ComputerAutomation
Naked Mini® Division

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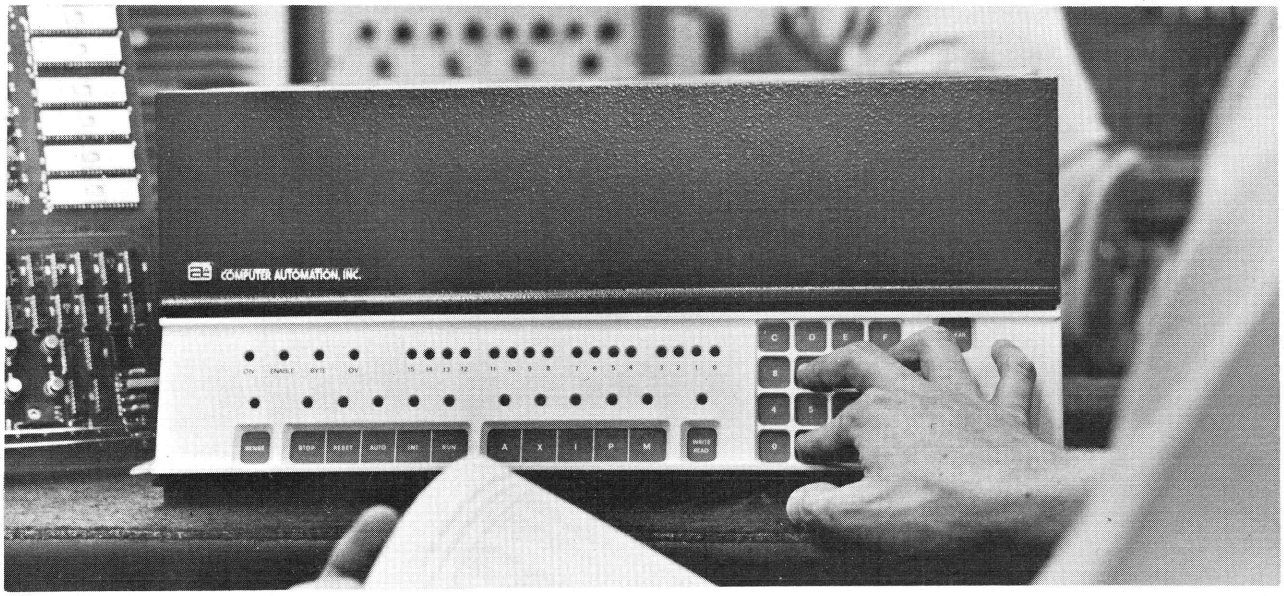
NAKED MINI



The unique Alpha/LSI hexadecimal keyboard makes data entry and program debugging fast and convenient.

THE LSI FAMILY

A family of low-cost OEM computers with a range to handle almost any job, big or small. With a low price tag that makes it really practical. And with complete compatibility so you can move in any direction as your needs change, quickly and easily.

THE NAKED MINI SERIES

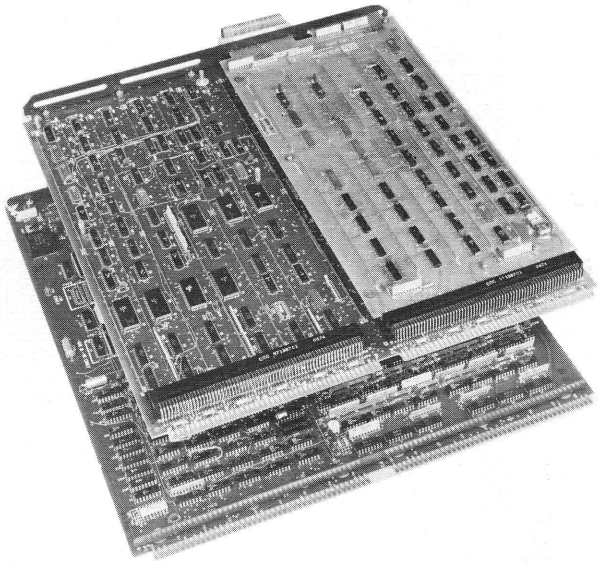
The mid-range of the LSI family, the NAKED MINI® series is truly the computer that's a component. To use it, just plug it into your product. The full-scale central processor, with full instruction set, DMA, and options is on a single card, 15" x 17". Memory up to 16K words is on a similar card. They're powered by your existing system supply.

One-On-One

Imagine all the products you can bury the NAKED MINI in. All your products that can benefit from a computer having powerful arithmetic capabilities, full byte and 16-bit word processing, and extremely flexible I/O. All your products that will now be more competitive, more flexible, and immune to obsolescence.

The possibilities seem endless. NAKED MINI belongs in any system that needs to see that certain things happen in certain ways at specific times. NAKED MINI lets you plug-in the intelligence you need to monitor, sequence and control effectively.

For the first time, OEM's can think of using a computer for 1-on-1 applications: smart



Shown is a NAKED MINI LSI-2 configuration, with processor board on top and memory board below.

terminals, key-to-disk data entry systems, automated bank tellers, delivery truck routing devices, continuous inventory control at fast-food outlets and other point-of-sale situations; information displays, communications concentrators, building security systems, laboratory instruments, patient monitoring systems, and classroom learning machines. Even mundane applications like vending machines and gas stations can now have their very own computer. A real computer.

ALPHA/LSI Minicomputer

If you need the NAKED MINI installed in its own fully encased mainframe chassis, we can do that, too. It's called ALPHA/LSI, and includes a power supply and a control console. It can easily be expanded to 512K words of 16-bit memory. And as many peripheral controllers and special-purpose interfaces as you need.

WE DID IT: THE GREAT OEM GAP

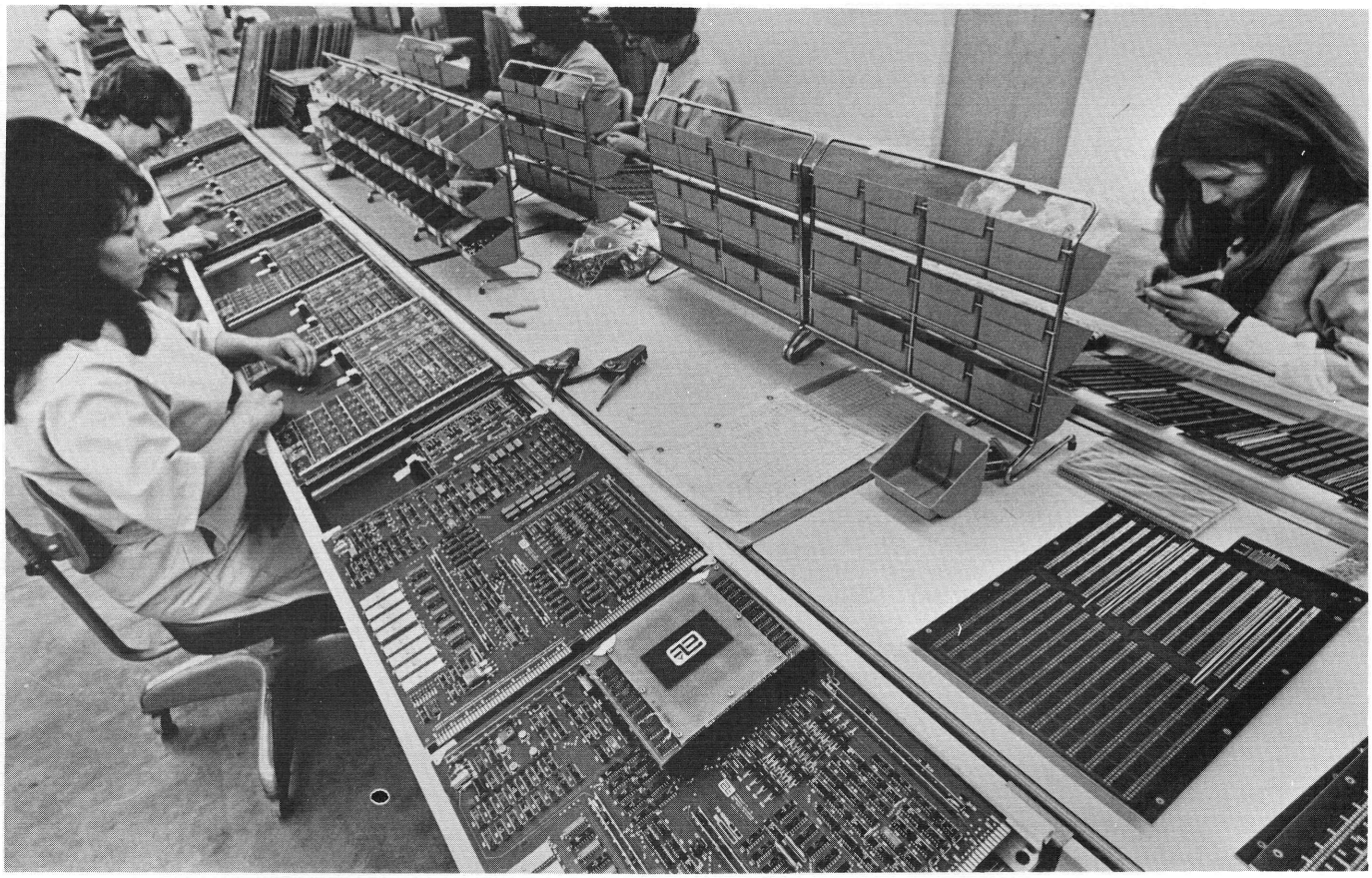
Very few suppliers really understand the OEM.

Other minicomputer companies don't. They're busy building end-user systems with lots of peripherals, one-of-a-kind features, and more speed and software than the job needs right now. The application is loosely defined and constantly changing. Someday the end user might — just might — need the extra goodies. Just in case, he has to pay fancy prices for them now.

Chip companies (so-called "microcomputers") don't really understand the OEM, either. They're producing do-it-yourself kits with weak instruction sets and limited input/output capability that end up costing more than a NAKED MINI by the time you buy the memory and get the chips interconnected, functionally tested, burned in, and truly operating. And even after doing all that, you wind up with something which performs more like a smart calculator than a real computer.

The OEM, on the other hand, has a well-defined problem. He needs a computer powerful enough to answer his product's requirements, with enough performance margin to accommodate the growth he expects in the future. Initial cost is important to him, since any savings are translated directly into profit. And because maintenance costs come right out of that same profit, he demands unfailing reliability.

Besides these requirements, the OEM has other needs — unique to him — which further separate him from the end user.



Pretested components being assembled onto boards and inspected.

He needs to get his product to the marketplace fast, to establish his position before the competition can react. This means he wants to shorten his development cycle as much as he can. He needs working hardware now, so he can get going on his prototype fast.

Also, an OEM may build a complete product line with a wide range of performance. At the low end of the line, he may need somewhat less computing power and slower, smaller memories, but he has to have the lowest possible price. In the middle and high ranges, he needs different combinations of computing power and memory size/speed but his cost constraints are less severe.

Further, for maximum flexibility, he needs to be able to reconfigure in the field — to change computing power, memory size, memory speed, special features — any or all of them, quickly and easily. His system has to be able to "grow up" as needed.

Overall, he has to have a low-cost, truly flexible way to satisfy these conflicting needs.

After seeing this gap and listening to what OEM people really wanted, we knew the time was right for the NAKED MINI family. Because of our specialized knowledge of the OEM, we were able to accurately define the needs of this market, overlooked by others.

THE 2/10 AND 2/20

The NAKED MINI series includes two processors, the LSI-2/10 and LSI-2/20. The LSI-2/20 is the faster processor in the series, with internal speed great enough to take advantage of our highest speed memories. The LSI-2/10 is about half the speed of the 2/20, but otherwise identical.

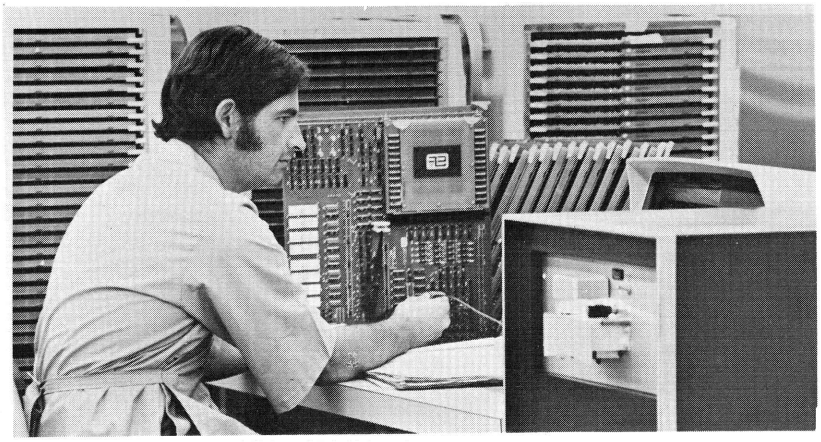
This means that user programs run correctly on any NAKED MINI, and one can be substituted for the other without program changes. You choose exactly the speed you need.

Some of the memories available for the LSI family are described below. Any combination of memories in any mix of types and speeds can be used with any processor. This means the user can configure exactly the combination which best suits his needs now, and later change the combination to meet new needs merely by exchanging or adding the appropriate processor or memory boards.

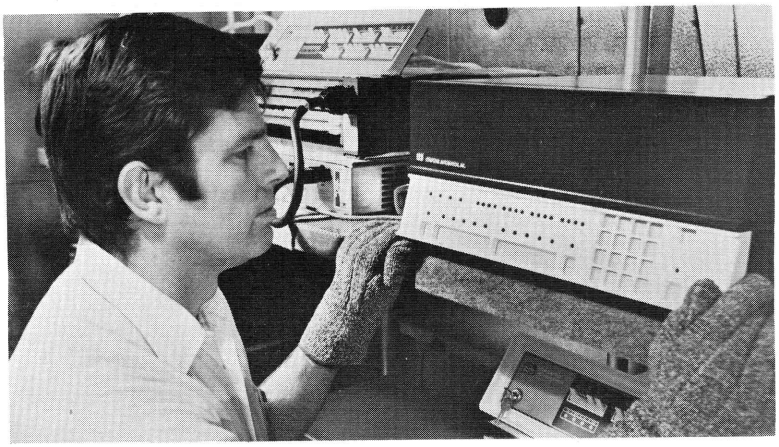
Now, indeed, any LSI system can "grow up" and change easily and quickly, even in the field.

Memories

To provide maximum flexibility, the LSI family offers a variety of memories in various types, speeds, and capacities. All memories work with any LSI processor, in any combination of types,



Processor board undergoing test, using our CAPABLE™ Computer-controller tester. CAPABLE verifies the correctness of every function — completely and automatically.



High temperature testing in an oven to verify long-term reliability. Test inincludes seventy-two hours at 50°C.

speeds, and sizes up to the maximum memory capacity of 512K words. As new memories become available, they will also work with all LSI processors.

CORE 1600

Core memory with a cycle time of 1.6 microseconds, in modules of 4K and 8K words.

CORE 1200

Core memory with a cycle time of 1.2 microseconds in modules of 16K words.

CORE 980

Fast core memory with a cycle time of 980 nanoseconds, in modules of 4K and 8K words.

PROM/ROM/RAM

Programmable read-only (PROM), read-only (ROM) and random access semiconductor (RAM) memories; available in various combinations.

HOW LSI COMPONENTS FIT TOGETHER

Since all elements — memories, processors, options interfaces — of the LSI family are designed to work together in any combination, it is possible to configure thousands of distinct combinations, merely by plugging the modules into the system, without special wiring or modification.

Shown below are only a few examples as illustrations of the many possibilities.

Problem 1. The user starts out with an LSI-2/10 processor with 8K of Core 1600 because processing requirements are not so severe. At some future time, he finds he needs more memory to handle his expanded requirements, and also more speed in processing and input/output.

Solution. Add 8K of fast Core 980, which provides more program storage. For greater overall speed, interleave the existing 8K of Core 1600 with the new 8K of Core 980, to give a total of 16K with an average effective cycle time of approximately 1.1 microseconds. If still more speed is needed, switch to the LSI-2/20 processor.

Problem 2. The user has a large processing program of more than 16K words, one part of which is a highly repetitive inner loop which must run very quickly.

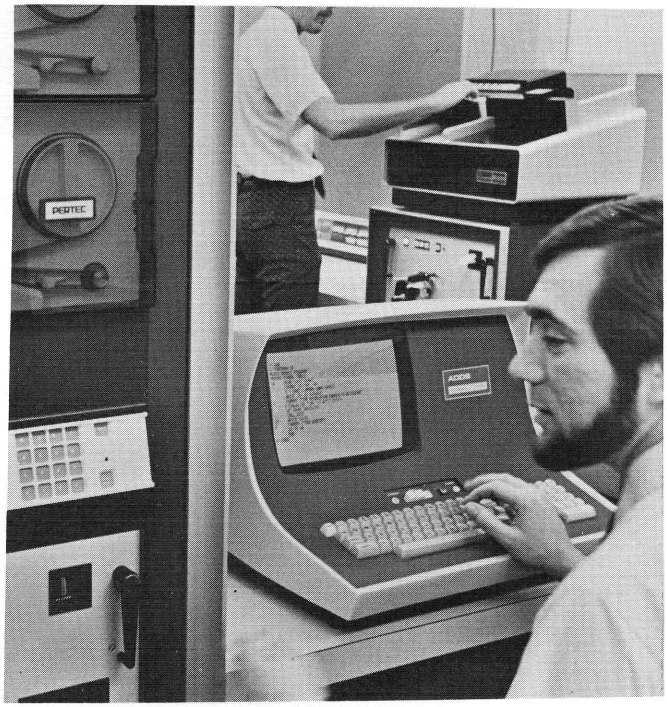
Solution 1. Use the LSI-2/20 with 4K words of Core 980 to provide faster execution of the inner loop plus a 16K module of Core 1200 for greater economy in storing the rest of the operating program.

Solution 2. If even faster processing is desired, use two 4K or two 8K modules of Core 980 which are interleaved, since the LSI-2/20 processor can take maximum advantage of the faster effective cycle time of the interleaved memories. The remainder of the memory requirement can be satisfied with lower cost, lower speed Core 1200 or Core 1600.

POWERFUL INSTRUCTIONS FOR SHORTER, FASTER PROGRAMS

There's a big and very important difference between raw cycle time and "getting the job done" time. We believe computers should work smart, as well as hard. They should offer built-in features that assure faster execution.

With NAKED MINI you get what many consider to be the most powerful instruction set on the market. With 188 instructions on the LSI-2 series — including 8 addressing modes and hardware multiply/divide — the NAKED MINI offers better memory efficiency than other mini's.



Development of cost-cutting software systems in our complete programming laboratory.

This efficiency lets you write shorter programs with faster run times — and keeps memory costs to a minimum, since tasks run in less memory. And programs are easier to write, too.

In short, you get speed where it counts: on the job.

Memory Reference Instructions

In typical mini-computer applications, the computer usually spends a large percentage of its execution time successively doing a few operations on each of many pieces of data stored in memory — rather than performing repeated operations on just a few pieces of data which could be stored in registers. This usually means that memory is referenced frequently.

NAKED MINI optimizes its instruction set for these typical minicomputer applications, to get greater efficiency and ease of programming. It provides a varied and powerful set of 30 memory reference instructions ideal for OEM's.

Multiply/Divide

Most minicomputers offer hardware multiply/divide instructions only as an extra cost option; slow and inefficient, memory-consuming programmed subroutines are the only alternative if the option is not purchased. Our instruction set includes hardware Multiply and Divide as a standard feature. And our Multiply instruction also performs a "Multiply and Add", useful in directly evaluating mathematical expressions of the form AX+B.

Indirect Addressing

True multi-level indirect addressing lets the user construct and use powerful addressing methods for effective table addressing.

Normalize

For efficient floating point operations, we include a complete double-word Normalize instruction which normalizes and updates the exponent.

Memory Scan

Here's a good example of multifunction instructions which, in other computers, would require time and memory-consuming subroutines. Scan provides a rapid search of any portion of memory for any word or byte value. Any block of contiguous memory locations can be scanned in a single instruction to see if it contains the desired value.

Compare Between Limits

By using only two Compare Memory And Skip instructions, it is possible to do a comparison between upper and lower limits quickly and simply in just two instructions.

Word and Byte Addressing

We provide both word and byte addressing for most memory reference instructions. This means that you can deal directly with either bytes or full words, as the application requires, without the complications required in computers without byte addressing. Twenty of the memory reference instructions provide arithmetic, logical, data transfer, and comparison capabilities for efficient handling of bytes and words.

Immediate Instructions

We provide a full complement of ten immediate instructions. The address portion of the instruction actually contains the 8-bit operand itself, rather than an address. Only half as much memory is needed, since both instruction and operand are contained in a single word. Immediates include Add, Subtract, Load, and Compare.

Single Word Instruction Format

With only a few exceptions, our instructions require only one memory location. Compare this with many other minicomputers which require two or more memory locations for most instructions.

Full Shift Capability

We provide a full complement of 16 shift instructions which can be: single or multiple place; left or right; single or double register; logical, circular, or arithmetic. Compare this with the basic single place shift found in most minicomputers.

Fast, Efficient, Conditional Jumps

The 63 conditional jump instructions test conditions within the processor (overflow, sense register, A and X registers) and perform conditional jumps, depending upon the results. Since each of these single word instructions performs both the test and the jump, memory is more efficiently utilized than with other computers which need two words for this function. Any combination of testable conditions can be tested in a single instruction.

Stack Instructions

Fifteen stack instructions allow the use of any memory location as a stack control pointer to maintain a stack anywhere else in memory.

Any number of routines can maintain any number of stacks located anywhere in memory. Further, it is possible to use any number of separately maintained stack pointers to access the same physical stack — a unique and exceptionally powerful implementation that invites the use of extremely sophisticated and effective programming techniques.

In addition, we accommodate not only the conventional load and store (Pop and Push) stack accesses but also arithmetic, Boolean, and compare operations on data contained in stacks.

I/O MAXI-BUS FOR EASE OF INTERFACING

Maxi-Bus provides 58 parallel lines for data, command, device address, status, and control information. This eliminates the timing problems created when data and address lines are time-shared. It makes interfacing easier, faster and less expensive.

Memory and input/output interfaces connect directly to the Maxi-Bus. Each operates asynchronously, at its own pace. This means that transfers can be made directly between an external device and memory without affecting the central processor, if desired.

It also means that as faster or lower cost memories and processors become available, they can be plugged into the system directly, without the need for modification.

This open ended design assures you of growth capabilities for the future, whenever your needs change.

Multiple Input/Output Modes for Maximum Power

You get three standard input/output systems for flexibility. Combined with a powerful set of 33 I/O instructions, this results in an I/O structure which is exceptionally efficient and easy to use.

Both word and byte data can be handled directly, with byte data being packed or unpacked automatically as desired.

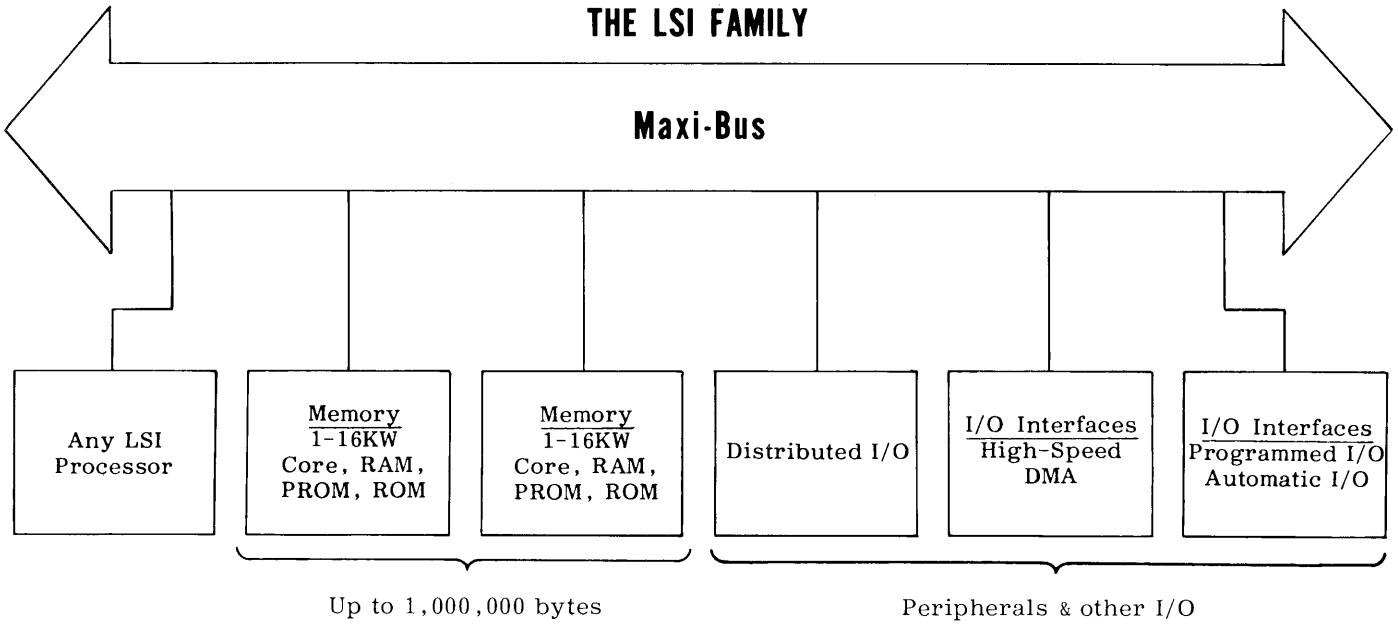
DIRECT MEMORY ACCESS (DMA)

For highest speed transfer rates, DMA transfers data on a cycle-stealing basis directly between the memory and the external device, bypassing the central processor.

PROGRAMMED INPUT/OUTPUT

For greater flexibility, Programmed I/O provides transfers between the external interface and the A or X registers, in words or bytes. Especially effective in applications where data must be examined immediately upon input (such as message handling, keyboard response, etc.) or where data is the result of a computation which must be output immediately.

Programmed I/O instructions can be combined with Sense-and-Skip instructions to produce a single instruction which performs a test and transfers only if the test result is satisfactory. For example, the two functions "Sense For Ready" and "Input" can be combined in one "Read" instruction. And, these instructions are interruptable.



AUTOMATIC I/O CHANNELS

Each channel transfers data between memory and external interfaces in blocks of any size without disturbing the processor's working registers. Word or Byte Count and Current Address for each channel are held in memory; each transfer automatically updates them until the count is complete. This use of memory for control registers lowers the cost of interfacing. Multiple channels can operate concurrently, with hardware priority control of each channel. Transfers can be full 16-bit words or 8-bit bytes with automatic packing/unpacking.

HARDWARE PRIORITY INTERRUPTS

Our hardware priority interrupts provide automatic handling of:

- recognition of an external event which requires immediate attention
- identification of which event, among many, actually occurred
- assignment of priority when several events occur simultaneously.

It also means really fast response to the event which caused the interrupt.

The necessary interrupt routines are simple, easy to write, take less memory space, and execute more quickly. Wasteful polling is completely eliminated.

Because we provide so many multi-function instructions, it is frequently possible to perform the equivalent of an entire interrupt subroutine in a single instruction. In such cases, the interrupt can be recognized and serviced without changing control from the current program, completely eliminating the overhead needed to save and restore processor status.

OPTIONS

To increase flexibility for various applications, we offer a number of useful options:

Power Fail/Restart

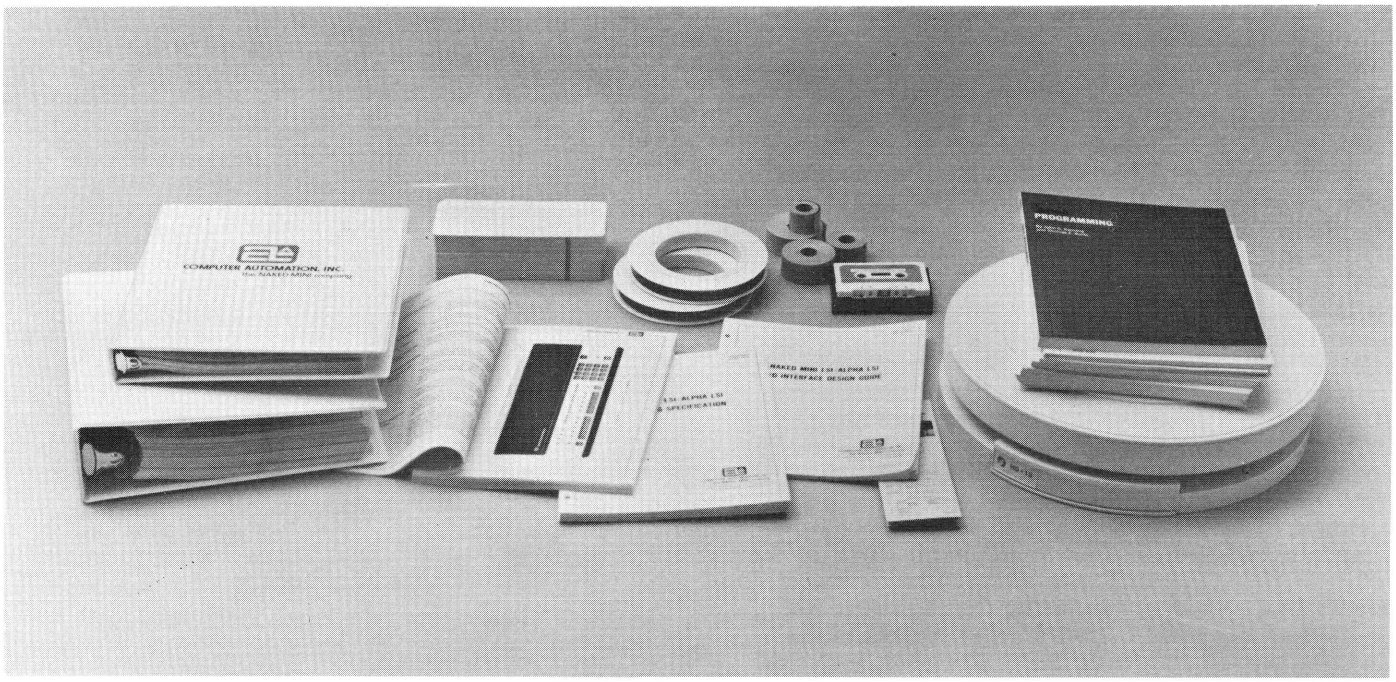
Monitors power supply voltage to provide an orderly shutdown upon power failure and automatic restart when power is restored.

Real Time Clock

Provides interrupts at jumper selectable frequencies of 0.1K, 1K, or 10K Hz or twice the AC line frequency. External frequency source may also be substituted.

Autoload

Allows program loading to be initiated automatically, remotely or from a front panel switch. The single option provides loading from Teletype, Paper Tape, Cassette, Magnetic Tape and Disc.



Computer Automation support includes extensive software and full documentation.

Memory Bank Controller

Provides for memory expansion to 524,288 words and for rapid context switching by controlling up to 32 memory segments.

Memory Parity

Generates and checks parity on each memory transfer and provides an interrupt if an error is detected. Available on special order.

Teletype/CRT Interface

Controls CRT or modified teletype in full duplex mode. For CRT provides 9 user-selectable speeds from 75 to 9600 baud.

PERIPHERAL EQUIPMENT

The product line includes a wide variety of standard peripheral equipment in most major functional types, such as teletypes, paper tape readers and punches, line printers, card readers, magnetic tape units, digital cassettes, plotters, keyboard displays, and various types of disk units.

We offer the entire device complete with interface; or, for OEM ecomony, just the interface alone.

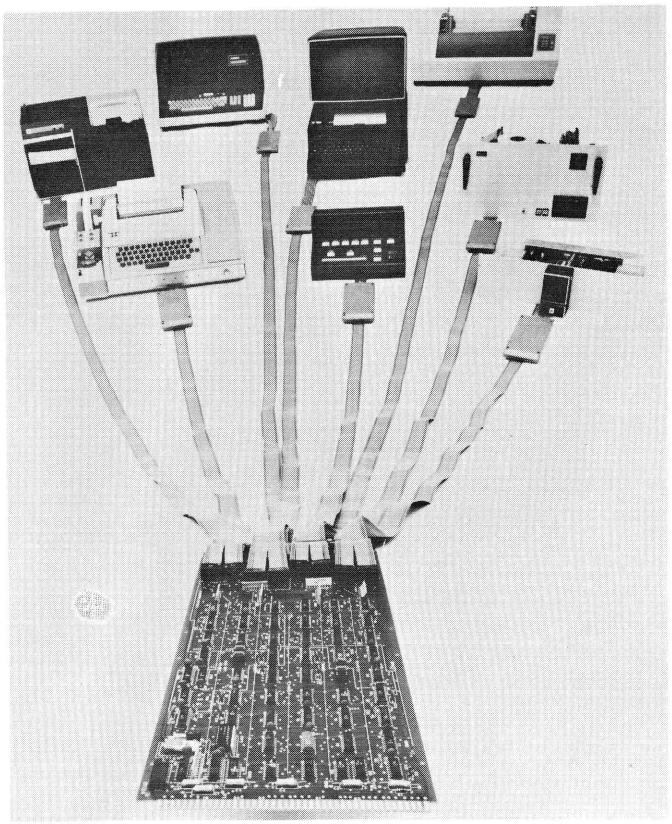
COMMUNICATIONS EQUIPMENT

A selection of communications interface equipment is available, including: dual Teletype/CRT/modem interfaces; single channel asynchronous modem controllers; asynchronous modem multiplexers; synchronous modem controllers; and automatic calling unit multiplexers.

DISTRIBUTED INPUT/OUTPUT SYSTEM

Computer Automation's Distributed I/O System provides a low-cost, high performance, and extremely flexible input/output system for interfacing a wide variety of standard peripherals or special purpose devices to any LSI series computer. Distributed I/O is a total system solution to the problems of peripheral interfacing.

The Distributed I/O System consists of a half-card I/O Distributor to which one to eight Intelligent Cables can be connected. Intelligent Cables are ribbon cables which include a microprogrammed PicoProcessor™ at the peripheral end of the cable. Standard PicoProcessors are available for most common peripheral devices and standard I/O disciplines. Because each individual PicoProcessor interface is a small computer which performs the detailed management of data flow and error checking, the software for all I/O devices interfaced with the Distributed I/O System is essentially identical.



I/O Distributor pictured with a variety of standard peripherals and user-designed I/O devices, including special consoles, instruments, etc.

One I/O Distributor can support up to eight Intelligent Cables interfaced to any combination of input or output, serial or parallel peripherals, all transferring data directly to or from memory concurrently.

High throughput is achieved with minimum overhead because Computer Automation's unique interrupt-driven Direct Memory Channel mode of I/O is used by the Distributed I/O System.

- Low Cost
- High Performance
- Simplified Cabling
- Simplified Programming
- Improved Reliability
- High Packaging Density
- Direct Memory Transfers
- Automatic End-of-Block Character Detection (Carriage Return Character)
- Error Detection
- Serial Interfaces Support Any Mix of Baud Rates from 75 Baud thru 19.2K Baud

GENERAL PURPOSE INPUT/OUTPUT INTERFACES

We offer a number of general purpose input/output interfaces in standard production. New interfaces are added frequently. Some representative units:

16-Bit Input/Output Module

Provides 16-bit input/output compatible with DTL/TTL, with control and sense lines.

Relay Output Module

Provides a set of 32 relay contacts which may be used to drive lamps, external relays, etc.

Relay Input Module

Presents 32 relay coils to the external environment. The contacts of these relays are presented to the processor's I/O bus. Interrupts are generated automatically upon a change in input.

64-Bit Output Module

Provides 64 DTL/TTL compatible outputs which may be used as a single output 64 bits wide or addressed and strobed in groups of 32, 16, or 8 bits.

64-Bit Input Module

Provides 64 DTL/TTL compatible inputs which may also be used in groups of 16 or 8 bits for multiple devices.

Priority Interrupt Module

Provides 16 inputs with individual change of state detectors. For use with momentary or toggle switches for operator initiated interrupts or as a general purpose priority interrupt module.

I/O Driver Module

Permits extending the processor I/O bus up to 25 feet from the processor.

SOFTWARE BUILT TO CUT COSTS

From the beginning, we built our software to cut the cost of OEM user programming. We did this first be designing it specifically to meet the needs of the OEM user — powerful enough to get his job done well because it was optimized for that job, but still fast and easy to use.

Then, to cut overall system cost, we made it efficient. Typically, our software is modular in construction. If you only use some of it, only a minimum configuration is required. This means you use only as much memory as you actually need, with no waste or unnecessary memory expense.

If you need more capability, it is available in larger, more powerful systems built to get maximum results from larger hardware configurations.

And, this comprehensive software produces efficient user code, so the programs it helps you to produce are efficient, too.

Described below are only a few of the software systems. Complete descriptions are available in a series of data sheets.

Operating Systems

REAL TIME EXECUTIVE SYSTEM (RTX)

A good example of software specifically engineered to help get an OEM user and his product to market fast. RTX is actually a modular system of many real-time elements — subsystems, subprograms, handlers — with a standard way of communicating. This means you can build up your application quickly and easily by combining RTX modules with your own application modules.

And, RTX is a completely open-ended system which is steadily growing in capability because we are always adding new program modules (tasks) to its library. This means that as your needs change and grow in the future, you can selectively add new tasks — of your own or from our library — or change any existing tasks without having to redo your entire application program.

INPUT/OUTPUT EXECUTIVE (IOX)

Operates as a subsystem under RTX. It provides the user with a complete, modular method of I/O device management and support. Application programming is faster since I/O protocol is already established and well-defined. Time-consuming I/O programming need no longer be done by the user.

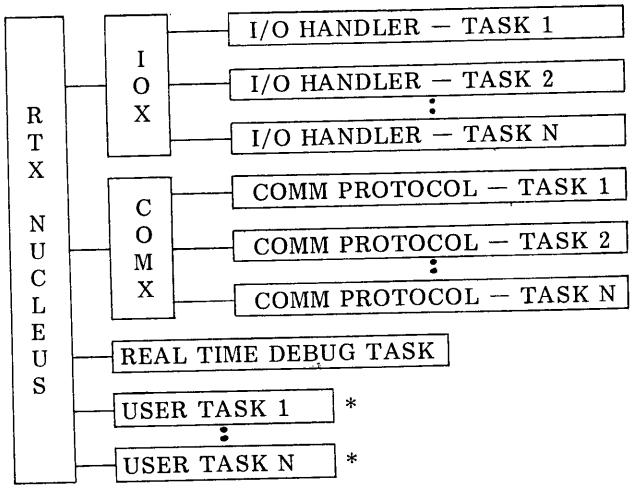
IOX is also open-ended. This means the user can develop virtually any kind of device handler unique to his application and operate it under IOX control. IOX supports most currently offered peripherals and communications devices.

COMMUNICATIONS EXECUTIVE (COMX)

Operates as a subsystem under RTX. It provides a modular method of communication protocol management and support.

REAL-TIME DEBUG (RTDBUG)

An interactive program which helps the user debug his application program. Because RTDBUG runs under RTX, the user can examine and — if necessary — alter his program, while the real-time program is actually running. This means user programs become operational faster and easier.



Tasks marked * are application dependent. All other tasks are available from the Computer Automation library.

DISK OPERATING SYSTEM (DOS)

A comprehensive system oriented toward fast development of user programs. Provides efficient control of sequential job operations, using easy-to-understand control cards on-line communications through the Teletype. DOS gives the user a complete system of program storage, maintenance and retrieval to simplify his program development. DOS supports all devices, with convenient methods of dealing with files of virtually any length, providing both random and sequential access. It is device-independent and automatically handles all user input/output, including service of all devices. It uses the disk for system secondary storage.

Higher Level Languages

ADVANCED BASIC

Includes all the features of Advanced BASIC above, plus Text Variables (string manipulation) and Matrix Instructions. This BASIC provides the user with capabilities not usually found in a small machine environment. Runs in 8K of memory.

EXTENDED MULTIPLE-USER BASIC

Same powerful language as Extended BASIC above. Supports up to eight users.

FORTRAN IV

A new FORTRAN IV compiler for the LSI family, which provides full ANSI X3.9-1966 compatibility plus added features that provide for real-time execution, in-line assembly language capability, and simplified I/O programming — a powerful tool for producing efficient applications software.

Recognizing that the OEM user is concerned about the cost of his product, and that processor memories contribute heavily to product cost, we have implemented a FORTRAN IV compiler that generates object code optimized for compactness.

Other Software

Our complete range of software also includes standard and Macro assemblers; file managers; utility programs; math packages; and diagnostics.

Since these software packages are constantly increasing in number and scope, please refer to the appropriate software data sheets for the latest information.

TYPICAL EXECUTION TIMES

All NAKED MINI processors have the same set of 188 instructions in common.

Execution times vary according to the processor type (LSI-2/10 or LSI-2/20) and the speed of the memory used. Following are some typical instruction times, shown in microseconds for three speeds of core memory. Direct relative addressing is assumed in calculations.

In most cases with the LSI-2/20 processor, execution times can be improved by interleaving memories to get faster effective cycle times. See the technical reference manual for a complete list of instruction execution times.

Instruction	Processor	Core 980	Core 1200	Core 1600
ADD/SUB	2/20	2.06	2.4	3.2
	2/10	4.12	4.8	6.4
AND/IOR	2/20	2.06	2.4	3.2
	2/10	4.12	4.8	6.4
JMP	2/20	1.38	1.4	1.6
	2/10	2.76	2.8	3.2
DVD	2/20	12.44	12.7	13.35
	2/10	24.9	25.4	26.7
AXI/SXI	2/20	1.08	1.2	1.6
	2/10	2.16	2.4	3.2

LIST OF INSTRUCTIONS

Memory Reference

Arithmetic

ADD	Add to A
ADDB	Add Byte to A
SUB	Subtract from A
SUBB	Subtract Byte from A

Logic

AND	AND to A
ANDB	AND Byte with A
IOR	Inclusive OR to A
IORB	Inclusive OR Byte with A
XOR	Exclusive OR to A
XORB	Exclusive OR Byte with A

Data Transfer

LDA	Load A
LDAB	Load A with Byte
LDX	Load X
LDXB	Load X with Byte
STA	Store A
STAB	Store Byte from A
STX	Store X
STXB	Store Byte from X
EMA	Exchange A and Memory
EMAB	Exchange A and Memory Byte

Program Transfer

JMP	Unconditional Jump
JST	Jump and Store P Counter
IMS	Increment Memory, Skip on Zero
SCM	Scan Memory
SCMB	Scan Memory Byte
CMS	Compare A with Memory, skip (high, low, equal test)
CMSB	Compare A with Memory Byte, skip (high, low, equal test)

Stack

ADDS	Add Stack Element to A
ANDS	AND Stack Element to A
CMSS	Compare Stack Element to A and skip (high, low, equal test)
EMAS	Exchange Stack Element and A
IMSS	Increment Stack Element and Skip on Zero
IORS	Inclusive OR Stack Element to A
JMPS	Jump to Stack Element
JSTS	Jump and Store to Stack Element
LDAS	Load Stack Element into A
LDXS	Load Stack Element into X
SLAS	Stack Pointer Value to A
STAS	Store A in Stack Element
STXS	Store X in Stack Element
SUBS	Subtract Stack Element from A
XORS	Exclusive OR Stack Element to A

Double Word Memory Reference

DVD	Divide
MPY	Multiply and Add
NRM	Normalize A and X

Byte Immediate

AAI	Add to A Register Immediate
AXI	Add to X Register Immediate
SAI	Subtract from A Register Immediate
SXI	Subtract from X Register Immediate
CAI	Compare to A Immediate, skip if not equal
CXI	Compare to X Immediate, skip if not equal
LAP	Load A Positive Immediate
LXP	Load X Positive Immediate
LAM	Load A Minus Immediate
LXM	Load X Minus Immediate

Conditional Jump

Conditional

JOC	Jump on Condition Specified

Arithmetic

JAG	Jump if A Greater than Zero
JAP	Jump if A Positive
JAZ	Jump if A Zero
JAN	Jump if A not Zero
JAL	Jump if A less than or equal to Zero
JAM	Jump if A Minus
JXZ	Jump if X Zero
JXN	Jump if X Not Zero

Control

JSS	Jump if Sense Indicator On
JSR	Jump if Sense Indicator Off
JOS	Jump if OV Set
JOR	Jump if OV Reset

Shift Class

Single Register Arithmetic

ARA	Arithmetic Right A
ARX	Arithmetic Right X
ALA	Arithmetic Left A
ALX	Arithmetic Left X

Logical

LRA	Logical Right A
LRX	Logical Right X
LLA	Logical Left A
LLX	Logical Left X

Rotate

RRA	Rotate Right A with OV
RRX	Rotate Right X with OV
RLA	Rotate Left A with OV
RLX	Rotate Left X with OV

Double Register Logical

LLL	Long Logical Left
LLR	Long Logical Right

Rotate

LRL	Long Rotate Left with OV
LRR	Long Rotate Right with OV

Register Change

Accumulator

ZAR	Zero A
ARP	Set A to Positive 1
ARM	Set A to Minus 1
CAR	1's Complement A
NAR	Negate A
IAR	Increment A
DAR	Decrement A

Index

ZXR	Zero X
XRP	Set X to Positive 1
XRM	Set X to Minus 1
CXR	1's Complement X
NXR	Negate X
IXR	Increment X
DXR	Decrement X

Overflow

SOV	Set Overflow
ROV	Reset Overflow
COV	Complement Overflow
SAO	Sign of A to OV
SXO	Sign of X to OV
LAO	Least significant bit of A to OV
LXO	Least significant bit of X to OV
BAO	Bit of A to OV
BXO	Bit of X to OV

Multi-Register

ZAR	Zero A and X
AXP	Set A and X to Positive 1
AXM	Set A and X to Minus 1
TAX	Transfer A to X
TXA	Transfer X to A
ANA	AND of A and X to A
ANX	AND of A and X to X
NRA	NOR of A and X to A
NRX	NOR of A and X to X
CAX	1's Complement A and put in X
CXA	1's Complement X and put in A
NAX	Negate A and put in X
NXA	Negate X and put in A
IAX	Increment A and put in X
IXA	Increment X and put in A
DAX	Decrement A and put in X
DXA	Decrement X and put in A
EAX	Exchange A and X
IPX	Increment P and put in X

Console Registers

ICA	Input Console Data Register to A
ICX	Input Console Data Register to X
ISA	Input Console Sense Register to A
ISX	Input Console Sense Register to X
OCA	Output A to Console Data Register
OCX	Output X to Console Data Register

Bit Clear/Set

BCA	Bit Clear A
BCX	Bit Clear X
BSA	Bit Set A
BSX	Bit Set X

Control

Processor

NOP	No Operation
HLT	Halt
STOP	Halt with Operand
WAIT	Wait for Interrupt

Mode Control

SBM	Set Byte Operand Mode
SWM	Set Word Operand Mode

Status

SIN	Status Inhibit
SIA	Status Input to A
SIX	Status Input to X
SOA	Status Output from A
SOX	Status Output from X

Interrupts

EIN	Enable Interrupts
DIN	Disable Interrupts
CIE	Console Interrupt Enable
CID	Console Interrupt Disable
PFE	Power Fail Interrupt Enable
PFD	Power Fail Interrupt Disable
TRP	Trap

Execute

EIX	Execute Instruction pointed to by X

Input/Output

Control

SEL	Select
SEA	Select and Present A
SEX	Select and Present X
SEN	Sense and Skip on Response
SSN	Sense and Skip on no Response

Unconditional

INA	Input Word to A
INAM	Input Word to A Masked
INX	Input Word to X
INXM	Input Word to X Masked
OTA	Output A
OTX	Output X
OTZ	Output Zero's

Conditional Word

RDA	Read Word to A
RDAM	Read Word to A Masked
RDX	Read Word to X
RDXM	Read Word to X Masked
WRA	Write A
WRX	Write X
WRZ	Write Zero's

Unconditional Byte

IBA	Input Byte to A
IBAM	Input Byte to A Masked
IBX	Input Byte to X
IBXM	Input Byte to X Masked

Conditional Byte

RBA	Read Byte to A
RBAM	Read Byte to A Masked
RBX	Read Byte to X
RBXM	Read Byte to X Masked

Block

BIN	Input Block to Memory
BOT	Output Block from Memory

Automatic (DMC)

AIN	Automatic Input to Memory-Word
AOT	Automatic Output from Memory-Word
AIB	Automatic Input to Memory-Byte
AOB	Automatic Output from Memory-Byte

THE LSI FAMILY

SPECIFICATIONS

Memory

Word Size:	16 bits/ word
Memory Size:	1,024 to 524,288 words
Addressing:	Both word and byte
Memory Parity:	Available option which adds one bit per byte

Functional

Instructions:	188 distinct basic instructions, plus many variations through address modes
Index Register:	Standard
Indirect Addressing:	Multi-level
Instruction Format:	Single word for most instructions
Direct Addressing:	768 words or bytes
Indirect Addressing:	32,768 words or 65,536 bytes
Power Fail Restart:	Available option
Real Time Clock:	Available option
Autoload:	Available option

Physical

Dimensions:	H	W	D
NAKED MINI/ LSI-2:	1.5"	19.5"	18.5"
ALPHA LSI-2:	8.7"	19.5"	19.6"

Weight:	
NAKED MINI/ LSI-2:	29.0 lbs., with full complement of options
ALPHA/LSI-2:	67.0 lbs., with full complement of options, power supply and panel

Electrical

Power Requirements:	
NAKED MINI/ LSI-2:	+5 volts dc at 13.5 amps; +12 volts dc at 0.6 amps; -12 volts at 2.8 amps
ALPHA LSI-2:	
Voltage:	115 (98 to 127) volts RMS or 230 (196 to 254) volts RMS
Frequency:	47 to 63 Hz, single phase
Power:	Without options — LSI-1 225 watt; LSI-2 275 watts With all slots full — 675 watts
Logic:	MOS LSI and TTL
I/O Bus Logic Level:	DTL/TTL compatible, 0 and +5 volts

Environmental

Temperature:	0° to 50°C
Humidity:	90% (non-condensing)

Software

Real Time Executive (RTX) includes modular Input/Output (IOX) and Communications COMX) subsystems
Disk Operating System
BASIC: Advanced, Extended and Multi-User versions
FORTRAN IV with real-time features
Conversational Assembler in addition to standard batch Assembler
Utility and Library programs
Quality Control Diagnostic (QCD) programs
File Managers
360/370 Cross Assembler

Input/Output

	LSI-2/20 with memory speed of 980	1200	1600	LSI-2/10 with memory speed of 980	1200	1600
I/O Transfer Rates (words/bytes/sec) DMA (std)	1,020,000	833,000	625,000	1,020,000	833,000	625,000
DMA (Interleaved)	1,666,000	1,429,000	1,250,000	1,666,000	1,429,000	1,250,000
Programmed I/O (Std; via registers)	130,000	125,000	112,000	65,000	62,500	56,000
Programmed I/O (Std; direct to memory)	90,000	83,000	70,000	45,000	41,500	35,000
Automatic I/O Channels (Std; multiple device capability without multiplexer); total	80,000	73,000	62,000	40,000	36,500	31,000

Conditional I/O:	Standard
Maximum number of I/O devices addressable:	248
I/O Word Length:	8 and 16 bits
Priority Levels:	5 standard (2 internal; 3 external)
Interrupts:	Fully vectored: 6 standard: additional provided by all standard I/O options

All specifications subject to change without notice.

FEATURES

Obsolescence-Proof Family

Open-ended design: change capacity or speed, quickly and easily, in the field.

Many processors; many kinds of memories in fourteen sizes; variety of options and interfaces.

Quality Construction

100% burn-in of IC's to MIL-STD-883

Full one-year unconditional factory warranty

Efficient Hardware Means Easy Integration

Memory from 1,024 to 524,288 16-bit words

Relative addressing eliminates fixed page problems

Indexed addressing for efficient loop control and table processing

Multi-level indirect addressing

Vectored priority interrupts

Full range of options includes Memory Parity, Power Fail/Restart, Real Time Clock, and Autoload

Complete set of peripheral and general purpose interface modules

Powerful Instruction Set for More Efficient Use of Memory

Hardware Multiply/Divide standard

Single word instruction format saves memory

Extensive byte capability means easier programming

Double-register Normalize instruction for floating point operations

Immediate instructions save storage space for constants

Complete set of logical instructions: OR, XOR AND, NOR

Memory Scan instruction for rapid memory search

Single and Double register rotate, logical, and arithmetic shift instructions

Stack instructions for program efficiency

Maxi-Bus Provides Multiple Input/Output Systems

Direct Memory Access (DMA) standard for very high speed transfers

Automatic I/O Channels for concurrent I/O

Programmed I/O through A or X registers

Comprehensive OEM Software Cuts Cost of Programming

Real Time Executive (RTX) is modular, includes Input/Output (IOX) subsystem

Disc Operating System

BASIC: Advanced, Extended and Multi-User versions

FORTRAN IV with real-time capability

File Manager in Disc, Magnetic Tape and Cassette versions

Conversational mode Assembler in addition to standard Assemblers

Utility and Library programs

360/370 Cross Assembler

Quality Control Diagnostic (QCD) programs

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