

Computer Automation Naked Milli (LSI-3/05)

MANAGEMENT SUMMARY

Introduced in January 1975, Computer Automation's Naked Milli (LSI-3/05) is the "little sister" of the company's LSI-2 Series family (Report M11-168-101), and has been very well received in the market. The latest enhancements to the Naked Milli include an analog I/O system, a magnetic tape controller, an IEEE controller, a 32-bit general-purpose controller, a floppy disk operating system, and an assembler/source editor.

The OEM Naked Milli is aimed at an in-between market—a market in which applications require more capability than is obtainable from slower microprocessors, but where users and designers do not need all the zip and flash offered by the ever upward-blossoming minicomputer systems or cannot tolerate their cost. Applications for the new processor are industrial automation and machine control, distributed processing systems, lab monitoring, pollution control monitoring, and data entry/output control.

The Naked Milli supports a real-time operating system (RTX) and a floppy disk operating system (3/05 FDOS) that includes an assembler/source editor (OMEGA). The assembly-language instruction set of the Naked Milli is a subset of that of the larger Computer Automation machines, and programs written for the Naked Milli can be run on the others. Programs already existing for larger CA LSI processors can also be assembled for use on the Naked Milli, since the cross-assembler substitutes appropriate macros for unimplemented instructions.

The Naked Milli, like its predecessor, is offered as a single half-board or as a package with memories, power

The Naked Milli represents the low end of CA's line, and, because of its placement in relation to minis and micros, competes with both. The Naked Milli is fully compatible with CA's LSI-2 series processors; system architecture is identical, and the instruction set is a subset of that of the Naked Mini systems.

CHARACTERISTICS

MANUFACTURER: Computer Automation, Inc., 18651 Von Karman, Irvine, California 92664. Telephone (714) 833-8830.

CA has offices in all major U.S. cities. In the United Kingdom, contact Computer Automation Ltd., St. Martin's House, 31/35 Clarendon Road, Watford, Hertfordshire WD1 1JA, England. Telephone (0923) 39627.

MODEL: Naked Milli (LSI-3/05).

DATA FORMATS

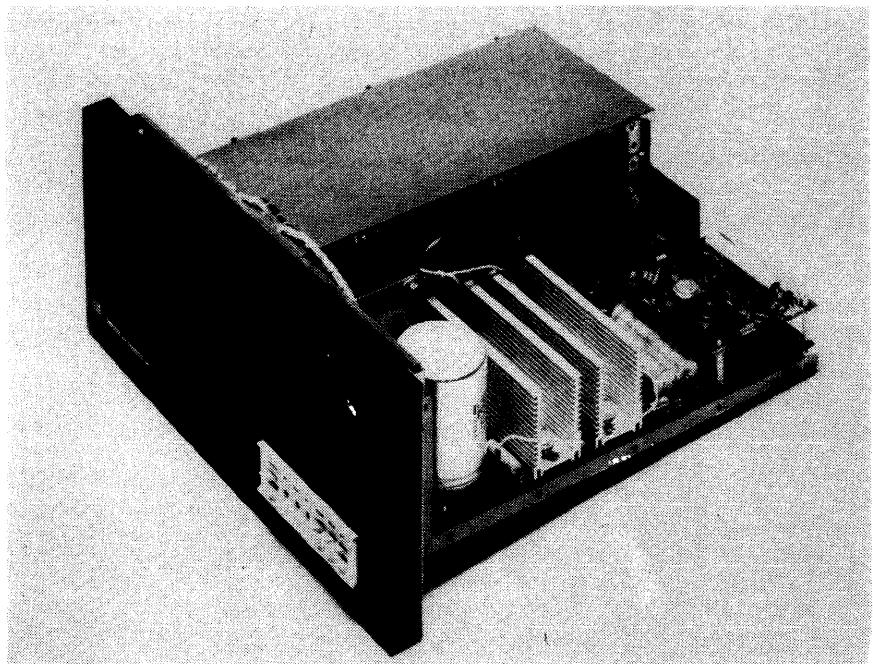
BASIC UNITS: Eight-bit bytes and 16-bit words.

FIXED-POINT OPERANDS: Binary, 15 bits plus sign; negative numbers in 2's complement form.

FLOATING POINT OPERANDS: Binary, two or three words; 7-bit exponent plus sign and 23- or 39-bit mantissa plus sign. Floating-point is by subroutine.

INSTRUCTIONS: One word, except direct memory channel I/O instructions (three words). Instruction set includes 8 arithmetic, 6 logical, 14 data transfer, 19 program transfer, 8 shift, 16 register change, 13 control, and 11 I/O including 4 direct memory channel instructions.

The packaged processor configurations of the LSI-3/05 Naked Milli range in price from \$825 to \$4,095. The smallest packaged version includes 256 words of RAM and sockets for up to 8K words of ROM and 2K words of PROM. The top-dollar configuration includes 16K words of core memory and a distributed I/O system with an I/O distributor and four intelligent cables.



Computer Automation Naked Milli (LSI-3/05)

supplies, cabinets, I/O controllers, and other useful hardware. The basic board is priced at \$295 (minimum order of 5) and, when combined with the different memories available, ranges in price from \$465 with 256 words of RAM to \$1,135 with 4K words of core memory. The packaged processor configurations range in price from \$825 to \$4,095.

The LSI-3/05 (CA's internal model designation for the Naked Milli) features architecture identical with that of the other LSI-series processors. It is a 16-bit machine with 95 instructions, 5 addressing modes, and 16-bit word or 8-bit byte processing. I/O transfers can be under program control, through DMA (direct memory access), or by "pseudo DMA" using direct memory channels (DMC).

CPU execution speeds lie between those of typical mini-computers and microcomputers. For example, a 16-bit add instruction takes between 6 and 7 microseconds, depending on overflow. This is less than one-third as fast as a DEC PDP-11/40 would perform the same function. On the other hand, the Intel MCS-4 takes three times as long as the Naked Milli to add two 16-bit numbers. As a further comparison, either the DEC PDP-11/05 minicomputer or the DEC LSI-11 microcomputer, which give the Naked Milli strong competition, needs 4.2 microseconds for the same operation.

A unique feature of all of CA's LSI Series computers is the Distributed I/O System. Connecting to the Maxibus, it consists of an I/O Distributor and one or more "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. The new I/O system provides interrupt priority control and interrupt vectoring for two interrupts per PicoProcessor. This new I/O system provides 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. (See Report M11-168-401 for additional details on the Distributed I/O System.)

The LSI-3/05 is up against some stiff competition in the minicomputer world. Because of its placement in relation to minis and micros, it competes with both. On the mini end, the Naked Milli competes in performance and characteristics with DEC's PDP-11 04 and LSI-11 models, and on the micro end with products such as National Semiconductor's IMP-16. The CA LSI-3/05 carries the smallest price tag of any of these (\$295 in lots of five) and claims the largest instruction set (95 instructions). It is, however, the slowest of the field and has no announced multiply/divide capabilities.

Memory reference instructions contain a 6-bit op code, a 3-bit address mode designator, and a 7-bit displacement. Shift instructions contain a 13-bit op code and a 3-bit shift count. Programmed I/O instructions are made up of an 8-bit op code and an 8-bit device address. Control instructions are 16-bit op codes.

INTERNAL CODE: Binary.

MAIN STORAGE

STORAGE TYPE: Core, MOS RAM, MOS PROM, or ROM in any combination (can be interleaved).

CYCLE TIME AND CAPACITY: See table below. (K=1,024 16-bit words.)

	Core	MOS RAM	MOS PROM	ROM
Capacity (K)	4, 8	½, 1, 2, 4, 8	2, 4	2, 4, 8
Cycle time, (nano-seconds)	980, 1200, 1600	1200	1200	1200

CHECKING: Core only, optional; one parity bit per byte.

STORAGE PROTECTION: None.

RESERVED STORAGE: Six locations in low memory for storage of internal interrupt vectors: power up, power down, real-time clock, uninstalled memory trap, unimplemented instruction trap, and console interrupt. In addition, one location must be reserved anywhere in memory for each I/O device in the system. The first 128 memory locations are considered "scratchpad."

CENTRAL PROCESSOR

GENERAL: The LSI-3/05 is basically a microcomputer with 95 macroinstructions implemented into its control memory. It consists of 84 integrated circuits (IC's), including four standard (i.e., "off-the-shelf") processor chips, and is mounted on 7½-inch by 15-inch "half-card." All memories and I/O controllers connect to a central bus (Maxibus) which is compatible with all other members of CA's LSI family. A set of microprogrammed controllers called intelligent cables connects through a special I/O Distributor made especially for the purpose. The processor cycle time is 250 nanoseconds.

CONTROL STORAGE: Bipolar read-only memory (ROM); 45-nanosecond access time, 512 24-bit words.

REGISTERS: Four program-accessible registers—one accumulator (A), an index register (X), program register, and program status register. All are 16-bit, TTL (transistor-transistor logic).

INDIRECT ADDRESSING: Multilevel indirect addressing is possible. It can be via scratchpad.

INDEXING: Postindexing, usable with direct or indirect addressing modes. Indexing can be program-relative. Indexed addressing modes are thus program-relative (plus and minus), direct, indirect indexed by X, and indirect indexed by X.

INSTRUCTION REPERTOIRE: 95 standard instructions: 25 memory reference, 10 byte immediate, 12 conditional jumps, 8 shifts, 16 register change, 13 control, and 11 I/O.

INSTRUCTION TIMINGS: All times are for one-word, fixed-point operands in *microseconds*, using 1200 nsec memory.

Computer Automation Naked Milli (LSI-3/05)

PERIPHERALS/TERMINALS

DEVICE	DESCRIPTION	SPEED
MAGNETIC TAPE		
22224-15	9-track, 800 bpi, 25 ips (uses 7-inch reels); four drives per controller interface; requires 1 slot	20KB
CARD EQUIPMENT		
22077-20	Reader, 80-column; requires ½ slot	285 cpm
LINE PRINTER		
22107-06	80 columns, ASCII character set; requires ½ slot	60-150 lpm
22107-32	132 columns, ASCII character set; requires ½ slot	165 lpm
PAPER TAPE		
22223-11	Reader	300 cps
22223-60	Reader/punch	300/75 cps
TELETYPEWRITER		
22205-00	ASR 33-20/3JC (modified)	110 bps
CRT TERMINALS		
22851-63	CRT keyboard/display terminal, 80 characters x 24 lines, 128-character ASCII set, selectable data rate	75-9600 bps

➤ 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. The only peripheral unit CA makes is a video display terminal, introduced at the same time the LSI-4 Series was announced. This unit can be used with all LSI Series computers (see Peripherals/Terminals table).

Software for the Naked Milli consists of the two operating systems; the OMEGA-3/05 assembly system; utilities including a bootstrap loader, binary loader (BLD), relocating object loader (LAMBDA), and link editor; a Distributed I/O System user microcode kit; and an arithmetic and statistical library package. □

➤

Load/Store:	5.25/8.0
Add/Subtract:	6.0/7.0
Multiply/Divide:	(software)
Compare and Branch:	6.75 to 7.75

INTERRUPTS: The LSI-3/05 contains one external interrupt level. Conflicts are resolved by each controller. Control is transferred through a 16-bit vector supplied by the controller. P (program) register storage is not automatic and must be included in the interrupt handler routine if desired. The JST instruction does this.

PHYSICAL SPECIFICATIONS

Dimensions:

Central Processor	7½ by 15 inches
Core Memories	15 by 15 inches
Semiconductor Memories	7½ by 15 inches
Standard Chassis	8¾ by 19 inches (includes power supply; provides 10 half-card slots.)
Jumbo Chassis	8¾ by 19 inches (does not include power supply; provides 18 half-card slots.)
MilliPack	8¾ by 19 inches (includes power supply; provides 4 half-card slots.)
Power Supply	5¼ by 19 inches

Voltages Required:

CPU, Memories, Controllers:	5 VDC, +12 VDC.
Power Supplies:	105-130 VAC, 60 Hz. (220 VAC, 50 Hz supplies are also available.)

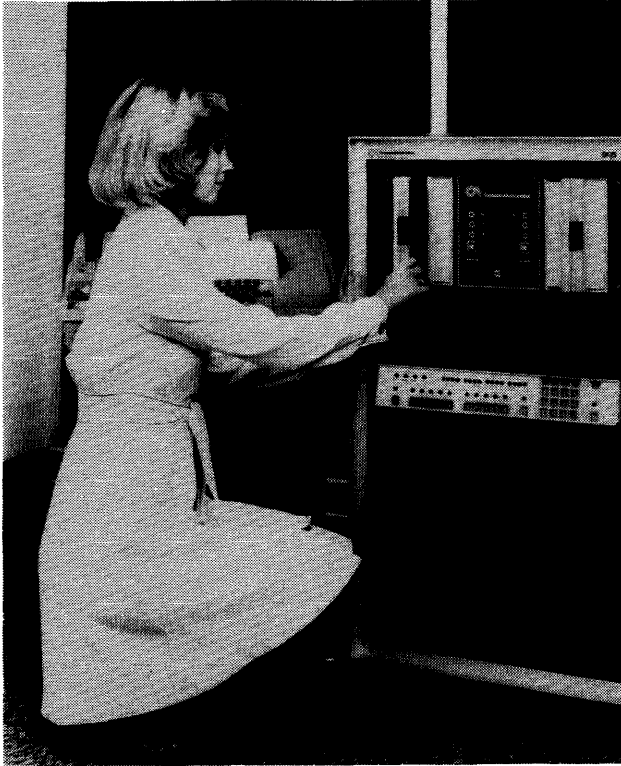
Operating Environment:

0-50° C., 0-95%
relative humidity.

INPUT/OUTPUT CONTROL

I/O CHANNELS: The LSI-3/05 has three I/O access mechanisms: programmed I/O transfers, direct memory access (DMA), and direct memory channels (DMC). Programmed transfers need no explanation, but the difference between DMA and DMC should be noted. Both techniques involve the controller accessing memory independently of the program operating in the CPU (cycle-stealing). DMA-type controllers are "primed" for the data transaction by the receipt of a "Start I/O" type of instruction which causes the controller to cycle-steal a three-word control packet from memory, store the control words in registers, and perform the indicated transfer. It continues cycle-stealing, updating the memory address and byte/word count until the specified number of transactions have been completed. It then signals termination via an interrupt. ➤

Computer Automation Naked Milli (LSI-3/05)



This LSI-3/05 Naked Milli system includes a dual-drive floppy disk unit. One of the recent enhancements to the Naked Milli is a Floppy Disk Operating System (FDOS). The minimum configuration required to use FDOS is a processor with 8K words of memory, a CRT or teletypewriter, and a floppy disk unit.

► DMC controllers, usually for lower-speed devices (card readers, paper tape equipment, terminals, etc.), operate similarly except that the control packet is not placed in registers on the controllers, but kept in memory and updated by processor hardware. DMC operation are initiated by programmed I/O. DMC is achieved by Auto I/O instructions. When the controller "needs" a data transfer, it generates an interrupt to the processor, resulting in execution of an Auto I/O instruction. For each data transfer, word or byte, the Auto I/O instruction is executed only once (i.e., one interrupt per data transfer). The Auto I/O instruction updates the I/O pointer and counter, which are two of the three words in the instruction itself. When the counter reaches zero, the execution of the instruction results in a signal telling the controller that the full data transfer is complete.

When it introduced the Naked Milli, CA also introduced the Distributed I/O System, consisting of an I/O Distributor and "intelligent cable"—cable-mounted microprocessors (PicoProcessors) used as device controllers. Eight intelligent cables can be connected to each I/O distributor. The PicoProcessor controllers operate in conjunction with the four automatic I/O instructions implemented in the LSI series processors.

The following PicoProcessor controllers are available:

14631-01 Line Printer controller for any Centronics line printer or equivalent.

14631-02 Card reader controller for any Documentation card reader or equivalent.

14631-03 Paper Tape Reader controller for any Remex or equivalent 300 character-per-second reader.

14631-04 Paper Tape Punch controller for any Remex or equivalent 75 character-per-second punch.

14631-11 General-Purpose byte-parallel controller, for use with most eight-bit input or output devices using negative-true logic and a "handshaking" I/O discipline.

14631-41 Magnetic Tape controller, for use with an external magnetic tape formatter to control up to four 7- or 9-track, NRZI or Phase-Encoded magnetic tape drives.

14676-01 IEEE controller, for interfacing the bus system defined by the IEEE 488-1975 specification; up to 14 IEEE 488-compatible peripherals can be attached.

14722-01 32-Bit General—Purpose controller, for interfacing parallel, multi-byte wide devices. Word size is selectable in 8-bit increments up to 32 bits. Data is transferred under Automatic I/O Programming control using an I/O polling discipline. Other interface disciplines can be implemented using a combination of computer software and PicoProcessor firmware control.

SIMULTANEOUS OPERATIONS: CPU operations can continue during DMA operations. I/O devices connected to the Distributed I/O System are limited to a combined transfer rate of 33K words per second.

CONFIGURATION RULES

As in other similar OEM-type processors, configuring LSI-3/05 systems focuses primarily on the power limitations of the bus. The Maxibus can drive up to 12 input loads (memories, controllers, I/O Distributors) before requiring refurbishing by an expansion chassis. Each I/O Distributor has connections for eight intelligent cables, and each system is limited to four distributors. Controllers are "limited" to 248 device addresses.

MASS STORAGE

18530-00 MOVING HEAD DISK SYSTEM: This disk unit uses the IBM 5440-type cartridge used with IBM's System/3 Models 6 and 10. It contains one fixed and one removable disk and has a total capacity of 4.92 million bytes. Average rotational delay is 20 milliseconds, average head positioning time is 40 milliseconds, and data transfer rate is 195K bytes per second. The controller has interfacing for up to three additional 22530-43 drives. Each drive requires 2 slots.

22530-00 MOVING HEAD DISK DRIVE: Add-on drive for 18530-43 above.

18566-00 DUAL FLOPPY DISK SYSTEM: 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 250K bits (not bytes) per second. The controller interfaces the DMA "channel" and can support an additional dual drive. It requires ½ slot.

22566-00 DUAL FLOPPY DISK DRIVE: Add-on unit for 18566-00 above. Requires ½ slot.

INPUT/OUTPUT UNITS

See Peripherals/Terminals Table.

COMMUNICATIONS CONTROL

14236-1X INTERFACE: For two CRT displays or modems. Provides RS-232C interface for two half-duplex channels, each with one control line and one status line. Available ►

Computer Automation Naked Milli (LSI-3/05)

► in speeds from 1100 to 9600 bits per second. Requires ½ slot.

14236-21 INTERFACE: For two modified ASR 33 teletypewriters 20-mA current loop interface, 110 bits per second, half-duplex operation. Has circuit for programmed on/off. Requires ½ slot.

14236-5X COMBINED CRT/TELETYPE INTERFACE: Consists of one 20-mA current loop interface at 110 bits per second and one RS-232C interface at 100 to 9600 bits per second. Both are half-duplex. Requires ½ slot.

14535-01 ASYNCHRONOUS MODEM CONTROLLER: For one full or half-duplex line with RS-232C interface. Five- to eight-bit character size; odd, even or no parity; echoplex and diagnostic loopback modes. Includes special character detection and variable stop bits. Handles 75 to 9600 bits per second. Send and receive speeds are independently strap-selectable. Has multiple vectored interrupts. Requires ½ slot.

14535-02 ASYNCHRONOUS MODEM CONTROLLER: For current loop interface. Requires ½ slot.

14512-21 ASYNCHRONOUS MODEM MULTIPLEXER: For two independent lines with RS-232C interfaces. Each line is programmable for full- or half-duplex operation; five- to eight-bit characters; odd, even, or no parity; echoplex and diagnostic loopback; special character detect; and variable stop bits. Send/receive speeds are individually strap-selectable, 75 to 9600 bits per second. Has multiple vectored interrupts for each line. Requires 1 slot.

14512-22 ASYNCHRONOUS MODEM MULTIPLEXER: Same as 14512-21 above except has current loop interface. Requires 1 slot.

14512-41 ASYNCHRONOUS MODEM MULTIPLEXER: Same as 14512-21 above except for four RS-232C lines. Requires 1 slot.

14512-42 ASYNCHRONOUS MODEM MULTIPLEXER: Same as 14512-41 above except has current loop interface. Requires 1 slot.

14513-00 SYNCHRONOUS MODEM CONTROLLER: For RS-232C or CCITT V.24 interface, full- or half-duplex line. Double buffered, programmable sync character, and one special character detect. Odd, even, or no parity and five- to eight-bit characters are program-selectable. Data rates to 9600 bits per second. Requires ½ slot.

14513-01 SYNCHRONOUS MODEM CONTROLLER: With internal clock option (1200-bps increments to 9600 bits per second).

14523-02 AUTOMATIC CALLING UNIT MULTIPLEXER: For two Bell 801 (ACU) or equivalent modems. Simultaneous operations, full digit buffering, and sense data line busy. Four vectored interrupts per data set.

14523-04 AUTOMATIC CALLING UNIT MULTIPLEXER: Same as 14523-02 above except it supports four Bell 801 or equivalent data sets.

In addition, the following PicoProcessor-based controllers are available for communications control through an I/O Distributor:

14632-01 CURRENT LOOP SERIAL CONTROLLER: For ASR 33 teletypewriters or other 20-mA current loop devices. Strap-selectable data rate, stop bit length, and parity. When used with Model 22205-00 teletypewriter, it controls motor on/off and reader.

14630-01 CRT SERIAL CONTROLLER: Interfaces any asynchronous RS-232C CRT display. Strap-selectable data rate, stop bit length, and parity. Half-duplex operation. Includes clear to send, carrier detect, and data set ready status inputs plus request to send and data terminal ready outputs. Has 25-pin male connector.

14630-02 MODEM CONTROLLER: Interfaces asynchronous serial modems. Same as 14630-01 except has 26-pin female connector.

Computer Automation offers no communications support software at this time. All communications programs and routines must be user-developed in assembly language on larger CA systems.

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. This data acquisition system can process up to 16 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 microseconds.

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, sample-and-hold amplifier, and 12-bit A/D converter. The multiplexer features random, sequential, and wrap-around addressing modes of operation for 8 differential or 16 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 a 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: Two operating systems for the Naked Milli are available: the real-time executive (RTX) and FDOS, a floppy disk operating system.

Real-Time Executive: RTX consists of an Executive, an Input/Output Executive (IOX), and a File Manager. These three modules provide the nucleus of RTX system functions, which include task scheduling, interrupt servicing, and inter-task communications. Application programs are designed and executed as independent, interrelated tasks or subordinate tasks, with up to 8191 task priority levels which can be defined or redefined dynamically.

IOX provides the user with complete input/output device independence and saves the user extensive program development time by supporting full I/O capability on all standard peripherals. The modular design of IOX permits the addition of I/O drivers for virtually any kind of device.

The File Manager provides directory and file management for sequential or random disk storage devices, allowing ►

Computer Automation Naked Milli (LSI-3/05)

► the applications programs to communicate with data files by name, independently of the physical types of devices on which they reside. In addition, the File Manager supports automatic blocking and unblocking of logical records stored in a sequential-access file.

Floppy Disk Operating System: 3/05 FDOS includes a monitor (FDOS), a linking loader (LAMBDA), a binary dump routine (BDP), a debug utility (DBG), and an assembler/source editor (OMEGA). This system is designed to provide source, object and binary programs, and data files on an LSI-3/05 floppy disk system. Since 3/05 FDOS maintains floppy diskette files in the same format as CA's LSI-2 Operating System (OS), files can be easily transferred between 3/05 FDOS and OS systems. (See Report M11-168-01 for LSI-2 OS information.) User programs and system modules such as the editor, assembler, link loader, and debug utility reside on floppy disk until they are loaded into memory by operator command. The minimum hardware configuration required is a processor with 8K words of memory, a CRT or teletypewriter, and a floppy disk.

LANGUAGES: OMEGA-3/05 is an assembly system that combines the features of a conversational source program editor and a high-performance two-pass assembler. OMEGA-3/05 supports bit-serial TTY, byte-serial TTY, and other peripherals via the Distributed I/O System. The basic assembler runs in 4K words of memory, and the extended version requires 8K words.

UTILITIES: CA offers an extensive line of utilities, editors, and I/O drivers, some of which are: Binary Loader (BLD), Relocating Object Loader (LAMBDA), Link Editor, Source Tape Preparation (STP) Text Editor, Binary Dump (BDP), Mass Storage Dump/Verify, Debug, Teletype/CRT Utility Package (TCUP), Concordance (CONC), High-Speed Paper

Tape, Card Reader, Line printer, and Cassette Tape Drivers, Cassette Tape Formatter, Moving-Head Disk Driver, and Moving-Head Disk Formatter.

PRICING

POLICY: Computer Automation offers the Naked Milli preferably to OEM customers in minimum lots of five. Various discount schemes are offered based on quantity orders or non-cancelable firm orders; no specific figures are given in the price list, and details are furnished through local sales representatives. All software is priced separately. Naked Milli processors and options, I/O Distributors, PicoProcessors, and semiconductor memories are covered by a 90-day factory warranty. All other products manufactured by CA are covered by a one-year factory warranty, beginning on the date of shipment. The warranty covers parts and labor, and repairs are performed at the factory in Irvine, California. All peripherals products are covered by a 30-day warranty.

SUPPORT: Computer Automation provides system support from 19 U.S. locations and 17 other international locations. On-site maintenance is generally the responsibility of the user and can usually be accomplished through board replacement. CA also provides factory repair service at Irvine, California; Ramsey, New Jersey; Chicago; Dallas; and London, England.

Training course in programming, interfacing, and maintenance are offered by CA at Irvine for \$250 per man/week.

EQUIPMENT: Computer Automation offers the Naked Milli in a number of packaged systems, or the LSI-3/05 processor can be purchased separately. See the following Equipment Prices for a complete breakdown of CA's Naked Milli offerings. ■

EQUIPMENT PRICES

		<u>Purchase Price</u>
PROCESSORS (CARDS ONLY)		
10300-00	LSI-3/05 CPU Type 0 with power fail/restart, vectored priority interrupts, and DMA port (½ card)	\$ 295
10300-01	LSI-3/05 CPU Type 1, same as Type 0 CPU plus real-time clock and autoloader (½ card)	395
10370-38	LSI-3/05 CPU Type 1 with 256 words of SC RAM and sockets for up to 8K words of SC ROM	465
10370-58	Same as 10370-38 with 1K words of SC RAM	575
10370-68	Same as 10370-38 with 2K words of SC RAM	725
10380-04	LSI-3/05 CPU Type 1 with 4K words of SC RAM	725
10380-08	LSI-3/05 CPU Type 1 with 8K words of SC RAM	1,075
10390-50	LSI-3/05 CPU Type 1 with 4K words of erasable PROM and 1K words of SC RAM	625
10390-60	Same as 10390-50 with 2K words of SC RAM	775
10320-01	LSI-3/05 CPU Type 1 with 1K words of half-card core memory	850
10320-04	Same as 10320-01 with 4K words of core memory	1,135
PACKAGED PROCESSOR CONFIGURATIONS		
10373-38	LSI-3/05 CPU Type 1 with 256 words of SC RAM, 10-Ampere power supply, operator console, chassis for three half-cards, and sockets for up to 8K words of SC ROM and for 2K words of PROM	825
10373-58	Same as 10373-38 with 1K words of SC RAM	950
10373-68	Same as 10373-38 with 2K words of SC RAM	1,100
10383-04	Same as 10373-38 except with 4K words of SC RAM and no sockets	1,145
10383-08	Same as 10373-38 except with 8K words of SC RAM and no sockets	1,525
10393-50	LSI-3/05 CPU Type 1 with 1K words of SC RAM and sockets for 4K words of EPROM, 10-Ampere power supply, operator console, and chassis for three half-cards	995
10393-60	Same as 10393-50 with 2K words of SC RAM	1,150
10323-01	LSI-3/05 CPU Type 1 with 1K words of core memory, 10-Ampere power supply, operator console, and chassis for three half-cards	1,200
10323-04	Same as 10323-01 with 4K words of core memory	1,585
10375-38	LSI-3/05 CPU Type 1 with 256 words of SC RAM, 15-Ampere power supply, chassis (with fan), for five half-cards, operator console, and sockets for up to 8K words of ROM	975
10375-58	Same as 10375-38 with 1K words of SC RAM	1,115

Computer Automation Naked Milli (LSI-3/05)

EQUIPMENT PRICES

		Purchase Price
PACKAGED PROCESSOR CONFIGURATIONS (Continued)		
10375-68	Same as 10375-38 with 2K words of SC RAM	\$ 1,265
10385-04	Same as 10375-38 except with 4K words of SC RAM and no sockets	1,345
10385-08	Same as 10375-38 except with 8K words of SC RAM and no sockets	1,750
10395-50	LSI-3/05 CPU Type 1 with 1K words of SC RAM, 4K words of EPROM, 15-Ampere power supply, operator console, chassis (with fan) for five half-cards	1,165
10395-60	Same as 10395-50 with 2K words of SC RAM	1,315
10325-01	Same as 10395-50 with 1K words of half-card core memory	1,375
10325-04	Same as 10395-50 with 4K words of half-card core memory	1,810
10376-38	LSI-3/05 CPU Type 1 with 256 words of SC RAM, 15-Ampere power supply, programmer console, chassis (with fan) for five half-cards, and sockets for up to 8K words of SC ROM	1,190
10376-58	Same as 10376-38 with 1K words of SC RAM	1,335
10376-68	Same as 10376-38 with 2K words of SC RAM	1,475
10386-04	Same as 10376-38 except with 4K words of SC RAM and no sockets	1,575
10386-08	Same as 10376-38 except with 8K words of SC RAM and no sockets	1,995
10396-50	LSI-3/05 CPU Type 1 with 1K words of SC RAM and sockets for 4K words of EPROM, 15-Ampere power supply, operator console, and chassis (with fan) for five half-cards	1,385
10396-60	Same as 10396-50 with 2K words of SC RAM	1,535
10326-01	Same as 10396-50 with 1K words of core memory	1,600
10326-04	Same as 10396-50 with 4K words of core memory	2,055
10356-24	LSI-3/05 CPU Type 1 with 4K words of half-card core memory, 25-Ampere power supply, operator console, and five full-slot chassis	2,260
10356-28	Same as 10356-24 with 8K words of core memory	2,690
10356-36	Same as 10356-24 with 16K words of core memory	3,695
10356-04	Same as 10356-24 with half-card CPU	2,360
10356-08	Same as 10356-28 with half-card CPU	2,795
10356-16	Same as 10356-36 with half-card CPU	3,805
10366-04	Same as 10356-24 with half-card CPU and 4K words of RAM-only memory	1,985
10366-08	Same as 10356-28 with half-card CPU and 16K words of RAM-only memory	2,295
10366-16	Same as 10356-36 with half-card CPU and 16K words of RAM-only memory	3,125
10368-16	LSI-3/05 CPU Type 1 with 16K words of core memory, five full-slot chassis, power supply, operator console, and distributed I/O distributor for four intelligent cables	4,095
SEMICONDUCTOR MEMORY		
11650-38	256 words of RAM and sockets for up to 8K words of ROM	290
11650-58	1K words of RAM and sockets for up to 8K words of ROM	400
11650-68	2K words of RAM and sockets for up to 8K words of ROM	550
11642-04	4K words of RAM	550
11642-58	8K words of RAM	900
11530-52	1K words of RAM and 4K words of EPROM (Erasable Programmable Read-Only Memory)	1,425
11530-62	2K words of RAM and 4K words of EPROM (Erasable Programmable Read-Only Memory)	1,575
CORE MEMORY		
11550-08	8K words, 980-nanosecond	1,950
11560-16	16K words, 1200-nanosecond	3,050
11671-04	4K words of half-card core memory	985
MEMORY OPTIONS		
12090-40	Battery Backup for RAM/ROM memories; 2-minute data retention (not available as field upgrade)	95
12085-20	Battery Backup for RAM/EPROM memories; 2-minute data retention (not available as field upgrade)	95
12542-00	Memory Bank Control; permits memory configurations greater than 32K words	900
30100-01	EPROM Programmer	2,950
I/O DISTRIBUTORS		
14629-14	I/O Distributor for four serial or parallel interfaces	380
14629-18	I/O Distributor for eight serial or parallel interfaces	485
14674-01	DMA I/O Distributor for four serial or parallel interfaces	862
INTELLIGENT CABLES		
14630-01	Asynchronous serial CRT interface	195
14630-02	Modem serial interface	195
14631-11	General-purpose 8-bit parallel interface	195
14631-01	Line printer interface	195
14631-02	Card reader interface	195
14631-03	Paper tape reader interface	195
14631-04	Paper tape punch interface	195
14632-01	Current-loop serial asynchronous interface	195
14631-41	Magnetic tape interface	300

Computer Automation Naked Milli (LSI-3/05)

EQUIPMENT PRICES

	Purchase Price
INTELLIGENT CABLES (Continued)	
14676-01 IEEE interface	\$ 300
14722-01 32-bit interface	300
14640-14 4-channel I/O Distributor/interface	495
14640-18 8-channel I/O Distributor/interface	680
MASS STORAGE	
Moving-Head Disks:	
18530-00 Disk drive system with one fixed and one removable disk, 4.92 million bytes; includes one pack	12,300
22530-00 Add-on drive for 18530-00 above	10,200
14530-01 Controller interface for up to 4 Diablo Model 31 or 33 drives (1500 rpm)	2,550
14530-02 Controller interface for up to 4 Diablo Model 43, 44, or Pertec D3000 Series drives (2400 rpm)	2,550
Floppy Disks:	
18566-00 Dual-drive system; 243K bytes per drive	4,300
22566-00 Add-on unit for 18566-00 above	3,700
14566-01 Controller for up to 4 IBM-compatible drives	930
MAGNETIC TAPE	
18224-15 Magnetic tape system; 9-track, 25 ips, 800 bpi; for 7-inch reels	8,275
22224-15 Add-on drive for 18224-15 above	6,300
14224-00 Controller/interface for up to four standard 9-track drives	2,400
LINE PRINTER	
22107-06 Line printer system; 80 columns, 60-150 lpm (requires 14223-00 controller)	4,950
22107-32 Line printer system; 132 columns, 165 lpm (requires 15223-30 controller)	8,438
PAPER TAPE EQUIPMENT	
22223-11 High-speed reader system, 300 cps (requires 14223-00 controller)	1,945
22223-60 High-speed reader/punch system, 300 cps/75 cps (requires 14223-00 controller)	5,625
CARD EQUIPMENT	
18223-43 Card reader system, 285 cpm (requires 14223-00 controller)	4,425
TERMINALS	
22205-00 Teletypewriter, modified for ASR 33	1,695
22215-00 Modification kit for teletypewriter	90
22851-63 Keyboard-Display terminal; 24 lines by 80 character, 128-character ASCII set, 75-9600 bits/second	1,900
GENERAL-PURPOSE INTERFACES	
14223-00 Controller for line printer, paper tape reader or punch, and card reader; 8 or 12-bit parallel input or output transfers	600
13213-00 16-Bit I/O Module, DTL/TTL compatible	500
13214-20 32-Bit Relay Output Module	750
13215-00 32-Bit Relay Input Module	750
13216-00 64-Bit Output Module	500
13219-00 64-Bit Input Module	500
13220-00 16-Channel Priority Interrupt Module	500
13222-00 I/O Drive Module	500
14511-00 I/O Terminator Module	125
ANALOG I/O SYSTEMS	
High-Level A/D Converter Systems:	
All converters are 12 bits, two's complement with a 28.5-microsecond conversion time; switch-selectable full-scale analog inputs of +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 Milli (LSI-3/05)

EQUIPMENT PRICES

ANALOG I/O SYSTEMS (Continued)

**Purchase
Price**

General Purpose D/A Converter System:

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
----------	-------------------	--------

A/D-D/A Converter Combinations:

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
12030-16	16 single-ended input channels and 2 output channels	2,495
12130-16	16 single-ended output channels with programmable gain and 2 output channels	2,670

COMMUNICATIONS

14236-1X	Dual interface for 2 CRT's	575
14236-21	Dual interface for 2 teletypewriters	500
14236-5X	Dual interface for 1 CRT and 1 current loop teletypewriter interface	600
14535-01	Asynchronous modem controller for RS-232C interface	600
14535-02	Asynchronous modem controller for current loop interface	575
14512-21	Asynchronous modem multiplexer for 2 RS-232C lines	950
14512-22	Asynchronous modem multiplexer for 2 current loop interfaces	850
14512-41	Asynchronous modem multiplexer for 4RS-232C lines	1,400
14512-42	Asynchronous modem multiplexer for 4 current loop interfaces	1,200
14513-00	Synchronous modem controller	1,200
14513-01	Synchronous modem controller with internal clock option	1,400
14523-02	Automatic Calling Unit multiplexer for 2 ACU's	800
14523-04	Automatic Calling Unit multiplexer for 4 ACU's	1,200

CHASSIS AND POWER SUPPLIES

12036-00	Programmer Console	395
12457-00	Operator Console	125
12095-03	Card Cage for 3 half-cards; includes motherboard	75
12095-05	Card Cage for 5 half-cards; includes motherboard	100
12046-03	Power Supply; +5VDC at 10A, +12VDC at 0.8A, -12VDC at 1.5A; includes power fail detect	250
12046-05	Power Supply; +5VDC at 15A, +12VDC at 1A, -12VDC at 1.5A; includes fan and power fail detect	375
12048-01	Battery Pack for RAM-only memories; provides 2-minute data retention	195
12034-00	Standard five full-slot chassis (requires 12044-00)	275
12044-00	Standard power supply	520

SOFTWARE PRICES

**Purchase
Price**

19005-03	RTX (Real-Time Executive)	\$ 500
20005-00	Millicomputer Package: includes OMEGA assembler; Automagic binary loader/dump, external reference object loader (relocating), and conversational debug; and LSI-3 diagnostics for CPU, memory, and TTY/CRT	140
20629-03	Distributed I/O System diagnostic	50
20223-XX	Paper peripherals diagnostic for paper tape reader/punch, card reader, or line printer	50
20566-03	Floppy disk diagnostic, driver, and formatter	75
20631-00	Distributed I/O System user microcode set	1,000
19003-04	FDOS (Floppy Disk Operating System)	500
200XX-00	Arithmetic and Statistical Library	300