor (DMP) channel, and the controller interface requires two slots in the peripheral controller interface. Write lockout is provided to insure track protection. Both models store data with 100 words per sector, 32 sectors per track, and 200 tracks plus 3 spares per surface. There are a total of 406 tracks on the 4126/4127 and 812 tracks on the 4128/4129. Data transfer rate is 97,800 words per second, and average access time is 90 milliseconds (including a 20-millisecond average rotational delay). Head positioning time is 15 milliseconds track-to-track and 135 milliseconds across all tracks. The drives rotate at 1500 rpm. The 4120 Series drives are manufactured by Diablo (Models 31 and 33).

The *4136 moving-head disk subsystem* consists of a controller and up to four disk drives, providing a total of up to 20 megawords (40 megabytes) of storage. The Model 4136 is the master drive and is provided with the controller. The Model 4137 is the add-on drive. The 4136 and 4137 each provide 5,013,504 words (10,027,008 bytes) of formatted storage. The subsystem connects to the processor by means of a direct memory processor channel and occupies two slots on the peripheral controller interface. Data is stored at 2200 bpi on the disk packs, which have 4 tracks per cylinder, 24 sectors per track, and 128 words per sector. There are 408 cylinders per pack. The drives have an average rotational delay of 12.5 milliseconds. Track-to-track, average, and across-all-tracks head movement times are 10, 35, and 70 milliseconds, respectively. Data transfer rate is 156.25K words (312.5K bytes) per second. The drives are rack-mountable and require 8¾ inches of vertical height. The 4136/4137 drives are manufactured by Wangco (Model T 2222).

There are eight models of the *4138 disk drives (IBM 3330-type)* offered: 4138-1 through 4138-8. The 4138-1 includes one 41,981,184-word (83,962,368-byte) disk drive and a controller for up to four drives. Model 4138-2 is the add-on disk drive. Models 4138-3 and -4 includes a dual-port adapter which permits two controllers to access one drive. Each disk drive that is to be "dual-accessed" must have the dual-port adapter. The 4138-3 includes one 4138-2 disk drive, dual-port adapter, and two disk controllers. The 4138-4 includes one 4138-2 disk drive and the dual-port adapter. The 4138-5 is the double-density version of the 4138-1 and includes one 83,962,368-word (167,924,656-byte) disk drive and a controller for up to four drives. The 4138-6, 4138-7, and 4138-8 are the double-density versions of the 4138-2, 4138-3, and 4138-4, respectively.

The 4138 disks have either 404 cylinders plus 7 spares, or, in the double-density version, 808 cylinders plus 7 spares; 19 tracks per cylinder; and 5,376 words (10,752 bytes) per track. Physical layout specifications for the 4138 include 128 words (256 bytes) per sector, 42 sectors per track, and 102,114 words (204,228 bytes) per cylinder. Also included in the 4138 subsystems are features such as error checking on an individual sector basis, overlapped seeks for two to four drives, and buffering of a full track of data. Average head positioning time is 28 milliseconds, and average rotational delay is 8.35 milliseconds.Track-to-track and across-all-tracks head movement times are 10 milliseconds and 55 milliseconds, respectively. The 4138 controller occupies four slots in the peripheral controller interface. The 4138 disk drives are supplied by Ampex (Models 9100 and 9200).

Two *floppy disk* models are offered. Model 4521 includes a single floppy disk drive and a controller; Model 4522 includes

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dual floppy disk drives and controller. The controller can support up to two drives and connects to the direct memory processor through one slot in the peripheral controller interface. The drive automatically unloads the heads 600 milliseconds after each transaction to minimize disk surface wear. Storage capacity is 157,696 words (315,392 bytes) per drive, with 128 words (256 bytes) per sector, 16 sectors per track, and 77 tracks per drive. Average rotational delay is 83.3 milliseconds with a disk rotational speed of 360 rpm, and average seek time over 28 tracks is 290 milliseconds. Track-to-track head positioning time and head settling time after the last step are both 10 milliseconds. Head load time is 80 milliseconds. The 4521/4522 floppy disk drives have a data transfer rate of 157,696 words (315,392 bytes) per second and are manufactured by Shugart.

The 4190 Memory+ System is a bulk core memory system designed to replace head-per-track swapping disks in high-performance systems. The bulk core subsystem operates as an I/O device and can accommodate up to 4 million bytes in 16 256K-byte increments. Addressing is organized into tracks and sectors, and Memory+ controller commands are the same as those issued to a head-per-track controller. One significant exception, however, is that Memory+ permits data transfers of as little as one word.

There are 128 words (256 bytes) per sector, 32 sectors or 4096 words (8192 bytes) per track, 32 tracks or 131,072 words (262,144 bytes) per module, 8 or 1,048,576 words (2,097,152 bytes) per file, 2 files or 2,097,152 words (4,194,304 bytes) per 4190, and up to four 4190's per CPU. Each Memory bulk core module is a continuous 128K by 18-bit array that is folded around the four surfaces of two printed circuit boards. The two boards are hinged together for easy access to any core area.

Each file can have its own dual-access interface, which permits the addition of a second device controller, allowing overlapped file access within a single-CPU system or shared access from another CPU. A self-test capability is present in each file, allowing either file in the Memory+ system to be taken off-line for testing or repair.

The controller operation is comparable to that of Modcomp's peripheral fixed-head disk systems, but there are significant performance differences. Access to a Memory+ device can occur within 1 microsecond following service initiation, and data can be transferred at rates of 3 to 4 megabytes per second using currently available Modcomp IV models. Should a main memory port be unavailable, data will be transferred via the I/O bus at its normal rate. Data buffering is not required since there are no overflow implications in the core memory modules.

The controller utilizes standard virtual-mode addressing for management of data transfers between Modcomp IV main memory and Memory+. Standard Modcomp II and IV main memory protect features are also implemented.

With two controllers connected to a single file, dual access to that group of up to eight core modules is time-shared. When two controllers are connected to two files, however, one controller may access one file while the other controller accesses the other file. Either controller can lock out the other form accessing either file.

The 4190 has a data transfer rate of 1.32 to 4.58 megabytes per second, average. Up to four-way block address interleaving using more than one 256K-byte module yields a transfer rate of 3.7 million bytes per second. Cycle time for the bulk core memory is 1500 nanoseconds, with an access time of 600 nanoseconds.

PRICING

Modcomp systems are available on a purchase-only basis, with separately priced maintenance and software.

Delivery is made FOB Modcomp's plant. The warranty period is 90 days after delivery. Modcomp provides one-time, no-charge, on-site installation at the purchaser's location within the contiguous United States. If a system is purchased with software, an additional $300 software service charge is billed, which includes delivery of the operating system (either Max II, III, or IV), support software (system languages) in object or load module form, and one set of software documentation. Additional copies of the software are available at prices specified in the equipment price list.

Software is supplied only with systems that have at least one disk drive or magnetic tape unit/disk drive combination. Software is always provided on the least costly medium that is compatible with the system configuration. Diagnostics and utilities are provided at no charge.

Modcomp provides software training for users with a basic knowledge of programming and maintenance training for those with at least two years of related technical training. Training courses are provided at the customer's site for a minimum of 10 students on a prearranged basis. Charges include $2000 for the first week and $1500 for week two or three, plus $60 per diem portal to portal and one round-trip economy air fare. Currently offered are 12 software courses varying in length from two days to two weeks and 21 maintenance courses varying in length from one to three weeks.

Full-service maintenance is provided under one of four plans. VIP service guarantees a response time of eight hours or less during prime time. Prime Time is defined as 8 a.m. to 5 p.m. Monday through Friday excluding Modcomp holidays. The VIP service also includes 12 preventive maintenance calls per year on a monthly schedule, unlimited remedial maintenance calls, six months to one year duration of contract with a 30-day termination clause after the initial six-month period, and no travel expenses if the customer is within a 50-mile radius of the service center. The maintenance rates quoted in the price tables are for VIP service.

Real-time service is a variation of VIP service offering four-hour response time. This service is billed at 1.25 times the rate of VIP service.

IP service is another variation of VIP service that offers the same features but without a guarantee as to response time. Pricing is available on a special-quote basis.

Extended service offers coverages which can range from a guaranteed two-hour response time up to and including coverage 24 hours a day, 7 days a week. Rates for this service are on a special-quote basis. A customer may not mix types of service within a single system configuration.

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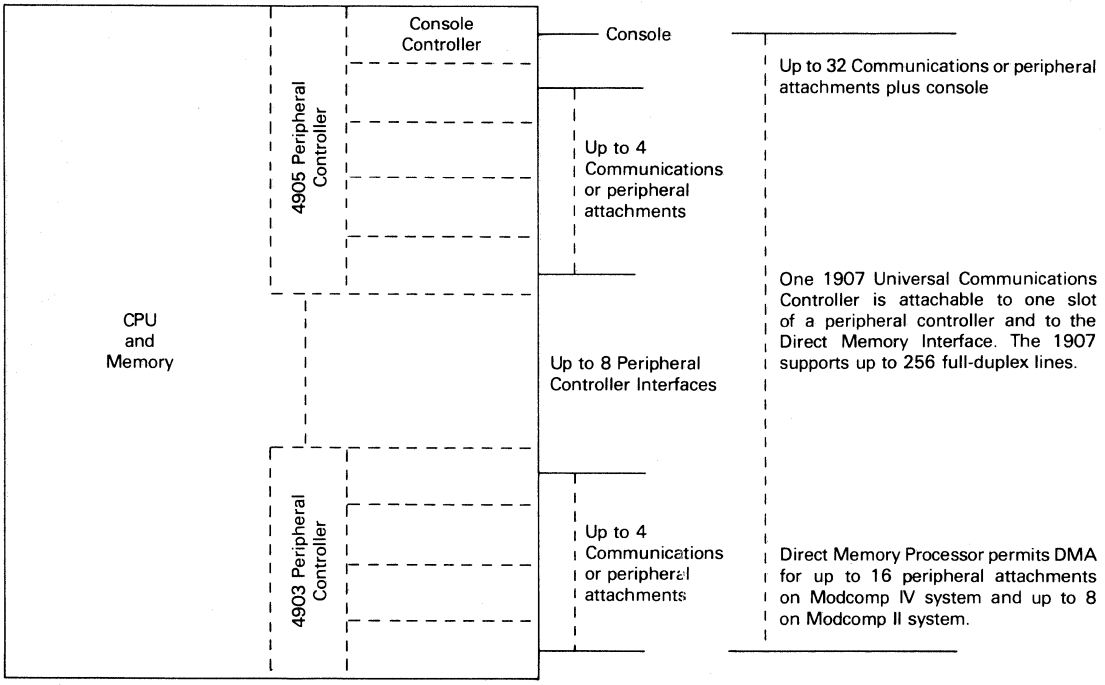
Configuration

Modcomp II or IV Computer System



		Purchase	Monthly Maint.
	Processors		
	Communications Processor, including Direct Memory Interface for Universal Communications subsystem, communications macros routines in ROM, and control console—		
II/26/CP2	Modcomp II CPU, 1.06-microsecond parity core memory, 64K bytes	21,650	258
II/45/CP2	Modcomp II CPU; 800-nanosecond parity core memory, 32K bytes, 4-port memory	24,250	185
IV/35/CP-3	Modcomp IV/35-B CPU; 1.06 microsecond parity core memory, 128K bytes, Direct Memory Processor, 4-port memory	55,400	360
	Memory		
3608	8K words of 800-nanosecond core for II/25, 45	4,330	30
3609	16K words of 800-nanosecond core for II/25, 45	6,700	33
3670	32K words of 1.06 microsecond core for II/26	8,250	45
3646-B	Memory Expansion Unit for IV/35 for 512K bytes, includes 4-port interface	9,800	50
3675	128K bytes 1.06 microsecond memory	17,950	90
	Peripheral Controller Interface		
4905	Peripheral Controller Interface with 375X Controller for console	2,580	10
4903	Peripheral Controller Interface	2,060	6
	Direct Memory Processor		
3704	8-channel DMP	1,550	8

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		Purchase	Monthly Maint.
	Communications		
1905	Asynchronous Multiplex Controller; 128 lines	1,240	50
1910	Asynchronous Multiplexer; 32 lines, 75-9600 bps	2,580	13
1912	Asynchronous Line Interface; 2-lines, RS-232C	515	5
1914	Asynchronous Line Interface; 2-lines, 20 ma current loop	515	5
1907A-2	Universal Communications Controller—		
	32-lines	3,710	50
1907A-3	64-lines	5,150	50
1907A-4	128-lines	8,240	50
1907A-5	192-lines	Home Office Quote	50
1907A-6	256-lines	Home Office Quote	50
	Universal Communications Chassis for 1907		
1930-IX	1 Port (32 lines)	3,610	30
	2 Port (32 lines)	4,440	30
	Line Interfaces—all 2 lines		
1931	Asynchronous; RS-232-C 75-19.2K BPS	515	
1932	Asynchronous; 20/60ma Isolated 75-19.2K BPS	515	
1933	Asynchronous; 20/60ma Bat. supplied 75-19.2K BPS	515	
1934-1	Byte-Sync.; RS-232-C 2K-9.6K BPS	570	
1934-2	Byte Sync.; Bell 301/303 19.2-230.4K BPS	670	
1934-3	Byte Sync.; CCITT V.35 40.8K BPS	600	
1939-1	Bit Sync.; RS-232-C 2K-9.6K BPS	825	
1939-2	Bit Sync.; Bell 301/303 19.2-230.4K BPS	905	
1939-3	Bit Sync.; CCITT V.35 40.8K BPS	850	
	Directly attached Line Interfaces—		
4810-XY	Asynchronous Interface; 2-lines, 20 ma current loop, 75-9600 bps	1,450	10
4811-XY	Asynchronous Interface; 2-lines, RS-232C, 75-9600 bps	1,450	10
4815	Synchronous Interface; 2-lines, RS-232C, 110-20K bps	1,450	10
4819	ACU Controller	2,900	13
	Console		
3752-X	Console Controller, RS-232C, for 4903 only	880	2
3753-X	Console Controller, Async Printer, for 4903 only	880	4
	Adapters		
1940	CDC 3000 Channel Adapter	6,000	—
1941	MC/CDC 3000, 6000 Satellite Coupler	8,000	80
1941-1	1941 with remote initialization	9,000	80
1950	MC/IBM 360, 370 Interface	8,000	70
1950-1	1950 with remote initialization	9,000	75
1950-2	1950 with power control	8,800	90
1950-3	1950 with remote initialization and power control	9,800	90
5950	IBM Emulator Channel	7,000	70
4820	MC/MC Parallel Computer Link	4,120	40
4824	MC/MC Serial Computer Link	2,060	40
	Disk Storage		
	Fixed-Head Disk and Controller—		
4103-1	256K words	18,600	105
4104-1	512K words	20,600	133
4106-1	1 Megaword	41,200	170
	Movable Head Disk and Controller—		
4126-1	1.3 megawords	9,800	85
4127	Additional 1.3 megaword drive for 4126-1	7,225	40
4128-1	2.6 megawords	12,900	125
4129	Additional 2.6 megaword drive for 4128-1	9,500	80
4136	10 megabytes	14,450	140
4137	Additional 10 megabyte drive for 4132	9,275	90
4138-1-E3	84 megabytes	33,000	230
4138-2-E3	Additional 84 megabytes drive for 4138-1-E3	25,750	200
	Controller and Floppy Disk drive—		
4521	150K words	4,020	40
4522	300K words	6,180	60

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		Purchase	Monthly Maint.
	Memory+ Bulk Core Storage		
4190	256K-byte Device File and Controller; up to 2 megabyte capacity	20,600	227
4191	256K-byte Device File; does not include controller; up to 4 megabyte capacity	15,450	115
4193	Memory+ Controller, with dual access	5,150	30
4192	256K-Byte Memory Module for 4190 or 4191	10,300	50
	Printers with Controllers		
4211-2	600-lpm Printer	17,000	125
4213	50-150-lpm Printer	9,500	91
4214-2	300-lpm Printer	14,450	75
4216-1	1000-lpm Printer	16,000	99
4217-1	Printer/Plotter	16,500	140
	Magnetic Tape Units with Controllers		
4148-1	9 track, 800 bpi	10,550	99
4156	9 track, 1600 bpi	10,300	165
4164-1	9 track, 75 ips, 800 bpi	13,700	135
4168-1	9 track, 1600 bpi, 75 ips	22,150	210
	Card Units with Controller		
4411-2	300-cpm Reader	5,310	50
4412-2	1000-cpm Reader	8,100	70
	CRTs		
4611	Basic CRT (requires 4811, 1912, or 1931)	2,010	25
4612	CRT; Hazeltine 1500 (requires 4811, 1912, or 1931)	2,840	25

SOFTWARE	**Purchase Price**
Modcomp II/IV Diagnostics/Utilities	20-1,250
MAX II, Core-resident version	600
MAX II/III Operating System/Support	800-2,300
MAX IV Operating System/Support	1,100-1,600
MAX IV Listings	4,000
MAX IV Support Software	700-1,200
MAX IV Support Listings	2,000
MAXCOM Software	500-1,000
MAXCOM Listings	1,200
VERSAPLOT Software	1,500-2,000*
VERSAPLOT Listings	1,500
X-Y Plotter Software	250-750*
X-Y Plotter Listings	100
IBM 2780/3780 Emulator Software	250-750*
IBM 2780 Emulator Listings	100
CDC 200 Emulator Software	250-750*
CDC 200 Emulator Listings	100
MAXNET III Software	1,000-1,500
MAXNET III Listings	1,200
MAXNET IV Software	1,100-1,600
MAXNET IV Listings	1,200
Sort/Merge	250-750*
Sort/Merge Listings	100

*Price depends on recording medium.■