

Computer Automation Naked Mini 4 (LSI 4 Series)

MANAGEMENT SUMMARY

Computer Automation, Inc., founded in 1967, has become one of the high-volume suppliers of minicomputers. The latest figures released by the company state that there are more than 25,000 CA minicomputer systems now in operation around the world, and that the company is currently shipping more than 150 systems per week.

Since its introduction of the Naked Mini 16 in April 1971, CA has addressed itself to the OEM and volume end user marketplace. Prior to this time, nearly all computer systems had been sold directly to their ultimate owners. The Naked Mini 16 was a general-purpose, three-board TTL processor that was offered in skeleton form so as to enable the OEM and volume end user to more easily design his specialized products and systems. The first Naked Mini 16 used 1600-nanosecond core memory and cost \$2,500 with 4K words, in single quantities. Both 16-bit and 8-bit Naked Mini versions were offered. With a chassis and power supply, the Naked Mini became the Alpha 16 or Alpha 8.

Over the next two years, approximately 3000 Naked Mini's were delivered—almost exclusively 16-bit machines.

In May 1973, CA took the next step forward and reduced the three boards to one, including up to 8K words of core memory, and called it the Naked Mini/LSI. The price, including 4K words of memory, was an impressively low \$990 in quantities of 200 or more—about half the price of its nearest competitors at the time. At the same

The Naked Mini 4 family, the current offering from Computer Automation, features a newly designed architecture with more registers, more powerful instructions, and faster execution times than its predecessor line. Like CA's previous LSI models, the new line is targeted directly at the OEM and large-volume end user markets.

CHARACTERISTICS

MANUFACTURER: Computer Automation, Inc., 18651 Von Karman, Irvine, California 92713. Telephone (714) 833-8830.

Computer Automation entered the market with the Naked Mini OEM minicomputer in 1971 and remained a strictly-OEM manufacturer until the end of 1975. The company is currently organized into three distinct divisions: the Naked Mini Division, the Industrial Products Division, and the Commercial Systems Division. The Naked Mini Division is responsible for the development and marketing of Computer Automation's mainstay minicomputer products, the LSI-2 series, the LSI-3 series, and the latest offering in the LSI family, the LSI 4 series, as well as specialty systems based on these computers. The Industrial Products Division markets the CAPABLE line of circuit testers to other manufacturers in the electronics industry. The Commercial Systems Division produces and markets the SyFA small business computer system (Report M11-168-301).

MODELS: Naked Mini and Alpha LSI 4/10, LSI 4/30, and LSI 4/90.

DATA FORMATS

BASIC UNIT: 16-bit word or 8-bit byte.



The LSI 4 family of processors includes the LSI 4/30, LSI 4/10, and LSI 4/90 (upper left to upper right). Packaged versions come in either an operator's console (lower left) or a programmer's console (lower right).

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▷ time, CA quietly decided to discontinue the marketing of 8-bit machines, concentrating instead on the 16-bit machines and their vastly larger market.

The Naked Mini/LSI, or LSI-1 as it was later named, was also offered in an Alpha version which included the new one-board processor and memory, power supply, chassis, and operator console. The Alpha LSI originally sold for \$1,990 in single quantities and could use up to 256K words of core or MOS memory.

The LSI-1 processor did not replace the existing Naked Mini 16 or Alpha 16, since it was a lower-performance version of the older minicomputers. That distinction was reserved for Computer Automation's line of LSI-2 minicomputers (Report M11-168-101) and the LSI-3/05 microcomputer, known as the Naked Milli (Report M11-168-201). The LSI-2 family currently includes the LSI-2/10, 2/20, and 2/60 MegaByter minicomputers. Still OEM-oriented, the LSI-2 minis are intended for use as components of large systems, and the "naked" versions are available only in quantities of five or more.

The Naked Milli (LSI-3/05) was unveiled in January 1975 and represented the low end of CA's line. Applications for the Naked Milli include industrial automation and machine control, distributed processing systems, lab monitoring, pollution control monitoring, and data entry/output control. Like its predecessors, the Naked Milli was offered as a single half-board or as a package with memories, power supplies, cabinets, and I/O controllers. The basic board was priced at \$295 (minimum order of 5) and, when combined with the different memories available, ranged in price from \$695 with 1K bytes of RAM to \$1,990 with 16K bytes of core memory.

The LSI 4 series, introduced in May 1977, is the latest entry in Computer Automation's line of minicomputers. Like its predecessors, the LSI-2 and LSI-3 series, the LSI 4 minicomputers address themselves to the OEM marketplace or large-volume end users and are offered in unpackaged (Naked Mini 4) configurations, consisting of a basic processor and memory, and in packaged versions (Alpha LSI 4) that include chassis, power supply, operator's console, and I/O ports in addition to the CPU and memory.

The new line of Naked Mini 4 computers includes three processors that CA claims are totally hardware- and software-compatible. At the low end, the LSI 4/10 is a full 16-bit minicomputer on a board that incorporates two custom N-channel MOS chips, 4K words of RAM or RAM/PROM memory, and 4 input/output channels, all packaged on a half-size (7.5 by 15 inches) circuit board. The basic LSI 4/10 is priced at \$645 per unit, with additional discounts available to volume purchasers. A basic packaged Alpha LSI 4/10 configuration is priced at \$995.

The Naked Mini 4/30 represents the company's new mid-range performance minicomputer, and offers significant price/performance improvements over the predecessor ▷

▶ **FIXED-POINT OPERANDS:** 16-bit words consisting of 15-bit integer and one sign bit. Negative numbers are in the two's-complement form. Larger fixed-point operands can be implemented through the use of optional variable-length byte string instructions.

FLOATING-POINT OPERANDS: Hardware option on all processors.

INSTRUCTIONS: The Naked Mini 4 family instruction set is divided into 14 functional groups, or classes, as follows:

Memory reference instructions—single- and multiple-word type; use the contents of memory in performing their operations.

Immediate instructions—operate on a selected register using a byte operand contained in the instruction.

Register-to-register instructions—reference two processor registers, a source and a destination register.

Shift instructions—perform shift and rotate operations on single registers and register pairs.

Conditional jump instructions—alter the sequence of program execution based on the result of a test Input/Output instructions; used to transfer data to/from peripheral devices.

Control instructions—used to regulate the operation of the processor and to enable and disable interrupts.

Stack instructions—enter data into, and retrieve data from, user-defined stacks in memory.

Trap instructions—used to emulate trap conditions.

Console service instructions—cause a data word to be transferred between the console and the processor, or between the console and memory, with the processor halting when the transfer has been made.

Character/numeric instructions—operate on characters and decimal numbers contained in strings within memory.

List instructions—operate on blocks of information in memory.

Floating point instructions—perform arithmetic and conversion operations on floating-point numbers.

Instructions are 1 or 2 words long, with 11 different formats. The first 64 words/bytes in memory are referred to as "scratchpad." These locations are the only ones accessible to instructions using direct addressing, and therefore can be addressed from anywhere in memory. Addressing modes include direct (to scratchpad), relative (to current location), indexed, indexed through scratchpad, indirect relative to current location, and indirect post-indexed.

INTERNAL CODE: ASCII.

MAIN STORAGE

STORAGE TYPE: Core or MOS.

CYCLE TIME: 850 or 1200 nanoseconds (full card) and 3 microseconds (half card) for core; 550 or 700 nanoseconds (full card) and 580 or 850 nanoseconds (half card) for MOS. Memory modules can be odd/even interleaved for faster effective cycle times.

CAPACITY: MOS memory—4K to 256K words in 1K, 2K, 4K, 8K, 16K, and 32K modules. Core memory—4K to 256K ▶

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PERIPHERALS/TERMINALS

DEVICE	DESCRIPTION	MANUFACTURER
MAGNETIC TAPE INPUT 18631-01	Industry-compatible, 25 ips, 9-track, 800 bpi, read/write, max. of 4 transports per controller (1 slot), 20KB/sec	—
LINE PRINTERS 22107-06 22107-32 45028-00 45028-02	80 columns, 64 characters, 120 cps or 60-150 lpm (½ slot) 132 columns, 64 characters, 165 lpm (½ slot) 132 columns, 64 characters, 300 lpm 132 columns, 64 characters, 600 lpm	Centronics Centronics Dataproducts Dataproducts
CARD UNIT 22077-20	Reader, 80-column, 285 cpm (½ slot)	Documation
PAPER TAPE UNITS 22223-11 22223-60	Reader, 300 cps (½ slot) Reader/Punch, 300/75 cps (1 slot)	Remex Remex
TERMINALS 22205-00 22851-63	Hard-copy terminal with paper tape read/punch CRT keyboard/display terminal, 24 lines by 80 characters, 128-character set, selectable data rate	Teletype ASR-33 Computer Automation

▷ LSI-2 and LSI-3 series. CA claims the 4/30 is typically twice as fast as the 4/10. A basic 4/30 with 16K words of RAM memory is priced at \$2,425. The basic packaged Alpha LSI 4/30 version carries a \$3,580 price tag.

The Naked Mini 4/90 is the top-performing member of the new family, and CA claims it is typically twice as fast as the 4/30. A basic 4/90 with 16K words of RAM memory is priced at \$3,220. The basic Alpha LSI 4/90 has 16K words of memory and a price tag of \$4,080.

Computer Automation stresses that the LSI 4 series of minicomputers features a "plug-in commonality" of hardware architecture and software packages. This means that each computer's instruction repertoire is a superset or subset of the other computers, and that all peripherals, memories, and other hardware items are usable with any and all processors.

All processors in the Naked Mini 4 family have the same 16-bit architecture, with six levels of priority vectored interrupts (including real-time clock, console, and four program-selectable I/O interrupt levels), multiple general-purpose registers, stack registers and instructions, 64K-word direct addressability, and both word and byte operations. Addressing modes include absolute, relative, and indirect, in several combinations with indexing. I/O modes are programmed, automatic, and DMA, all of which operate on word or byte data.

All Naked Mini 4 processors have a basic or "core" instruction set (subset) which is common to all processors, and the instruction set of each processor is a superset of the next more powerful machine's instruction

▶ words in 4K, 8K, and 16K modules. MOS and core memories can be intermixed.

CHECKING: MOS memories include invalid-data detect sensing logic which provides protection from accessing bad data resulting from power failures. Full-card MOS memories have an optional parity bit associated with each eight-bit byte.

STORAGE PROTECTION: None.

RESERVED STORAGE: About 20 of the first 256 words are normally reserved for device interrupt addresses.

CENTRAL PROCESSOR

GENERAL: There are currently three LSI 4 models: the LSI 4/10, LSI 4/30, and LSI 4/90. All offer the same 16-bit architecture with six levels of priority vectored interrupts (including real-time clock, console, and four program-selectable I/O interrupt levels), multiple general-purpose registers, stack registers and instructions, 64K-word direct addressability, and both word and byte operations; optional features include floating-point, list, and scientific instructions, and on-board battery backup for RAM memory. The LSI 4/10 is contained on a 7.5-inch by 16.9-inch half-card, while both the 4/30 and the 4/90 are contained on a full 15-inch by 16.9-inch card.

CONTROL STORAGE: None.

REGISTERS: All of the LSI 4 series processors contain eight 16-bit user-accessible registers, including two general-purpose accumulators, one index register/accumulator for post-index operations where indirect addressing is encountered, one index register/accumulator for pre-index operations, a stack pointer register, a stack limit register, a program counter, and a status word register.

INDIRECT ADDRESSING: Multilevel indirect addressing is possible.

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➤ set. All modules interface to a common Maxibus, which provides full I/O compatibility and "plug-in" interchangeability throughout the product line.

A unique feature of all of CA's LSI series systems is the Distributed I/O System. Connecting to the Maxibus, it consists of an I/O Distributor and "intelligent cables," each containing a PicoProcessor, a small microprocessor (3 by 8 inches and about 1 inch thick) with a 250-nanosecond cycle time. The I/O Distributor is a 7½-by-15-inch half-card that acts as a standard interface between the processor and up to eight I/O channels. Each I/O channel consists of an appropriately programmed PicoProcessor and an I/O device. The I/O Distributor buffers and steers data between the computer bus and the PicoProcessors. It also provides interrupt priority control and interrupt vectoring for two interrupts per PicoProcessor. This I/O system provides direct memory access (DMA) or direct memory channel (DMC) control to a wide range of devices, which can be 8- or 16-bit, serial or parallel mode. Automatic byte packing and unpacking are also standard.

DMC is a data transfer method that operates like a DMA-type controller (in which, as the name implies, the controller transfers data directly to and from memory, keeping track of word/byte counts and buffer addresses in self-contained registers). Under DMC, the operation is similar, except that the count and address registers are not integral with the controller but instead are in selected locations in main memory, forming a small data control block. Updating these locations is done in the processor through execution of interrupt-driven direct memory channel instructions. Input and output operations, word or byte, can occur concurrently in any mix on all channels. Once started, data transfers continue until either the specified number have occurred or an error condition has been detected, at which time a separate vectored terminate interrupt is issued to the main processor.

A special feature, for serial channels only, is available to provide clocks and a special ASCII control mode. All common data rates from 75 through 19,200 bits per second are available for up to eight PicoProcessor interfaces for each distributor. Each channel can operate at any data rate, selectable by straps on the I/O Distributor.

The ASCII control mode is enabled or disabled for each device under program control. In this mode, each input character is examined. If the character is a carriage return, input is terminated and the appropriate vectored interrupt is generated. This means that an input operation can be concluded either by transferring the correct number of characters or by detection of carriage return. In addition, under ASCII control mode, the eighth (parity) bit of each input character can be unconditionally set to one to speed up formatting.

The PicoProcessor contains interface drivers and receivers. It translates peripheral interface signals into standardized three-state bus signals and passes them on to the I/O Distributor. This microprocessor responds to ➤

➤ **INDEXING:** Memory addresses can be indexed using the X and Y registers. Pre- and post-indexing is also possible during indirect addressing operations.

INSTRUCTION REPERTOIRE: The LSI 4/10 processor has 85 standard and 37 optional instructions. The standard instruction set is made up of 13 single-word memory reference instructions, 9 immediate instructions, 3 multiple-word memory reference instructions, 12 register-to-register instructions, 6 single-register shifts, 4 bit manipulation instructions, 16 conditional jumps, 6 control instructions, 8 I/O instructions, 2 emulate traps, 2 stack instructions, and 4 status change instructions. The 37 optional instructions consist of 3 single-register shifts, 9 double-register shifts, 18 multiple-word memory reference instructions, and 7 floating-point instructions.

The LSI 4/30 processor has 102 standard and 24 optional instructions. The standard instruction set has 13 single-word memory reference instructions, 9 immediate instructions, 8 multiple-word memory reference instructions, 12 register-to-register instructions, 9 single-register shifts, 9 double-register shifts, 4 bit manipulation instructions, 16 conditional jumps, 6 control instructions, 8 I/O instructions, 2 emulate traps, 2 stack instructions, and 4 status change instructions. The 24 optional instructions consist of 13 double-word memory reference instructions, 7 floating-point arithmetic instructions, and 4 list instructions.

The LSI 4/90 has 115 standard and 24 optional instructions. The standard instruction set has 13 single-word memory reference instructions, 9 immediate instructions, 21 multiple-word memory reference instructions, 12 register-to-register instructions, 9 single-register shifts, 9 double-register shifts, 4 bit manipulation instructions, 16 conditional jumps, 6 control instructions, 8 I/O instructions, 2 emulate traps, 2 stack instructions, and 4 status change instructions. The optional instructions consist of a business set of 13 character/numeric string manipulation instructions or a scientific set of 7 floating-point instructions, and 4 list instructions. The business set and scientific set are mutually exclusive.

INSTRUCTION TIMINGS: All times shown are in microseconds for full-word, fixed-point operands and direct addressing mode. The execution times shown are for an LSI 4/10 with 850-nanosecond on-board MOS memory, an LSI 4/30 with 700-nanosecond MOS memory, and an LSI 4/90 with 550-nanosecond MOS memory.

	<u>4/10</u>	<u>4/30</u>	<u>4/90</u>
Copy	3.6	1.8	1.3
Add/Subtract	3.0	1.8	1.5
Multiply/Divide	66.6/71.9	12.7/12.2	12.3/11.9
Compare and Skip	5.6	2.2	1.8

INTERRUPTS: Three types of interrupts are recognized by the system: I/O, Console, and the Real-Time Clock (RTC) interrupt. These interrupts are differentiated by vector addresses supplied externally in the case of the I/O interrupts or internally for the Console and RTC interrupts.

The LSI 4 series interrupt/trap system permits the CPU to execute one or more instructions outside the presently executing program flow to respond to conditions external or internal to the CPU. Both the interrupt and trap suspend the executing program and vector to a location in memory specific to the interrupt or trap being processed, where a single instruction is executed. Instructions executed at these specific locations are called "interrupt instructions." Valid interrupt instructions include automatic input word, automatic input byte, automatic output word, automatic output byte, increment and skip, jump and stack, jump and store, no operation, and halt. ➤

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➤ computer commands, manages all data transfers, including strobe and command line sequences, and monitors all peripheral status lines. No program intervention is required. Because the Pico-Processors are microprogrammed, only two different types, serial and parallel, are required to interface a wide range of both standard and special devices.

The serial PicoProcessor is available with EIA or current loop interface. The current loop unit controls a standard ASR teletypewriter, including automatic tape reader and motor on/off control. The EIA version controls CRT terminals or modems using five- through eight-bit characters and odd, even, or no parity.

The parallel PicoProcessor can be microcoded to control 8-bit, 16-bit, and 32-bit input and output devices. To date, standard programs have been developed for paper tape readers and punches, line printers, card readers, magnetic tape, and some general-purpose interface disciplines. Each PicoProcessor mounts in a small plastic box and can be attached to the peripheral it controls by adhesive-backed hook-and-loop fastening strips or by screws.

Computer Automation wisely prefers to keep the posture of an OEM-oriented vendor, selling its products to other manufacturers who add value by incorporating them into large systems. CA's service facilities consist of five repair sites: the factory in Irvine, California, and facilities in Ramsey, New Jersey (near New York); Elk Grove, Illinois (a suburb of Chicago); Dallas, Texas; and Watford, Hertfordshire, England (a suburb of London). CA's policy towards peripherals has always been simple and eloquent—buy directly from the manufacturer and save money. However, if a customer requests it, CA will include specified peripherals on a package basis, and is now offering its own CRT display terminal, introduced at the same time the LSI 4 Series was announced. This unit can be used with all LSI series computers. □

➤ The RTC interrupt is the highest-priority interrupt. The vector for the RTC interrupt is generated internally by the processor. The console interrupt, initiated by the console interrupt switch on the console, has a higher priority than I/O interrupts but lower than the RTC interrupt. The interrupt vector for the console interrupt is also generated internally by the processor. I/O interrupts are initiated by the I/O controllers connected to the MaxiBus. I/O interrupts are lower in priority than either RTC or console interrupts. Within a priority level, precedence is given to the module closest to the processor. The I/O controller supplies the interrupt vector during the interrupt address request cycle of the processor. All interrupt conditions can be enabled or disabled by the Status Inhibit (SIN) instruction and/or by bits in the Status Register.

PHYSICAL SPECIFICATIONS: The LSI 4 minicomputers are available in various processor/memory and packaged configurations. In the PC board versions, the systems are referred to as Naked Mini 4's, while the packaged versions are known as Alpha LSI 4 systems. The LSI 4/10 half-card PC board is 7.5 inches wide by 16.9 inches deep, while the LSI 4/30 and 4/90 full-card boards are 15 inches wide by 16.9 inches deep. Power requirements for the 4/10 are 5.4A at +5 volts; for the 4/30, 8.3A



The top-of-the-line LSI 4/90 is shown with a programmer's console, floppy disk (top), medium-capacity disk unit (below), and CA's own CRT terminal. The 4/90 processor is priced at \$10,075 when configured with 64K words of 550-nanosecond memory, chassis, power supply, and operator's console.

➤ at +5 volts; and for the 4/90, 13.5A at +5 volts. Operating environment for all LSI 4 systems is 32 to 122 degrees Fahrenheit with humidity not exceeding 95 percent (non-condensing).

INPUT/OUTPUT CONTROL

I/O CHANNELS: The MaxiBus supports 5 data transfer modes with 64 parallel lines. The modes are direct programmed I/O, interrupt programmed I/O, automatic word I/O under interrupts, automatic byte I/O under interrupts, and DMA.

Direct programmed I/O transfers the data directly to and from the operating registers of the processor. Programmed I/O instructions can be combined with Sense and Skip instructions to allow testing of controller or peripheral status prior to making a transfer.

In the interrupt programmed I/O mode, the processor can initiate an I/O operation with interrupts, in which case it will be interrupted when the operation is complete and will vector to an interrupt service routine.

The automatic word I/O mode permits the transfer of 16-bit data to or from memory at high data rates with minimal interruption of the main program. The auto I/O instruction is executed once per interrupt, transferring the data, incrementing the memory pointer and data count in a single instruction, and immediately returning to the mainline program. When all data has been transferred, the interface issues an End-of-Block interrupt. The automatic byte I/O mode operates exactly the same as the automatic word I/O mode but transfers 8-bit bytes, automatically packing or unpacking two bytes per word into memory. The maximum data transfer rate under the automatic I/O modes is 38K words/bytes per second for the LSI 4/10, 80K words/bytes per second for the LSI 4/30, and 115K words/bytes per second for the LSI 4/90. ➤

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► The Distributed I/O System, consisting of an I/O Distributor and "intelligent cables"—cable-mounted microprocessors (PicoProcessors) used as device controllers—is used for input/output control. A variety of intelligent cables can be connected to each I/O Distributor. The PicoProcessor controllers operate through the four automatic I/O instructions.

The following PicoProcessor controllers are available:

- Line printer controllers for any Centronics or Data-products line printer or equivalent.
- Card reader controller for any Documation card reader or equivalent.
- Paper tape reader controller for any Remex or Facit reader or equivalent.
- Paper tape punch controller for any Remex or Facit punch or equivalent.
- General-purpose byte-parallel controller for use with most 16-bit input or 8-bit output devices using positive- or negative-true logic and a "handshaking" I/O discipline.
- CRT controller for Computer Automation CRT.
- Teletypewriter controller for standard asynchronous TTY devices.
- Magnetic tape controller for 7- or 9-track NRZI or phase-encoded tape drives.
- IEEE controller for interfacing the bus system defined by the IEEE 488-1975 specification.
- 32-bit general-purpose controller for interfacing parallel, multi-byte wide devices. Word size is selectable in 8-bit increments up to 32 bits, and data is transferred under automatic I/O programming using and I/O polling discipline.
- BiSync controller for interfacing the I/O Distributor to peripheral devices that use BiSync protocol.

CONFIGURATION RULES: Each of the basic Naked Mini LSI 4 CPU's consists of one board and no chassis. Three and five half-card cages are provided for half-card (LSI 4/10) based configurations, and five and nine full-card chassis are offered for full-card (LSI 4/30, 4/90) configurations. Half-card modules can be used in full-card chassis. Expansion chassis are offered to allow for expansion beyond five or nine full cards. Each expansion chassis includes a five- or nine-slot chassis, a blank front panel, an expansion buffer controller, interconnecting cables, and a power supply. Up to two expansion chassis may be used to provide maximum capabilities of 27 full cards or 54 half cards.

Each core memory module requires one slot position. MOS RAM, ROM, and PROM memories and general-purpose I/O options require half a slot each. See the Mass Storage section and Peripherals/Terminals table for individual device slot requirements.

MASS STORAGE

45003-00 DUAL FLOPPY DISK SUBSYSTEM: This unit includes two drives, power supply, cables, and controller/interface. It is compatible with the IBM 3740 system. Capacity is 243K bytes per drive. Average head positioning time is 176 milliseconds, average rotational delay is 83

milliseconds, and data transfer rate is 15,625 words per second (nominal). The DMA-type controller can support two additional drives and requires 1/2 slot.

45009-00 MEDIUM-CAPACITY DISK SUBSYSTEM: This 5-million-word cartridge disk system includes a drive unit with one fixed and one removable disk and an interface for up to three additional drives. Average head positioning time is 35 milliseconds, average rotational delay is 12.5 milliseconds, and data transfer rate is 156K words per second. The interface and controller occupy two half-slot positions.

45011-00 MEDIUM-CAPACITY DISK SUBSYSTEM: This system is the same as the 45009-00 except that it has a 10-million-word capacity.

45014 HIGH-CAPACITY DISK SUBSYSTEM: This 80-million-byte removable-pack disk system includes a drive unit and controller for up to three additional drives. Average head positioning time is 30 milliseconds, average rotational delay is 8.3 milliseconds, and data transfer rate is 1.2 million bytes per second. The interface and controller occupy two half-slot positions.

INPUT/OUTPUT UNITS

Computer Automation will supply paper tape equipment, line printers, a card reader, disk units, and magnetic tape drives, but recommends that the user purchase only the interface from Computer Automation and the I/O devices directly from their manufacturers.

See also Peripherals/Terminals table.

COMMUNICATIONS CONTROL

For data communications, Computer Automation offers intelligent cables for TTY's, asynchronous modems, and bisync (RS-232 and RS-422) communications, 2-channel and 4-channel automatic calling unit multiplexers, and 4-channel and 8-channel asynchronous multiplexers.

ANALOG I/O SYSTEM

This system provides analog-to-digital (A/D) and digital-to-analog (D/A) converters for laboratory and industrial applications. Two high-level A/D converters on a half-card and an A/D-D/A converter combination, also on a half-card, are available.

SOFTWARE

OPERATING SYSTEMS: Three operating systems are available for the LSI 4 series, including a basic memory-resident system. All are separately priced. The memory-resident system can include the Omega conversational assembler/editor and utility package with loaders and debuggers.

A *Real-Time Executive (RTX4)* is offered as a modular system consisting of a multi-tasking executive, an I/O supervisor, a communications supervisor, and a real-time debugging program. RTX4 is designed to help the OEM user construct real-time application programs.

The *OS4 Operating System* is available to support disk, magnetic tape, and other standard peripheral devices. OS4 is a device-independent, batch-oriented system that supports program development and provides automatic control of job sequencing, I/O, interrupt handling, library support, file management, and on-line operator communication.

LANGUAGES: The user has a choice of two assemblers, *Omega 4*, a conversational assembler/editor that operates in

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► **8K, and MACRO**, a full macro assembler used with OS4. CA also offers *FORTRAN IV* for program development. The complete *FORTRAN IV* plus extensions compiles and executes under either OS4 or RTX4.

UTILITIES: The *Multi-Terminal Editor (MULTED)* allows up to four users to concurrently create or edit source files while allowing production programs to execute in a background partition. MULTED runs under the OS4 operating system on 64K-word systems, with support for program development shared in the foreground 32K partition and 32K reserved for background production. Programs in assembler or higher-level languages can be developed under MULTED.

The system provides the terminal users with the ability to create a new file, edit an existing file, submit a checked-out file to the batch queue for processing, send a message to another edit terminal, and get a command summary display by typing "HELP." The source editor is a line-oriented text editor that provides insertion and deletion operations on source text. Character editing, including string search and string replacement functions, is also provided. With MULTED the user can create or edit text for use as source input to the Naked Mini 4 assembler or compilers. By using re-entrant code, only one copy of the editor resides in memory to service up to four users.

A number of basic utilities and program development aids are also available.

APPLICATIONS: In general, the user must develop his own applications programs. A user library is offered free to all CASH (Computer Automation System House) network members.

PRICING

POLICY: Computer Automation provides the Naked Mini LSI 4 minicomputers for sale only in quantities of five or more units. Alpha systems are available in single-unit quantities. The OEM-oriented company also recommends that buyers of its computers deal directly with other vendors for peripheral/terminal equipment, but will provide certain units if desired. Most software is separately priced, as are all elements of the system that are not necessarily required by the OEM buyer.

SUPPORT: The amount of field support provided depends strictly upon individual negotiations and is related directly

to the purchase quantity. Computer Automation provides system support from 15 U.S. locations as well as 13 other offices worldwide. The LSI 4 processors are covered by a one-year warranty.

On-site maintenance is generally the responsibility of the user, and can be performed rather easily through simple board replacement. Users, therefore, should keep a supply of spares on hand.

Computer Automation also provides one-week programming/maintenance training courses for \$2,000 per man per week. Training credits are granted to new customers, are relative to the total number of units sold via a purchase order, and are issued on an initial-order basis only. Training credits allocated to DOS customers are issued on an order-by-order basis, relative to the quantity sold. These credits are valid for six months after date of issue and can be applied only to courses taught at the Irvine facility. The current training credit allocation scale is:

6-25 units: 1 free week
25-50 units: 2 free weeks
50+ units: 3 free weeks
1-9 DOS: 2 free weeks
10+ DOS: 3 free weeks

EQUIPMENT: A Naked Mini 4 system with an LSI 4/10 processor, 4K words of on-board RAM memory, MaxiBus interface, power-fail/auto-restart, real-time clock, four I/O distributor channels, and a 3-half-card housing with power supply and operator's console is priced at \$995.

A Naked Mini 4 system with an LSI 4/30 processor, 16K words of 700-nanosecond RAM memory, MaxiBus interface, power-fail/auto-restart, real-time clock, 5-full-card housing with power supply and operator's console, and 4-channel distributor is priced at \$3,580.

A Naked Mini 4 system with an LSI 4/90 processor, 32K words of 550-nanosecond memory with battery backup and parity, MaxiBus interface, power-fail/auto-restart, real-time clock, 9-full-card housing with power supply and programmer's console, and 8-channel I/O distributor is priced at \$6,760.

See the Equipment Prices section following for the prices of the various packaged Alpha LSI 4 configurations. ■

EQUIPMENT PRICES

All Naked Mini 4 Family processors have identical architecture and a MaxiBus interface which provides compatibility throughout the line. All processors include power fail/auto restart, auto load, and real-time clock as standard features. LSI 4/10 processors include four I/O distributor channels on the CPU board.

	Purchase Price
LSI 4/10 COMPUTERS	
53730-31 CPU with 1K words of RAM and 3K PROM sockets	\$ 595
53730-04 CPU with 4K words of RAM	645
CPU/MEMORY COMBINATIONS	
CPU with RAM 700-nanosecond, full-card memory	
41046-00 4/10 with 8K words	1,195
41047-00 4/10 with 16K words	1,995
41049-00 4/10 with 32K words	3,295
CPU with RAM 700-nanosecond, full-card memory with battery backup:	
41076-00 4/10 with 8K words	1,325
41077-00 4/10 with 16K words	2,125
41079-00 4/10 with 32K words	3,425

**Computer Automation Naked Mini 4
(LSI 4 Series)**

EQUIPMENT PRICES

CPU/MEMORY COMBINATIONS (Continued)

**Purchase
Price**

CPU with RAM 700-nanosecond, full-card memory with battery backup and parity:

41107-00	4/10 with 16K words	2,225
41109-00	4/10 with 32K words	3,600
41107-00	4/30 with 16K words	2,425
43109-00	4/30 with 32K words	3,800
49107-00	4/90 with 16K words	3,220
49109-00	4/90 with 32K words	4,570

CPU with RAM 550-nanosecond, full-card memory with battery backup

43067-00	4/30 with 16K words	2,840
43069-00	4/30 with 32K words	4,250
49067-00	4/90 with 16K words	3,240
49069-00	4/90 with 32K words	4,650

CPU with RAM 550-nanosecond, full-card memory with battery backup and parity:

43097-00	4/30 with 16K words	3,015
43099-00	4/30 with 32K words	4,425
49097-00	4/90 with 16K words	3,415
49099-00	4/90 with 32K words	4,825

CPU with RAM 580-nanosecond, half-card memory:

41075-15	4/10 with 16K words	995
41075-31	4/10 with 32K words	1,295
43075-15	4/30 with 16K words	1,995
43075-31	4/30 with 32K words	2,295
49075-15	4/90 with 16K words	2,495
49075-31	4/90 with 32K words	2,795

CPU with RAM 580-nanosecond, half-card memory with battery backup:

41075-16	4/10 with 16K words	1,095
41075-32	4/10 with 32K words	1,395
41075-64	4/10 with 64K words	2,595
43075-16	4/30 with 16K words	2,095
43075-32	4/30 with 32K words	2,395
43075-64	4/30 with 64K words	3,595
49075-16	4/90 with 16K words	2,595
49075-32	4/90 with 32K words	2,895
49075-64	4/90 with 64K words	4,095

CPU with core 850-nanosecond, full-card memory:

41005-00	4/10 with 4K words	1,570
41006-00	4/10 with 8K words	2,245
43005-00	4/30 with 4K words	1,970
43006-00	4/30 with 8K words	2,645
49005-00	4/90 with 4K words	2,370
49006-00	4/90 with 8K words	3,045

CPU with core 1200-nanosecond, full-card memory

41017-00	4/10 with 16K words	3,100
43017-00	4/30 with 16K words	3,250
49017-00	4/90 with 16K words	3,650

CPU with core 3000-nanosecond, half-card memory

41023-00	4/10 with 4K words	1,280
41024-00	4/10 with 8K words	2,130

ALPHA CONFIGURATIONS

Includes CPU, RAM memory, chassis, power supply, operator's console, power fail/auto restart, auto load capability, and 4 input/output ports for use with intelligent cables in 4/10 configurations and 8 input/output ports in 4/30 and 4/90 configurations.

41110-00	Alpha 4/10A with 10-amp power supply, 4K words of memory	995
41111-00	Alpha 4/10B with 17-amp power supply, 4K words of memory	1,195
45067-00	Alpha 4/10E with 17-amp power supply, 16K words of memory	1,670
45095-00	Alpha 4/10G with 17-amp power supply, 32K words of memory	1,970
45096-00	Alpha 4/30F with 36-amp power supply, 16K words of memory	3,580
45097-00	Alpha 4/30G with 36-amp power supply, 32K words of memory	3,880
45098-00	Alpha 4/30I with 36-amp power supply, 64K words of memory	5,080
45099-00	Alpha 4/90F with 36-amp power supply, 16K words of memory	4,080
45100-00	Alpha 4/90G with 36-amp power supply, 32K words of memory	4,380
45101-00	Alpha 4/90I with 60-amp power supply, 64K words of memory	10,075

Computer Automation Naked Mini 4 (LSI 4 Series)

EQUIPMENT PRICES

	Purchase Price
ADD-ON MEMORIES AND OPTIONS	
RAM memories, 700-nanosecond, full-card:	
11600-08 8K words	995
11600-16 16K words	1,895
11600-32 32K words	3,170
11601-08 8K words with battery backup	1,125
11601-16 16K words with battery backup	2,025
11601-32 32K words with battery backup	3,300
11611-16 16K words with battery backup and parity	2,125
11611-32 32K words with battery backup and parity	3,475
RAM memories, 550-nanosecond, full-card:	
11701-16 16K words with battery backup	2,145
11701-32 32K words with battery backup	3,555
11711-16 16K words with battery backup and parity	2,320
11711-32 32K words with battery backup and parity	3,730
RAM memories, 580-nanosecond, half-card:	
45089-15 16K words	
45089-31 32K words	1,250
45089-16 16K words with battery backup	1,050
45089-32 32K words with battery backup	1,350
Core memories, 3000-nanosecond, half-card:	
11671-04 4K words	985
11703-08 8K words	1,895
Core memories, 1200 nanosecond, full-card:	
11673-16 16K words	3,050
Core memories, 850-nanosecond, full-card:	
11677-04 4K words	1,275
11677-08 8K words	1,950
RAM memories, 850-nanosecond, half-card:	
11642-14 4K words	550
11642-18 8K words	900
RAM/PROM memories, half-card:	
53678-00 No RAM, PROM sockets	280
53678-39 256 words of RAM, PROM sockets, battery backup	400
53678-59 1K words of RAM, PROM sockets, battery backup	510
53678-69 2K words of RAM, PROM sockets, battery backup	660
HOUSINGS	
3-half-card housings:	
10303-00 10-amp basic housing	325
40011-00 10-amp with operator console	400
40012-00 10-amp with programmer console	650
40020-00 17-amp basic housing	425
40021-00 17-amp with operator console	450
40022-00 17-amp with programmer console	700
5-half-card housings:	
10305-00 17-amp basic housing	475
40031-00 17-amp with operator console	575
40032-00 17-amp with programmer console	825
5-full-card housings:	
10506-00 25-amp basic housing	795
40051-00 25-amp with operator console	895
40052-00 25-amp with programmer console	1,145
12098-00 25-amp with expansion panel/buffer	940
40060-00 36-amp basic housing	1,095
40061-00 36-amp with operator console	1,195
40062-00 36-amp with programmer console	1,445
40063-00 36-amp with expansion panel/buffer	1,245

Computer Automation Naked Mini 4
(LSI 4 Series)

EQUIPMENT PRICES

		Purchase Price
HOUSINGS (Continued)		
9-full-card housings:		
10508-00	36-amp basic housing	1,295
40071-00	36-amp with operator console	1,395
40072-00	36-amp with programmer console	1,645
12099-00	36-amp with expansion panel/buffer	1,595
40080-00	60-amp basic housing	1,495
40081-00	60-amp with operator console	1,595
40082-00	60-amp with programmer console	1,845
40083-00	60-amp with expansion panel/buffer	1,795
CPU/MEMORY OPTIONS		
49682-39	Autoload ROM supporting paper tape reader	50
49682-38	Autoload ROM supporting floppy disk and paper tape reader	75
49782-37	Autoload ROM supporting magnetic tape, medium-capacity disk controller, high-capacity disk controller, and floppy disk	100
12048-01	Battery pack for half-card RAM; mounts on 10-amp and 17-amp power supplies	195
53686-01	LSI 4/10 expanded instruction set	175
53686-02	LSI 4/10 memory battery backup	195
53686-03	LSI 4/10 expanded instruction set and memory battery backup	295
53698-01	LSI 4/30 expanded instruction set	295
53772-02	LSI 4/90 floating-point instruction set	395
DISTRIBUTED I/O		
I/O Distributors:		
53701-02	4-channel distributor	250
53701-01	8-channel distributor	290
14674-02	4-channel distributor, DMA	735
14674-04	4-channel IOD with any 2 Type 1 cables	105
Type 1 Intelligent Cables:		
14630-10	CRT (RS-232-compatible for 22851-80 CRT)	160
14632-01	TTY, current loop-20 ma	160
14630-02	Asynchronous modem, RS-232	160
14631-01	Line printer (Centronics)	160
14631-13	Line printer (Dataproducts)	195
14631-02	Card reader (Documation)	195
14631-03	Paper tape reader (Remex)	160
14631-53	Paper tape reader (Trend)	195
14631-04	Paper tape punch (Remex)	160
14631-54	Paper tape punch (Facit)	195
14631-11	General-purpose, negative-true, 16 bits in/8 out	160
14631-12	General-purpose, positive-true, 16 bits in/8 out	160
Type 2 Intelligent Cables:		
14631-41	Magnetic tape	300
14676-01	IEEE-488 interface	300
14722-01	General-purpose, negative-true, 32-bit	225
45000-00	BiSync/Async, RS-232	300
45001-00	BiSync/Async, RS-422	300
MASS STORAGE		
Floppy Disk Subsystems:		
45003-00	Dual drive with controller	2,700
22566-20	Add-on dual drive	2,300
45007-00	Single drive with controller	2,010
22566-21	Add-on single drive	1,610
14696-01	Floppy disk controller	930
15566-01	Cable for floppy disk controller	75
Medium-Capacity Disk Subsystems:		
45009-00	5-million-byte subsystem	9,100
45011-00	10-million-byte subsystem	9,600
14702-01	Medium-capacity disk controller	2,100
14694-10	Add-on PME controller	1,200
15949-10	Daisy chain cable (PERTEC)	420
22530-00	5-million byte add-on drive	8,100
45008-00	10-million byte add-on drive	8,600
45102-00	Diablo compatible device cable	420

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EQUIPMENT PRICES

MASS STORAGE (Continued)

High-Capacity Disk Subsystems:

		Purchase Price
14655-11	High-capacity disk controller	2,500
14655-20	Add-on PME controller	1,400
15655-02	10-foot cable	300
15655-12	20-foot cable	325
15655-22	30-foot cable	350
45014-00	80-million-byte disk subsystem	17,300
45030-00	80-million-byte add-on drive	15,300

PERIPHERALS

18631-01	Magnetic tape subsystem; 25 ips, 800 bpi, with formatter and intelligent cable	10,000
22205-00	ASR 33 teleprinter (Teletype)	1,695
22215-00	ASR 33 teleprinter mod kit	90
22851-63	CRT terminal (RS-232-compatible)	1,900
22077-20	Card reader, 285 cpm (Documentation)	4,425
2223-11	Paper tape reader, 300 cps (Remex)	1,945
2223-60	Paper tape reader, 300/75 cps (Remex)	5,625
22107-06	Line printer, 80 col., 100 cps (Centronics)	4,950
22107-32	Line printer, 132 col., 165 cps (Centronics)	8,435
45028-00	Line Printer, 300 lpm (Dataproducts)	11,800
45029-00	Line Printer, 600 lpm (Dataproducts)	16,000

COMMUNICATIONS

45015-02	2-channel automatic calling unit	350
45015-04	4-channel automatic calling unit	500
45060-04	4-channel asynchronous multiplexer	995
45060-08	8-channel asynchronous multiplexer	1,495
45081-15	15-ft. modem device cable	50
45080-25	25-ft. CRT device cable	50

ANALOG SUBSYSTEMS

High-Level A/D Converters:

11130-16	A/D 16 single-ended input channels with programmable gain	1,100
11131-16	A/D 16 differential input channels with programmable gain	1,500

A/D-D/A Converter Combinations:

12130-16	Dual D/A 16 single-ended input channels with programmable gain	1,700
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Distributed I/O:

45093-00	64-bit output module	400
45094-00	64-bit input module	400

SOFTWARE DEVELOPMENT HOUSINGS

40090-00	Desk cabinet with 5-full-card chassis, 36-amp power supply, and programmer's console	2,800
40090-01	Desk cabinet with dual floppy disk, 5-full-card chassis, 36-amp power supply, and programmer's console	5,500
40091-00	Desk cabinet	1,400
20807-01	Cabinet, 35 inches high	1,350
20211-01	Cabinet, 52 inches high	2,035

The above desk-style housings are intended for use in software development systems. When ordered with a CPU, memory, and at least 4 channels of distributed I/O, depending on memory size, the following software packages may be ordered free of charge on the same purchase order; with housing model 40090-00 and 8K of memory, OMEGA 4 (20029-00) and RTX 4 (19005-40); with housing model 40090-01 and 12K of memory, OMEGA 4 and RTX 4; with housing model 40030-09 and 16K of memory, OS 4 (93460-01) and RTX 4; with housing model 40090-01 and 32K of memory, OS 4, RTX 4, and FORTRAN IV (45066-00).

SOFTWARE PRICES

SYSTEMS SOFTWARE

19005-40	RTX4 Real-Time Executive (paper tape)	\$ 500
19005-41	RTX 4 Real-Time Executive (diskette)	500
45066-00	FORTRAN IV (diskette)	1,500
20029-00	OMEGA 4 (paper tape)	200
20029-01	OMEGA 4 (diskette)	200
45087-00	OMEGA 4 Plus (diskette)	500
93460-01	OS 4	2,000
45069-00	Multiterminal Editor (MULTED)	500

Computer Automation Naked Mini 4
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SOFTWARE PRICES

DIAGNOSTICS

Prices given below are for software supplied on diskette. If ordered on paper tape, add \$10 to the price given.

Processor Acceptance test:

45018-11	LSI 4/10	60
45018-21	LSI 4/10 with expanded instruction set	90
45018-31	LSI 4/30	60
45018-41	LSI 4/30 with expanded instruction set	90
45018-51	LSI 4/90	60
45018-61	LSI 4/90 with scientific instruction set	90
45018-71	LSI 4/90 with business instruction set	90
45083-01	Full-card RAM memory diagnostic	60
45021-01	Distributed I/O diagnostic	60
45022-01	IEEE-488 intelligent cable diagnostic	60
45024-01	Magnetic tape intelligent cable diagnostic	60
45026-01	Floppy disk, diagnostic with formatter and DLD	60
45025-01	Disk diagnostic	60
45027-01	Analog subsystem diagnostic	60
45082-00	Async multiplexer diagnostic and test cables (RS-232)	150

When one of the following disk cartridges is ordered, all software items on diskette which appear on the same sales order will be copied onto the cartridge.

45016-00/	Software on 5- or 10-megabyte disk cartridge	200
01		