

# Computer Automation Naked Mini 4 (LSI 4 Series)

## MANAGEMENT SUMMARY

Computer Automation, Inc., founded in 1967, claims to be the third largest supplier of minicomputers in the United States. The latest figures released by the company state that there are more than 18,000 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 latest 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). Computer Automation's revenues have grown from \$2.1 million in 1971 to more than \$30 million in fiscal 1976.

**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).

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

▷ 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 MegaByte 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 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, 24K and 32K modules. Core memory—▶

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

### PERIPHERALS/TERMINALS

DEVICE	DESCRIPTION	MANUFACTURER
<b>MAGNETIC TAPE INPUT</b>		
22224-15	Industry-compatible, 25 ips, 9-track, 800 bpi, read/write, max. of 4 transports per controller (1 slot), 20KB/sec	Pertec 7820
<b>LINE PRINTERS</b>		
22107-06	80 columns, 64 characters, 120 cps or 60-150 lpm (½ slot)	Centronics 306
22107-32	132 columns, 64 characters, 165 lpm (½ slot)	Centronics 103
<b>CARD UNIT</b>		
22077-20	Reader, 80-column, 285 cpm (½ slot)	Documation M200
<b>PAPER TAPE UNITS</b>		
22223-11	Reader, 300 cps (½ slot)	Remex 305
22223-60	Reader/Punch, 300/75 cps (1 slot)	Remex 3075
<b>TERMINALS</b>		
22205-00	Hard-copy terminal with paper tape read/punch CRT keyboard/display terminal, 24 lines by 80 characters, 64-character set, selectable data rate	Teletype ASR-33 ADDS 580
22230-00		
22851-63	CRT keyboard/display terminal, 24 lines by 80 characters, 128-character set, selectable data rate	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 8K words of RAM memory is priced at \$1,690. The basic packaged Alpha LSI 4/30 version carries a \$2,395 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 8K words of RAM memory is priced at \$2,090. The basic Alpha LSI 4/90 has 16K words of memory and a price tag of \$4,395.

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 ➤

➤ 4K to 256K 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. ➤

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

➤ 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 812-nanosecond on-board MOS memory, an LSI 4/30 with 700-nanosecond MOS memory, and an LSI 4/90 with 550-nanosecond MOS memory.

	4/10	4/30	4/90
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. ➤

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

▷ 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.

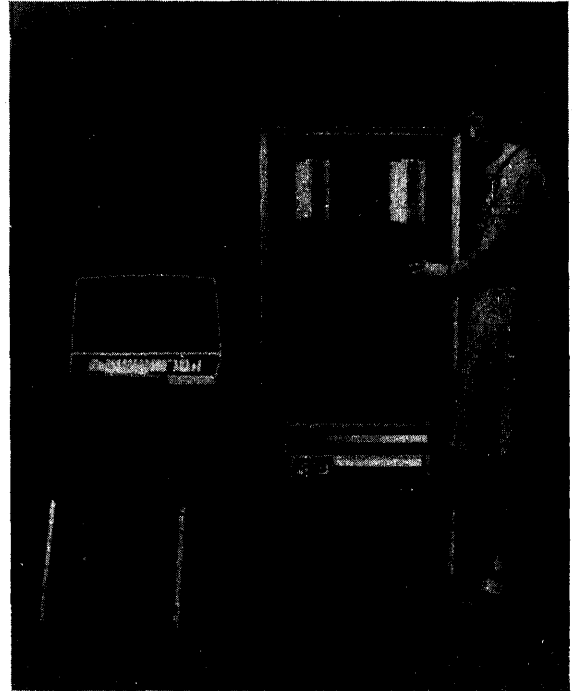
The serial PicoProcessor is available with EIA or current loop interface. The current loop unit controls a standard ASR teletypewriter, including automatic tape reader and motor on/off control. The EIA version controls CRT terminals or modems using five- through eight-bit characters and odd, even, or 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 4s, 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 new CRT terminal. The 4/90 processor is priced at \$9,950 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. ▶

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

► 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 or ADDS 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.
- SDLC controller for interfacing the I/O Distributor to synchronous data links that use SDLC 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.

**14655-11 HIGH-CAPACITY DISK CONTROLLER:** Interfaces up to four 40-, 80-, 150-, or 300-million-byte disk storage modules. 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

**SDLC COMMUNICATIONS CONTROLLER:** This is a high-performance microprogrammed DMA communications controller for interfacing any LSI series computer to a synchronous data link communications channel. Features include a multi-character data buffer, intelligent microprocessor-based design with on-board dedicated memory, half- or full-duplex operation at any standard rate up to 50K bits per second, EIA RS-232 interface standard with full data set controls, and internal diagnostics as a standard feature. The unit is composed of two half-cards and a connector panel with standard EIA 25-pin connector.

**BISYNC/ASYNCH COMMUNICATIONS PROCESSOR:** This is a high-performance microprogrammed DMA communications processor for interfacing 4 to 32 independent synchronous and/or asynchronous lines. Each line has independent half- or full-duplex operation with selectable character size and parity, and supports any standard rate up to 50K bits per second. Features include a multi-character data buffer, intelligent microprocessor-based design with on-board dedicated memory, EIA RS-232 interface with full data set controls, and internal diagnostics. The Bisync/Async Communications Processor is composed of a half-card and additional half-cards for each eight communication channels required. It includes from 4 to 32 channels, plus a connector panel with standard EIA 25-pin connector.

### ANALOG I/O SYSTEM

This system provides analog-to-digital (ADC) and digital-to-analog (DAC) converters for laboratory and industrial applications. It is available in two basic configurations: a dual DAC contained on a half-card, or a dual DAC together with an ADC on a half-card. Either half-card can be plugged into the mainframe of any LSI Series

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

computer. This data acquisition system can process up to 64 input channels of analog data at a throughput rate of 35,000 acquisitions per second (28.5 microseconds per conversion), and 2 analog output channels with a full-scale settling time of 1.0 microsecond.

The ADC subsystem includes a programmable real-time clock, end-of-conversion interrupt, and externally triggered data conversion as standard features. The analog-to-digital converter includes internal voltage regulation, an analog input multiplexer, a sample and hold amplifier, and a 12-bit A/D converter. The multiplexer features random, sequential, and wrap-around addressing modes of operation for 32 differential or 64 single-ended analog input channels. Analog input channels are protected against overvoltage.

The DAC subsystem contains two 12-bit digital-to-analog converters, a buffer register for each channel, an output power amplifier for driving up to 50 feet of cable, 2-axis control, and selectable set-up delay for intensity control signals to devices such as an oscilloscope, strip-chart recorder, and analog plotter. Each of the two DAC's has full 12-bit resolution with full-scale settling to within 1.0-microsecond for any of 4 switch-selectable output voltage ranges. Separate output buffer registers assure the independence of each analog output channel and provide an infinite hold capacity.

### 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 (RTX)* 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. RTX is designed to help the OEM user construct real-time application programs.

A full *Disk Operating System (DOS)* is available to support disk, magnetic tape, and other standard peripheral devices. DOS 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*, a conversational assembler/editor that operates in 8K, and *MACRO*, a full macro assembler used with DOS. CA also offers *BASIC*, *PASCAL*, and *FORTRAN IV* for program development. The complete *FORTRAN IV* plus extensions compiles under DOS, and compiled programs can be executed under either DOS or RTX.

*PASCAL*, a high-level block-structured programming language, operates under DOS in a minimum of 32K bytes of memory. *PASCAL* incorporates features of *COBOL*, *ALGOL*, and *PL/1*. According to CA, *PASCAL* contains the data structuring capabilities of *COBOL*, the compact arithmetic expressions of *PL/1*, the block-structured organization of *ALGOL*, and a complete set of diagnostic functions. *PASCAL* is well suited for quick, efficient development of DOS-based utilities and support routines. It also has an enhanced I/O capability to take full advantage of the DOS I/O system.

**UTILITIES AND APPLICATIONS:** A number of basic utilities and program development aids are available, but 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 \$2,995.

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 with 2 intelligent cables is priced at \$7,100.

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

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

### 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
<b>LSI 4/10 COMPUTERS</b>	
53730-01 CPU with 1K words of RAM	\$ 520
53730-31 CPU with 1K words of RAM and PROM sockets	595
53730-02 CPU with 2K words of RAM	595
53730-22 CPU with 2K words of RAM and PROM sockets	645
53730-04 CPU with 4K words of RAM	645
<b>CPU/MEMORY COMBINATIONS</b>	
CPU with RAM 700-nanosecond, full-card memory:	
41048-00 4/10 with 24K words	2,810
41049-00 4/10 with 32K words	3,465
43046-00 4/30 with 8K words	1,690
43047-00 4/30 with 16K words	2,590
43048-00 4/30 with 24K words	3,210
43049-00 4/30 with 32K words	3,865
49046-00 4/90 with 8K words	2,090
49047-00 4/90 with 16K words	2,990
49048-00 4/90 with 24K words	3,610
49049-00 4/90 with 32K words	4,265
CPU with RAM 700-nanosecond, full-card memory with battery backup:	
41076-00 4/10 with 8K words	1,420
41077-00 4/10 with 16K words	2,320
41078-00 4/10 with 24K words	2,940
41079-00 4/10 with 32K words	3,595
43076-00 4/30 with 8K words	1,820
43077-00 4/30 with 16K words	2,720
43078-00 4/30 with 24K words	3,340
43079-00 4/30 with 32K words	3,995
49076-00 4/90 with 8K words	2,220
49077-00 4/90 with 16K words	3,120
49078-00 4/90 with 24K words	3,740
49079-00 4/90 with 32K words	4,395
CPU with RAM 700-nanosecond, full-card memory with battery backup and parity:	
41107-00 4/10 with 16K words	2,420
41108-00 4/10 with 24K words	3,090
41109-00 4/10 with 32K words	3,770
43107-00 4/30 with 16K words	2,820
43108-00 4/30 with 24K words	3,490
43109-00 4/30 with 32K words	4,170
49107-00 4/90 with 16K words	3,220
49108-00 4/90 with 24K words	3,890
49109-00 4/90 with 32K words	4,570
CPU with RAM 550-nanosecond, full-card memory:	
43037-00 4/30 with 16K words	2,710
43039-00 4/30 with 32K words	4,120
49037-00 4/90 with 16K words	3,110
49039-00 4/90 with 32K words	4,520
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



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

### EQUIPMENT PRICES

	Purchase Price
<b>CPU/MEMORY COMBINATIONS (Continued)</b>	
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
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
49006-00            4/90 with 8K words	3,045
<b>ALPHA CONFIGURATIONS</b>	
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:	
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
41112-00            Alpha 4/10C with 17-amp power supply, 8K words of memory	1,695
41113-00            Alpha 4/10D with 25-amp power supply, 8K words of memory	1,995
41114-00            Alpha 4/10E with 25-amp power supply, 16K words of memory	2,795
41115-00            Alpha 4/10F with 36-amp power supply, 16K words of memory	3,095
43110-00            Alpha 4/30D with 25-amp power supply, 8K words of memory	2,395
43111-00            Alpha 4/30E with 25-amp power supply, 16K words of memory	2,995
43112-00            Alpha 4/30F with 36-amp power supply, 16K words of memory	3,495
43113-00            Alpha 4/30G with 36-amp power supply, 32K words of memory	4,695
43114-00            Alpha 4/30H with 60-amp power supply, 32K words of memory	5,195
49110-00            Alpha 4/90F with 36-amp power supply, 16K words of memory	4,395
49111-00            Alpha 4/90G with 36-amp power supply, 32K words of memory	5,795
49112-00            Alpha 4/90H with 60-amp power supply, 32K words of memory	6,195
49113-00            Alpha 4/90I with 60-amp power supply, 64K words of memory	9,595
<b>ADD-ON MEMORIES AND OPTIONS</b>	
RAM memories, 700-nanosecond, full-card:	
11600-08            8K words	995
11600-16            16K words	1,895
11600-24            24K words	2,515
11600-32            32K words	3,170
11601-08            8K words with battery backup	1,125
11601-16            16K words with battery backup	2,025
11601-24            24K words with battery backup	2,645
11601-32            32K words with battery backup	3,300
11611-16            16K words with battery backup and parity	2,125
11611-24            24K words with battery backup and parity	2,795
11611-32            32K words with battery backup and parity	3,475
RAM memories, 550-nanosecond, full-card:	
11700-16            16K words	2,015
11700-32            32K words	3,425
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
Core memories, 3200-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

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

**EQUIPMENT PRICES**

**ADD-ON MEMORIES AND OPTIONS (Continued)**

**Purchase  
Price**

RAM/PROM memories, half-card:

53678-00	No RAM, PROM sockets	280
11678-38	256 words of RAM, PROM sockets	305
11678-58	1K words of RAM, PROM sockets	415
11678-68	2K words of RAM, PROM sockets	565

**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

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

**COMPUTER OPTIONS**

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
53685-02	LSI 4/90 scientific instruction set	395
53685-01	LSI 4/90 business instruction set	395

**DISTRIBUTED I/O**

I/O Distributors:

53701-02	4-channel distributor	380
53701-01	8-channel distributor	485
53674-01	4-channel distributor, DMA	865
14640-14	4-channel IOD with any 2 Type 1 cables	495
14640-18	8-channel IOD with any 2 Type 1 cables	680

Type 1 Intelligent Cables

14630-10	CRT (CAI)	195
14630-01	CRT (ADDS)	195
14632-01	TTY, current loop—20 ma	195
14630-02	Asynchronous modem, RS-232	195
14631-01	Line printer (Centronics)	195
14631-13	Line printer (Dataproducts)	195
14631-02	Card reader (Documation)	195
14631-03	Paper tape reader (Remex)	195
14631-53	Paper tape reader (Trend)	195
14631-04	Paper tape punch (Remex)	195
14631-54	Paper tape punch (Facit)	195
14631-11	General-purpose, negative-true, 16 bits in/8 out	195
14631-12	General-purpose, positive-true, 16 bits in/8 out	195

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

### EQUIPMENT PRICES

	Purchase Price
<b>DISTRIBUTED I/O (Continued)</b>	
Type 2 Intelligent Cables:	
14631-41           Magnetic tape (Pertec)	300
14676-01           IEEE-488 interface	300
14722-01           General-purpose, negative-true, 32-bit	300
45000-00           BiSync/Async, RS-232	300
45001-00           BiSync/Async, RS-422	300
Type 3 Intelligent Cable:	
45002-00           SDLC, RS-232	450
<b>MASS STORAGE</b>	
Floppy Disk Subsystems:	
45003-00           Dual drive with controller	4,300
22566-20           Add-on dual drive	3,700
45007-00           Single drive with controller	2,900
22566-21           Add-on single drive	2,300
14696-01           Floppy disk controller	930
15566-01           Cable for floppy disk controller	75
Moving-Head 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
14655-10           Storage module disk controller	2,500
<b>PERIPHERALS</b>	
22205-00           ASR 33 teleprinter (Teletype)	1,695
22215-00           ASR 33 teleprinter mod kit	90
22215-01           Teleprinter cable	35
22851-63           CRT terminal (CAI)	1,900
22077-20           Card reader, 285 cpm (Documation)	4,425
2223-11           Paper tape reader, 300 cps (Remex)	1,945
2223-60           Paper tape reader, 300/75 cps (Remex)	5,656
22107-06           Line printer, 80 col., 100 cps (Centronics)	4,950
22107-32           Line printer, 132 col., 165 cps (Centronics)	8,438
<b>COMMUNICATIONS</b>	
45013-04           4-Channel Async/Bisync multiplexer	1,885
45013-08           8-Channel Async/Bisync multiplexer	2,825
45013-16           16-Channel Async/Bisync multiplexer	5,645
45013-24           24-Channel Async/Bisync multiplexer	8,470
45013-32           32-Channel Async/Bisync multiplexer	11,295
14652-01           SDLC communications controller	2,400
45015-02           2-Channel automatic calling unit	350
45015-04           4-Channel automatic calling unit	500
<b>ANALOG I/O SYSTEMS</b>	
<b>High-Level A/D Converter Systems</b>	
All converters are 12 bits, two's-complement with a 28.5-microsecond conversion time; switch-selectable full-scale analog inputs of 0-5V, + 5V, + 10V, and 0-10V; maximum sampling rate is software-dependent, but typically will be 35,000 samples/second; the real-time clock is programmable from 1 microsecond to 40 seconds; an optional programmable input gain amplifier multiplies the input by 1, 2, 4 or 8.	
11030-16           16 single-ended input channels	1,575
11130-16           16 single-ended input channels with programmable gain	1,750
11030-32           32 single-ended input channels	1,975
11130-32           32 single-ended input channels with programmable gain	2,150
11030-64           64 single-ended input channels	2,275
11130-64           64 single-ended input channels with programmable gain	2,450
11031-08           8 differential input channels	1,575
11131-08           8 differential input channels with programmable gain	1,750
11031-16           16 differential input channels	1,975
11131-16           16 differential input channels with programmable gain	2,150
11031-32           32 differential input channels	2,275
11131-32           32 differential input channels with programmable gain	2,450

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

**EQUIPMENT PRICES**

		<u>Purchase Price</u>
<b>General Purpose D/A Converter System</b>		
Two 12-bit, two's-complement converters are provided along with switch-selectable output ranges of 0-5V, + 5V, + 10V and 0-10V; maximum settling time of 1.0 microsecond; Z-axis intensity control and set-up delay; four TTL-compatible output lines for the transmission of control signals to analog devices.		
12031-00	2 output channels	950
<b>A/D-D/A Converter Combinations</b>		
Analog-to-digital converter and digital-to-analog converter contain the same features as described above.		
12031-08	8 differential input channels and 2 output channels	2,495
12131-08	8 differential input channels with programmable gain and 2 output channels	2,670
12031-16	16 single-ended input channels and 2 output channels	2,495
12131-16	16 single-ended input channels with programmable gain and 2 output channels	2,670
<b>Low-Level A/D Converter (=100MV)</b>		
11041-08	8 differential input channels	1,575
11041-16	16 differential input channels	1,975
11041-32	32 differential input channels	2,275
<b>SOFTWARE DEVELOPMENT HOUSINGS</b>		
40090-00	Desk cabinet with 5-full-card chassis, 36-amp power supply, and programmer's console	2,400
40090-01	Desk cabinet with dual floppy disk, 5-full-card chassis, 36-amp power supply, and programmer's console	6,500

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 40030-01 and 16K of memory, DOS 4 (19010-41) and RTX 4; with housing model 40090-01 and 32K of memory, DOS 4, RTX 4, and FORTRAN IV (20570-21).

**SOFTWARE PRICES**

19005-41	RTX Real-Time Executive	\$ 500
20570-21	FORTRAN IV (diskette)	1,500
19014-01	PASCAL (diskette)	900
19001-61	DOS BASIC (diskette)	400
19001-50	RTX BASIC (paper tape)	400
19001-51	RTX BASIC (diskette)	400
20029-00	OMEGA 4 (paper tape)	200
20029-01	OMEGA 4 (diskette)	200
19003-41	OMEGA 4 Plus (diskette)	300
19010-41	DOS 4	2,000