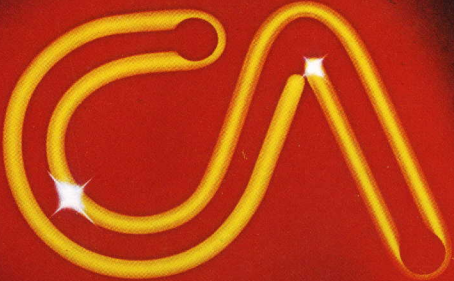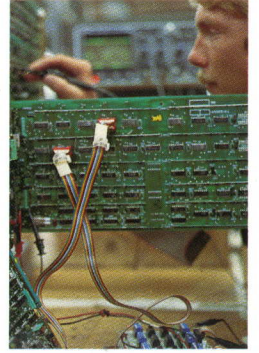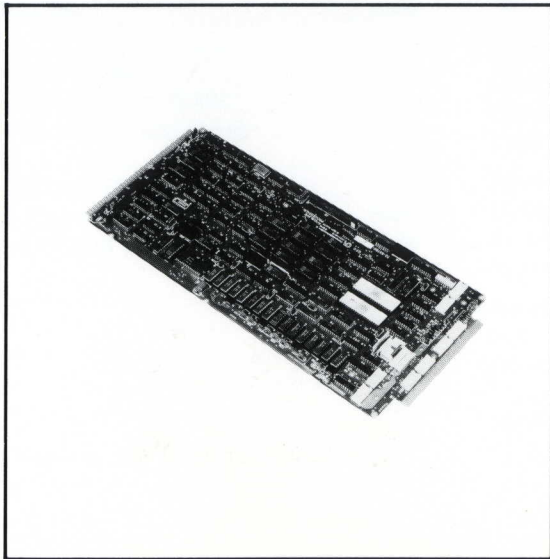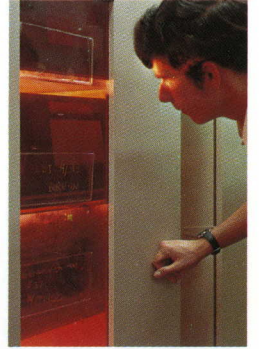# General Information

NAKED MINI® 4 COMPUTER FAMILY

ComputerAutomation

NAKED MINI® Division

WHERE OEM'S COME FIRST.

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AN OVERVIEW

Computer Automation, Inc., founded in 1967, currently is the third largest supplier of minicomputers in the industry. More than 30,000 Computer Automation minicomputer systems are now in operation around the world, and the company currently is shipping more than 150 systems per week.

Computer Automation always has maintained a steadfast dedication to volume system users, consistently understanding and translating their needs into appropriate products and services. Product lines have continually been improved and expanded to offer higher performance at lower prices. In addition, Computer Automation still manufactures, supports, and enhances previous products, fulfilling a commitment to customers who have selected Computer Automation equipment as long-term, essential components of their systems. The satisfaction of knowledgeable computer users, both Original Equipment Manufacturers (OEM's) and Volume End Users, has established Computer Automation's reputation firmly as a pre-eminent supplier of low-cost, high-performance minicomputers.

Customers use Computer Automation minicomputers in a complete spectrum of minicomputer applications, such as instrumentation, data acquisition, process control, banking, quality control and inspection, data communications, and distributed data processing systems.

Computer Automation concentrates its design and marketing talents on the challenge of delivering the most cost effective computers available, thus enhancing our customer's position within his respective field.

Intense marketing and engineering attention is directed to lowering the cost of computerization. The NAKED MINI® Division has consistently led the industry in providing higher performance at lower cost.

This unique dedication to the interests of its customers enables Computer Automation to grow at a rate far in excess of the overall industry. A significant percentage of sales revenue is invested each year in new product research and development. Customers profit from this investment by a steady stream of new and improved products.

Computer Automation recognizes fully that in the world of the OEM, the cost of computerization includes more than the initial purchase price. It includes software development costs; therefore Computer Automation offers a range of software products for both development and execution environments. Moreover, it includes maintenance and repair costs; therefore Computer Automation manufactures the most reliable equipment possible, and backs it up by a full one-year warranty.

In keeping with its tradition of providing high reliability, flexibility, and performance at lowest possible prices, Computer Automation is proud to introduce its newest family: the NAKED MINI® 4.

The NAKED MINI® 4 Family covers the entire minicomputer price/performance spectrum and provides OEM's with the breadth, strength, and flexibility necessary to configure systems suited to their unique needs. The NAKED MINI® 4 Family is completely modular with a full complement of fully compatible hardware and software that enables system users to design exactly the configurations they need, without fear of obsolescence or limitation.

In summary, Computer Automation offers the resources of a company that is dedicated to success in the marketplace and to the realization that this success comes from customer satisfaction.

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iii
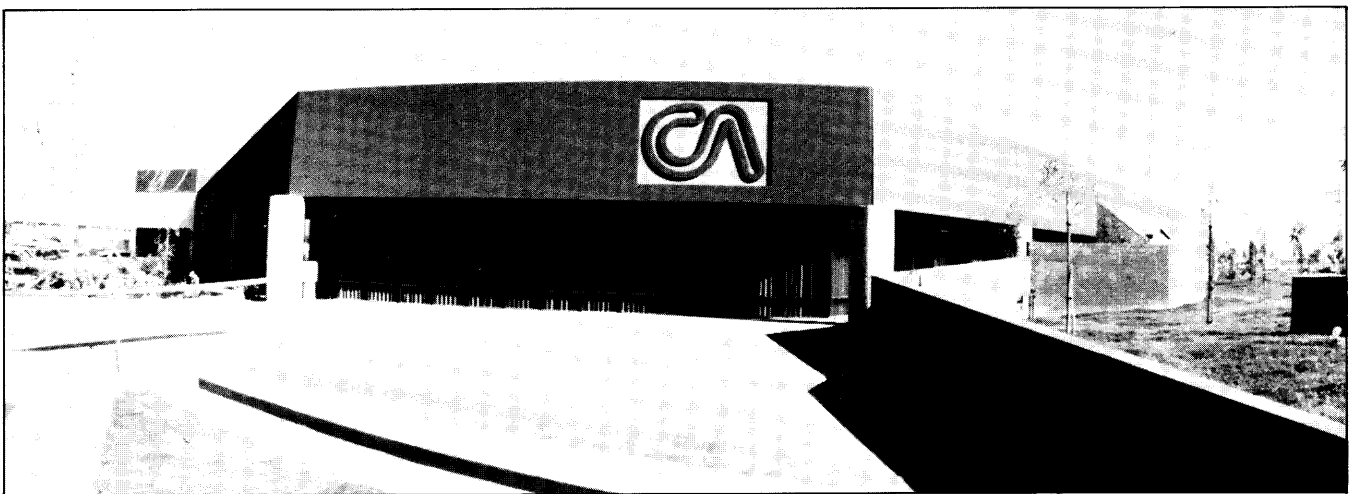
NAKED MINI 4 Family

Section I
Hardware

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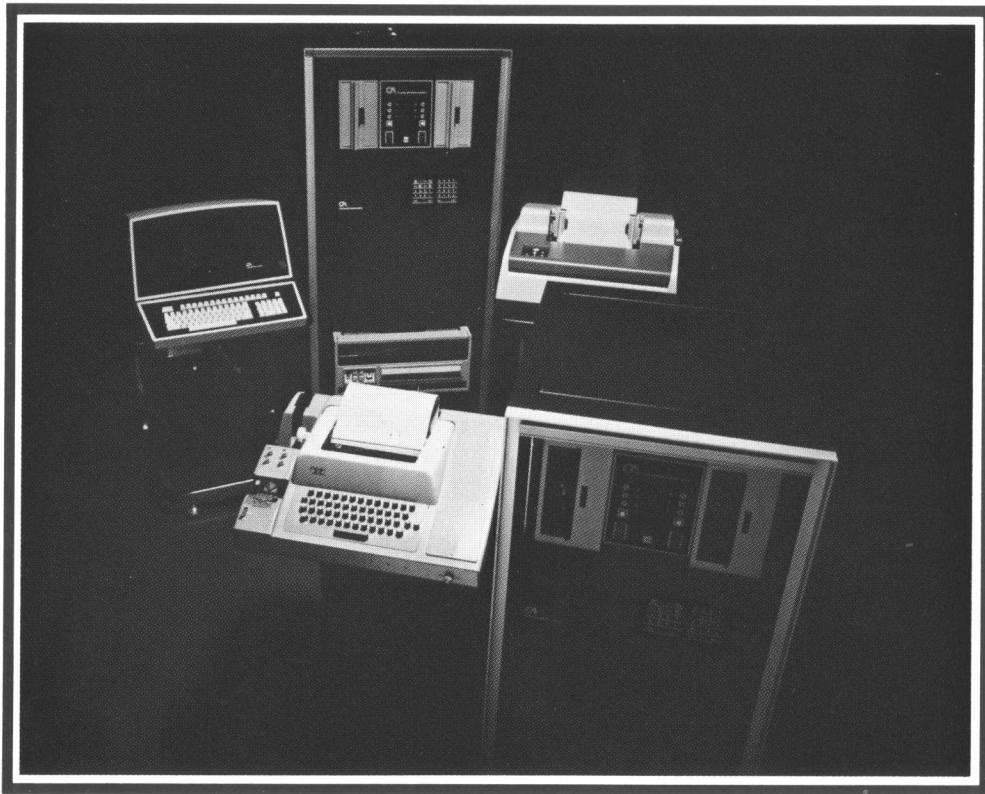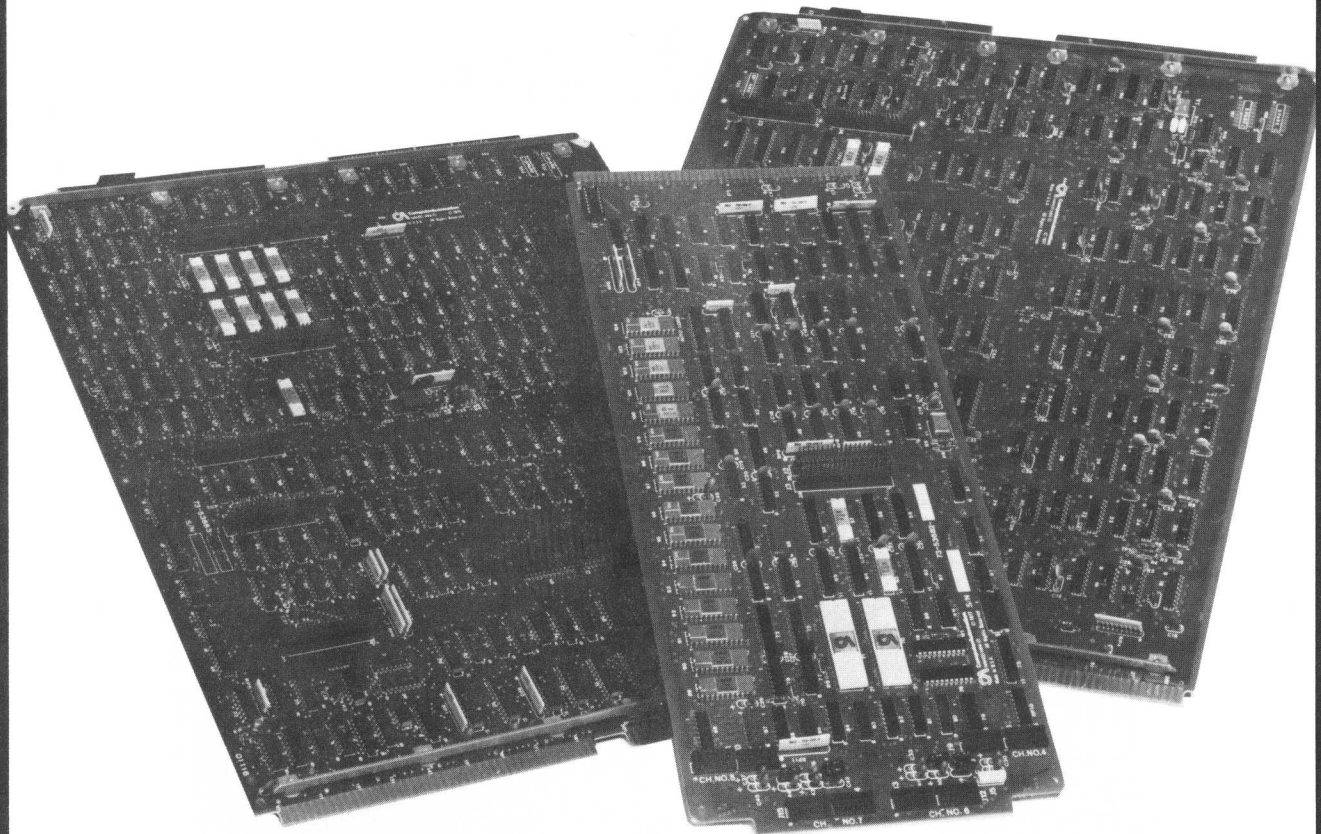
PROCESSORS

INTRODUCTION

The NAKED MINI 4 Family contains three processor models, covering the entire minicomputer price/performance spectrum. Each processor offers 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, 128K bytes direct addressability, and both word and byte operation. Addressing modes include absolute, relative, and indirect, in several combinations with indexing. I/O modes are programmed, automatic, and direct Memory Access (DMA), all of which operate on word or byte data.

All processors include Power-Fail, Auto Restart, AutoLoad, and Real-Time Clock capabilities as standard features.

The instruction set of each processor is a subset of the next more powerful processor's instruction set, which provides software compatibility. All modules interface to a common MAXI-BUS®, which provides full I/O compatibility and "plug-in" interchangeability throughout the product line.

4/10

The model 4/10 offers the ultimate in flexibility: a minicomputer-on-a-board with processor and four distributed I/O channels on a single half-card. This provides full minicomputer performance at micro-computer prices. To fill the exact need of the OEM, various configurations of RAM and core memory are offered, ranging from 8K to 128K bytes.

The standard 4/10 instruction set is the common subset for all processors and contains memory reference, register-to-register, control, I/O, immediate, shift, stack, conditional jump, trap, status change, bit manipulation, and multiply and divide operations. Floating point, double-register shift and multiple word memory reference instructions, and battery backup for the on-board RAM memory are available as options.

The 4/10 is software and hardware compatible with all NAKED MINI 4 processors and products.

4/30

The 4/30 is the mid-range of the NAKED MINI 4 processor family, with fast internal speeds and an extremely versatile instruction set to meet the varying performance needs of the OEM customer. The instruction set includes all the basic 4/10 instructions, plus additional single and double register shifts, and multiple word memory reference instructions. The optional instruction set expansion feature provides floating point, list, and additional multiple word memory reference instructions.

4/90

The 4/90 is Computer Automation's top of the line, high-performance processor, offering maximum performance and flexibility. The instruction set includes hardware multiply/divide, bit, byte, word, and stack manipulation, and double register shifts as standard. Options include floating point and list instructions.

The 4/90 provides more standard instructions than the 4/30 and, typically, is 50% faster, making it suitable for the most demanding applications.

4/10S Slave Computer™

Slave Computing is a concept for improving computer-system performance by adding parallel, autonomous computers, each with their own processor, memory, I/O, and software, as DMA devices on the system bus.

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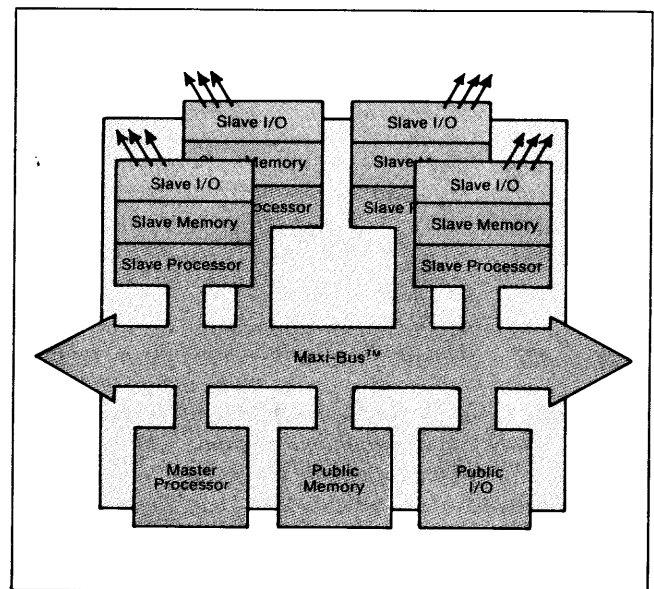
The 4/10S Slave Computer is a half-card computer, containing 32K bytes of private RAM memory, and four integral I/O distributor ports. The slave computer can access all system memory as well as its own 32KB private memory. Any intelligent cable may be connected to the I/O ports.

The CPU views the 4/10S as a slave DMA device. The 4/10S operates concurrently with the CPU.

The 4/10S has the same basic instruction set as the 4/10, plus additional stack relative, bit manipulation, and communications-oriented instructions.

The host CPU can start, stop, or interrupt the slave computer. The slave computer may communicate with the host CPU via sytem memory or may interrupt the host.

PROCESSOR ARCHITECTURE

All NAKED MINI 4 Family processors have identical architecture and MAXI-BUS interface, which provides compatibility of processors with hardware modules throughout the product line.

The architectural features of the NAKED MINI 4 processors are described below, including data types processed, addressing modes, I/O modes, register file, status register contents, interrupt and trap handling, real-time clock, and AutoLoad and AutoStart capabilities.

Data Types

The processors support the following data types:

- Addresses
- Fixed-Point Numbers
- Double-Precision Fixed-Point Numbers
- Character Strings
- Decimal Strings
- Floating Point
- Magnitude Value
- Bits
- Stacks
- Lists

Addresses

Addresses may be word or byte addresses. In general, a full 16-bit word is provided for addressing, which allows direct addressing for up to 128K bytes of memory.

Fixed-Point Numbers

Fixed-point numbers are represented as 16-bit signed two's-complement numbers, where the most significant bit (MSB), bit 15, is the sign bit.

Double-Precision, Fixed-Point Numbers

Double-precision, fixed-point data is represented in two 16-bit words, where the first word holds the sign and the most significant 15 bits of the value.

Character Strings

Character strings are comprised of from one to 4095 8-bit byte characters in successive byte memory locations, not necessarily starting or ending on a word boundary. Each byte may have any value.

Numeric (Decimal) Strings

Numeric strings are comprised of from one to thirtytwo 8-bit ASCII byte (decimal) digits in successive byte memory locations, not necessarily starting or ending on a word boundary. Decimal strings may be unsigned, positive, or negative values. The sign is encoded into the right-most (least significant) digit; all other digits are normal ASCII code.

Floating Point

Floating point numbers are represented in two 16-bit words, where the first word contains the sign bit of the fraction, an 8-bit base-two exponent, and seven of the high-order eight bits of the normalized fraction. The second word contains the low-order 16-bits of the mantissa. The binary exponent uses excess 128 code.

Magnitude Values

Unsigned 16-bit magnitude values are supported, providing for numbers in the range 0 thru $65,535_{10}$.

Bits

A bit is a binary digit having the value of 0 or 1. Bits are used to form data word and data byte formats.

Stacks

A stack is a contiguous group of memory word locations, where the current entry (top) in the stack is addressed by a stack pointer. The stack pointer is contained in the K register. The L register contains an address which defines the physical limit of the stack. If a stack instruction causes the stack size to exceed this limit, a Stack Exception Trap is generated by the processor.

Lists

A list is a collection of blocks of consecutive memory locations, or "nodes". The pointer to the next node is the first word of each node. The first word of the first node of the list is the HEAD pseudo-node.

Memory Addressing

The processor accesses a specific location in memory by combining the reference address in the instruction with address modifiers. These address modifiers are absolute or relative (symbolically R), direct or indirect (symbolically I), preindexing (symbolically Y), and postindexing (symbolically X).

Address Modifiers

The reference address modifiers are available for use with all double word memory reference instructions and with the floating point instructions. Some single word memory reference instructions may use only two modifiers. The following figure illustrates the sequence used by the processor to compute the effective address.

Effective Address Computation
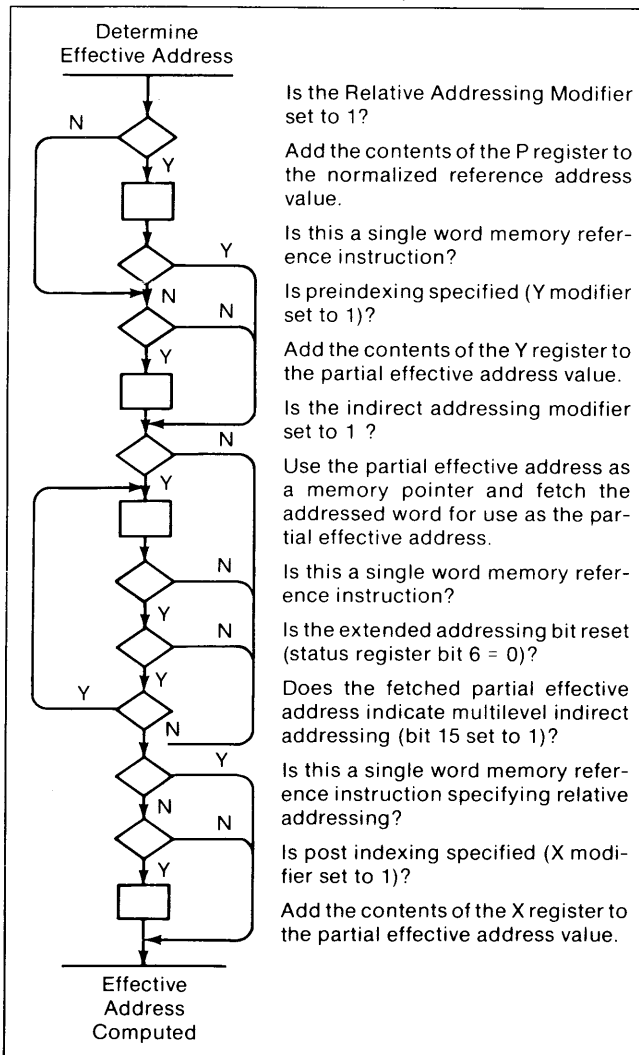
The absolute or relative modifier defines whether the reference address in the instruction is independent of (absolute) or dependent on (relative) the location of the instruction. For single word memory reference instructions, the reference address is 6-bits when absolute is selected and 8-bits when relative is selected. For double word memory reference and floating point instructions, the reference address is 16-bits.

The preindexing modifier determines if the contents of the Y register must be combined with the partially computed effective address. Preindexing cannot be used with single word memory reference instructions when relative addressing is selected.

The direct or indirect address modifier determines if the partially computed effective address is the actual partially computed address (direct), or the address of pointer to the actual address (indirect). The double word memory reference and floating point instructions are limited to a single level of indirect addressing. The single word memory reference instruction allows multi-level indirect addressing.

The postindexing modifier is the final modifier considered in computing the effective address and determines if the contents of the X register must be combined with the partially computed effective address. Postindexing cannot be used with single word memory reference instructions when relative addressing is selected.

1.3.2 Status Register Address Modifiers

For single word memory reference instructions the status register extended addressing bit (bit 6) and byte mode bit (bit 2) also affect the computation of the effective address.

The byte mode bit (bit 2) controls whether the single word memory reference instructions address memory as a series of 16-bit words (byte mode = 0) or 8-bit bytes (byte mode = 1).

The extended address bit (bit 6) controls the availability of multi-level indirect addressing. When the extended address bit is set = 0, multi-level indirect addressing is enabled and the address range is limited to the lower 64K bytes of memory (:0000 to :7FFF). When the extended address bit is set = 1, multi-level indirect addressing is disabled and the address range is extended to the full 128K bytes of memory (:0000 to :FFFF).

Input/Output

The NAKED MINI 4 Family of computers features five distinct input/output modes which, when combined with a set of general I/O instructions, provide a very powerful and easy to use I/O structure. These modes are as follows:

- Programmed I/O
- Interrupt I/O
- Automatic Word I/O
- Automatic Byte I/O
- Direct Memory Access

Transfers can be made to or from the A, Q, X, or Y registers or directly to or from memory. Both word and byte data can be handled directly, with byte data packed automatically, if desired, without requiring time and space consuming routines.

Programmed I/O

To ensure convenience in handling data which must be examined immediately upon input or output, 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.

Interrupt I/O

The processor may initiate an I/O operation with interrupts in which case it will be interrupted when service is required and will vector to an appropriate interrupt service routine specified by the I/O controller.

Automatic Word I/O with Interrupts

This mode permits 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 controller generates an end-of-block interrupt.

Automatic Byte I/O with Interrupts

This mode permits transfer of 8-bit bytes to or from memory, automatically packing (or unpacking) two bytes per word into memory. When all data has been transferred, the controller issues an end-of-block interrupt.

Direct Memory Access

Very high data transfer rates can be achieved with Direct Memory Access (DMA) I/O. DMA transfers data to and from memory independent of any processor interaction. Multiple DMA controllers can use the DMA feature concurrently (using alternate memory cycles) up to the full memory transfer rate.

REGISTER FILE

All of the NAKED MINI 4 processors contain eight user-accessible registers. These registers are:

Table I-1. Register File

A	General Purpose Accumulator
Q	General Purpose Accumulator
Y	Pre-Index Register/Accumulator Used for indexed address operations and also as an accumulator for a number of instructions. When used in conjunction with indirect addressing, the contents of the Y register are added to the instruction address field to determine the location of the indirect pointer.
X	Post-Index Register/Accumulator Used for indexed address operations and also as an accumulator for a number of instructions. When used in conjunction with indirect addressing, the contents of the X register modify (are added to) the last indirect address pointer.
K	Stack Pointer This register is used in conjunction with stack instructions as a pointer to the current (top) stack entry.
L	Stack Limit This register is used in conjunction with stack instructions as a pointer to the maximum physical limit of the stack.
P	Program Counter At instruction fetch time, the contents of P define the memory location of the next instruction, except when the instruction is being fetched as a result of an interrupt service or other special cases.
S	Status Word This register contains processor status information (Table I-2).

Table I-2. Bit Designation for Status Information.

Bit	Status Information
15	I/O Interrupt Level Inhibit
14	I/O Interrupt Level Inhibit
13	I/O Interrupt Level Inhibit
12	I/O Interrupt Level Inhibit
9,10,11	Reserved
8	Global Control of All Interrupt Levels
7	Reserved
6*	Extended Addressing Mode
5	Real-time Clock Interrupt Enable
4	Console Interrupt Enable
3	Reserved
2*	Byte Mode
1*	Overflow Bit
0*	Carry Bit

*These bits are altered by Push and Pop Instructions.

Interrupts and Traps

The interrupt/trap system permits the processor to execute one or more instructions outside of the presently executing program flow to respond to various external or internal conditions. Both the interrupt and the 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 or trap instructions," respectively. The following instructions are valid interrupt instructions:

- Automatic Input Word
- Automatic Input Byte
- Automatic Output Word
- Automatic Output Byte
- Increment and Skip
- Jump and Store
- Jump and Stack
- No Operation
- Halt

Interrupts

Three types of interrupts are recognized by the system: real-time clock, console, and I/O. These interrupts are differentiated by vector addresses supplied externally in the case of the I/O interrupts or internally for the console and real-time clock (RTC) interrupts.

Enabling and Disabling: All interrupt conditions may be enabled or disabled by the STATUS INHIBIT (SIN) instruction and/or by bits in the Status Register (S).

Real-Time Clock (RTC) Interrupt: The RTC location :0091 is incremented at twice the line frequency or as determined by an externally provided signal. The real-time clock interrupt is generated when location :0091 increments to zero and is the highest priority interrupt. Although the RTC increment itself is not an interrupt, it nevertheless has priority over all interrupts.

Console Interrupt: The console interrupt is initiated by the console interrupt switch on the console. This interrupt is defined to have a priority higher than I/O interrupts but below the RTC interrupt. The interrupt vector is also generated internally by the processor.

I/O Interrupts: I/O interrupts are initiated by the I/O controllers connected to the MAXI-BUS. I/O interrupts are lower in priority than real-time clock 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 (16-bit address pointer) during the Interrupt Address Request (IAR) cycle of the processor. The vector can be any number ranging from :0000 to :FFFF.

Traps

Traps recognized by the system are: Power Fail, Stack Exception, Arithmetic Exception, Unimplemented Instruction, Memory Exception, System, and User Traps. The traps are differentiated by unique vector addresses supplied internally by the CPU and by information stored at the storage area set aside for that trap.

Power-Fail Trap: The Power-Fail Trap is executed when the power supply informs the processor of a power fail condition, and upon completion of the currently executing instruction. Power Fail is the only trap which can be disabled (a Status Inhibit instruction temporarily inhibits the processor from recognizing this trap). Register contents including processor status are unchanged during a Power-Fail Trap.

Stack Exception Trap: The Stack Exception Trap is invoked if either a Jump and Stack instruction or a Push instruction causes the Stack Pointer to point to a stack location less than L+7. When a Stack Exception Trap occurs, all register contents, except K, P, and processor status S in the case of the Push instruction, are unaltered. The trap is taken after the instruction has executed. The value of P is stored at the trap location (:009C), and the instruction causing the trap is stored at :009D.

Arithmetic Exception Trap: The Arithmetic Error Trap is invoked if a divide operation produces a quotient which is too large or if a Floating Point arithmetic operation produces exponent overflow. The value of P is stored at the trap location (:00A8), and the instruction causing the trap is stored at :00A9.

Unimplemented Instruction Trap: Any instruction that is not implemented in a given NAKED MINI 4 processor invokes the Unimplemented Instruction Trap when encountered as an instruction.

Memory Exception Trap: A Memory Exception Trap occurs if an attempt is made to access a memory location that is not installed in the system or if a parity error occurs during an operation on a RAM memory equipped with the parity option.

System and User Traps: Two instructions (STRAP and UTRAP) provide for traps to dedicated memory locations. STRAP is utilized by CAI software. UTRAP is provided for user-desired emulation routines.

The following chart describes all memory locations associated with interrupts and traps.

Table I-3. Interrupts and Traps

Interrupt[1]	Trap[2]	Other[3]	Memory Space[4]
		Power Up	:80[5]
	Unimplemented Instruction		:84—:87
	Memory Exception		:88—:8B
	Power Fail		:8C—:8F
		RTC Increment	:91
RTC			:92—:93
Console			:94—:95
	Stack Exception		:9C—:9F
	User Trap		:A0—:A3
	System Trap		:A4—:A7
	Arithmetic Exception		:A8—:AA
I/O			:0000—:FFFF[6]

[1]Interrupts are shown in order of priority, with the real-time clock (RTC) interrupt having highest priority.
[2]Priority is not relevant for traps. The conditions for generating the traps are mutually exclusive timewise, and they are always taken when the trap condition occurs (except for a Power Fail Trap under the range of a STATUS INHIBIT instruction or after an uninterruptable instruction).
[3]The two events shown in this column are not traps or interrupts, but are nevertheless shown to provide a complete table of dedicated memory locations.
[4]The first location of the memory space for interrupts and traps is referred to as the interrupt or trap location.
[5]Colon (:) indicates hexadecimal address.
[6]This vector is received by the processor during an Interrupt Address Request (IAR) cycle resulting from the interrupt.

Real-Time Clock

The real-time clock (RTC) function increments memory location :0091 each time a clock pulse is detected. This function is referred to as the real-time clock increment. When location :0091 increments to zero, an internal interrupt is generated with a vector to location :0092. This is the real-time clock interrupt. If an RTC increment causes an RTC interrupt, that interrupt is serviced immediately without intervening instructions, traps, or other interrupts.

The time base is derived from the TTLF signal (twice the line frequency) from the power supply, or from external user-supplied input. The accuracy of the TTLF signal is governed by the power source line frequency.

The real-time clock increment is enabled globally by bit 8 of the status word and specifically by bit 5 of the status word, and is also under control of the STATUS INHIBIT (SIN) instruction.

AutoLoad and AutoStart

The AutoLoad function stores a 512 byte program from an AutoLoad ROM into low memory, and then executes the program beginning at location :0000. There are no programming constraints; therefore, the loaded AutoLoad program may use the full resources of the computer after properly initializing the status register. AutoLoad may be initiated by the console, on power up, or remotely via connections on the processor.

The AutoStart operation is an alternative to AutoLoad and is initiated on power up if the AutoLoad jumper is not installed. When initiated, the processor loads the Status (S) register with :0000, the P counter with :0080, the Y register with :0040, and enters the run mode. Any RAM memory which contains bad data (due to power loss) will output all zeros, which the processor executes as a NOP (no operation) and continues executing until reaching core, ROM, or other valid memory.

Instruction Sets

The major distinction among the three NAKED MINI 4 processors is the instruction set implemented by each and the relative execution speed of the instructions. The instruction sets are described below.

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Table 1-4. Basic Common Instruction Sets for 4/10, 4/30 and 4/90.

Instruction Mnemonic	Description	Instruction Mnemonic	Description	Instruction Mnemonic	Description	Instruction Mnemonic	Description
Single Word — Memory Reference Class				**I/O Class**			
COPY	Load	XOR	Exclusive OR	OUT	Output Data	AIB	Automatic Input Byte
COPY	Store	CSK	Compare and Skip	IN	Input Data		
ADD	Add	JMP	Jump	SELP	Select and Present	AOT	Automatic Output Word
SUB	Subtract	JST	Jump and Store	SST	Sense and Skip True		
EXCH	Exchange	IMS	Increment & Skip	AIN	Automatic Input Word	AOB	Automatic Output Byte
AND	AND	JSK	Jump and Stack P				
OR	Inclusive OR						
Register-To-Register Class				**Control Class**			
COPY	Copy	OR	Inclusive OR	FMT	Fetch Machine Type	RSK	Return thru Stack
NEG	Negate	CSN	Compare Not Equal	UIS	Update Interrupt Status	HLT	Halt
ADD	Add	CSK	Compare 3-Way			SIN	Status Inhibit
SUB	Subtract	EXCH	Exchange	XNX	Index Next Instruction	NOP	No Operation
AND	And	COMP	Complement				
XOR	Exclusive OR	CSM	Compare Magnitude				
Immediate Class				**Status Change Class**			
COPY	Load Byte Negative	CSK	Compare 3-Way	SBIT	Set Status Bit	CBIT	Complement Status Bit
COPY	Load Byte Positive	AND	AND	RBIT	Reset Status Bit		
SUB	Subtract Byte	OR	Inclusive OR			TBIT	Test Status Bit
ADD	Add Byte	XOR	Exclusive OR				
CLSN	Compare Equal						
Bit Manipulation Class				**Emulate Traps Class**			
SBIT	Set Bit	CBIT	Complement Bit	UTRAP	User Trap	STRAP	System Trap
RBIT	Reset Bit	TBIT	Test Bit				
Stack Class				**Single Register Shift Class**			
PUSH	Push Registers on Stack	POP	Pop Registers off Stack	SHIFT	Left logical thru OV		
				ROTATE	Left Rotate		
Conditional Jumps Class				ROTATE	Left Rotate thru OV		
JEQ	Zero	JNED	Jump if Reg not 0, And Decrement	SHIFT	Right Logical thru OV		
JNE	Non-zero						
JGT	Greater than Zero	JTSS	Jump if Sense Switch On				
JLE	Less than or Equal to Zero	JFSS	Jump if Sense Switch Off	**Multiple-Word Memory Reference Class**			
JGE	Positive	JTOV	Jump if OV Set	ADDC	Add with Carry		
JLT	Negative	JFOV	Jump if OV Not Set	MUL	Multiply		
IJEQ	Increment and jump if Zero	JTCY	Jump if Carry Set	DIV	Divide (single quadrant)		
IJNE	Increment and Jump if Not Zero	JFCY	Jump if Carry Not Set				
JEQD	Jump if Reg=0, and Decrement						

Table I-5. Optional and Additional Standard Instructions
For the 4/10, 4/30, 4/90 and 4/10S

Instruction Mnemonic	Description	4/10	4/30	4/90
Single Register Shift Class				
SHIFT	Left Logical	Opt	Std	Std
SHIFT	Left Logical thru OV	Std	Std	Std
ROTATE	Left Rotate	Std	Std	Std
ROTATE	Left Rotate thru OV	Std	Std	Std
SHIFT	Right Logical	Opt	Std	Std
SHIFT	Right Logical thru OV	Std	Std	Std
ROTATE	Right Rotate	Opt	Std	Std
ROTATE	Right Rotate thru OV	Std	Std	Std
SHIFT	Right Arithmetic	Std	Std	Std
Double Register Shifts Class				
SHIFT	Left Logical	Opt	Std	Std
SHIFT	Left Logical thru OV	Opt	Std	Std
ROTATE	Left Rotate	Opt	Std	Std
ROTATE	Left Rotate thru OV	Opt	Std	Std
SHIFT	Right Logical	Opt	Std	Std
SHIFT	Right Logical thru OV	Opt	Std	Std
ROTATE	Right Rotate	Opt	Std	Std
ROTATE	Right Rotate thru OV	Opt	Std	Std
SHIFT	Right Arithmetic	Opt	Std	Std
Multiple Word Memory Reference Class				
COPYE	Load	Opt	Opt	Std
COPYE	Store	Opt	Opt	Std
ADDE	Add	Opt	Opt	Std
SUBE	Subtract	Opt	Opt	Std
EXCHE	Exchange	Opt	Opt	Std
CSM	Compare Magnitude	Opt	Std	Std
CSKE	Compare 3-way	Opt	Opt	Std
CEA	Compute Effective Address	Opt	Std	Std
ANDE	And	Opt	Opt	Std
ORE	Inclusive Or	Opt	Opt	Std
XORE	Exclusive Or	Opt	Opt	Std
ADDC	Add with Carry	Std	Std	Std
SUBC	Subtract with Carry	Opt	Std	Std
JMPE	Jump	Opt	Opt	Std
JSTE	Jump and Store	Opt	Opt	Std
IMSE	Increment and Skip	Opt	Opt	Std
MUL	Multiply	Std	Std	Std
DIV**	Divide	Std	Std	Std
JSKE	Jump and Stack P	Opt	Std	Std
DMSE	Decrement Memory and Skip	Opt	Opt	Std
COPYE	Load Double	Opt	Std	Std
COPYE	Store Double	Opt	Std	Std
Floating Point Class				
FIX	Fix	Opt	Opt	Opt
FLOAT	Float	Opt	Opt	Opt
ADDF	Floating Add	Opt	Opt	Opt
SUBF	Floating Subtract	Opt	Opt	Opt
MULF	Floating Multiply	Opt	Opt	Opt
DIVF	Floating Divide	Opt	Opt	Opt
CSKF	Floating Compare	Opt	Opt	Opt
List Class				
SEARCH	Search	NA	Opt	Opt
LOCATE	Locate	NA	Opt	Opt
INSERT	Insert	NA	Opt	Opt
DELETE	Delete	NA	Opt	Opt

Instruction Mnemonic	Description	4/10	4/30	4/90	4/10S
Memory Bit Manipulation Class					
MSB	Memory Set Bit	N/A	N/A	N/A	Std
MSKS	Memory Set Bit and Skip	N/A	N/A	N/A	Std
MRB	Memory Reset Bit	N/A	N/A	N/A	Std
MSKR	Memory Reset Bit and Skip	N/A	N/A	N/A	Std
MCB	Memory Complement Bit	N/A	N/A	N/A	Std
MSKC	Memory Complement Bit and Skip	N/A	N/A	N/A	Std
MSKO	Memory Bit Skip If One	N/A	N/A	N/A	Std
MSKZ	Memory Bit Skip If Zero	N/A	N/A	N/A	Std
Extended Stack Class					
Copy	Load Stack Relative	N/A	N/A	N/A	Std
Copy	Store Stack Relative	N/A	N/A	N/A	Std
Push	Push Single Register	N/A	N/A	N/A	Std
POP	Pop Single Register	N/A	N/A	N/A	Std
Alloc +	Allocate	N/A	N/A	N/A	Std
Alloc -	Deallocate	N/A	N/A	N/A	Std
Data Move and Data Scan					
MVB	Byte Block Move	N/A	N/A	N/A	Std
XLB	Byte Translate Block	N/A	N/A	N/A	Std
SLBS	Byte Translate Block and Skip	N/A	N/A	N/A	Std
SCM	Byte Scan Memory	N/A	N/A	N/A	Std
Context Switching					
SAVES	Save Context on Stack	N/A	N/A	N/A	Std
RESTS	Restore Context From Stack	N/A	N/A	N/A	Std
Slave Control Service					
ISCDR	Input from Slave Control Data Register	N/A	N/A	N/A	Std
OSCDR	Output to Slave Control Data Register	N/A	N/A	N/A	Std
IMSCDR	Input to memory from Slave Control Data Register	N/A	N/A	N/A	Std
OMSCDR	Output from memory to Slave Control	N/A	N/A	Std	N/A
STOP	Stop	N/A	N/A	N/A	Std
STEP	Single Step	N/A	N/A	N/A	Std
START	Start	N/A	N/A	N/A	Std

**Single quadrant divide standard on 4/10; four quadrant standard on 4/30 and 4/90 and on 4/10 with optional instruction set.*

LEGEND:
Std = Standard
Opt = Optional
NA = Not Available

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Representative Instruction Execution Times

Representative execution times for selected instructions from each class with appropriate memories are given in the table below. The execution times are shown in microseconds.

Table 1-6. Execution Times

Instruction Mnemonic	4/10 with 550 ns RAM	4/30 with 550 ns RAM	4/90 with 550 ns RAM	Instruction Mnemonic	4/10 with 550 ns RAM	4/30 with 550 ns RAM	4/90 with 550 ns RAM
Memory Reference Class				IJNE			
COPY (Load)	3.9	1.7	1.4	(No Jump)	5.2	1.0	1.0
ADD	4.1	1.7	1.4	(Jump)	5.2	1.0	1.1
EXCH	5.0	2.8	2.2	JEQD			
AND	4.6	1.7	1.4	(No Jump)	4.5	1.1	1.1
CSK				(Jump)	4.5	1.1	1.1
(Less Than)	5.9	1.9	1.5	JNED			
(Greater Than)	6.9	2.1	1.8	(No Jump)	5.9	1.2	1.2
(Equal)	6.8	2.1	1.8	(Jump)	6.0	1.2	1.2
JMP	6.0	1.2	0.8	**Input/Output Class**			
JST	8.7	1.9	1.6	AOT	33.1	13.3	11.8
IMS				AIN	33.3	12.8	11.2
(Skip)	7.8	2.6	2.1	OUT	6.8	2.5	2.2
(No Skip)	7.0	2.6	2.1	IN	6.6	2.5	1.9
JSK	10.5	2.9	2.2	SELP	6.0	2.5	2.2
Register-To-Register Class				SST	6.0	2.2	1.8
COPY	3.9	1.1	0.7	**Control Class**			
ADD	3.2	1.1	0.7	FMT	6.0	1.5	1.3
EXCH	5.1	1.7	1.0	UIS	12.5	5.3	5.5
AND	3.9	1.1	0.7	XNX	5.3	1.5	1.4
CSN				RSK	5.9	2.5	2.2
(Equal)	4.5	1.3	0.8	**Single-Register Shift Class**			
(Not Equal)	5.1	1.3	1.3	SHIFT L (1 place)	8.2	1.5	1.0
CSK				SHIFT LO (1 place)	6.1	1.5	1.0
(Less Than)	4.5	1.3	0.8	ROTATE L (1 place)	5.6	1.5	0.9
(Greater Than)	5.1	1.5	1.4	ROTATE LO (1 place)	9.4	1.5	1.0
(Equal)	5.1	1.5	1.4	SHIFT R (1 place)	7.5	1.6	1.0
Immediate Class				SHIFT RO (1 place)	6.1	1.5	1.0
COPY (Pos.)	2.2	0.9	0.7	ROTATE R (1 place)	7.6	1.5	0.7
ADD	2.4	0.9	0.7	ROTATE RO (1 place)	9.4	2.5	1.0
CLSN				**Double-Register Shift Class**			
(Equal)	4.9	1.2	0.9	SHIFT L	9.7	2.2	1.4
(Not Equal)	5.7	1.2	1.0	SHIFT LO	9.7	2.2	1.4
AND	2.2	1.0	0.7	ROTATE L	9.6	2.2	1.4
Bit Manipulation Class				ROTATE LO	12.0	2.2	1.4
SBIT	3.8	1.5	0.7	SHIFT R	10.2	2.2	1.4
RBIT	3.7	1.6	0.7	SHIFT RO	10.2	2.2	1.4
CBIT	3.8	1.5	0.7	ROTATE R	10.2	2.1	1.4
TBIT	6.3	1.7	0.8	ROTATE RO	11.5	2.2	1.4
Stack Class				**Multiple Word Memory Reference Class**			
PUSH	28.3	8.9	8.0	MUL	66.6	12.7	12.3
POP	22.8	8.1	7.6	DIV	71.9	12.2	11.9
Conditional Jump Class							
JEQ							
(No Jump)	3.5	0.9	0.9				
(Jump)	5.7	0.9	0.9				
JNE							
(No Jump)	3.6	0.9	0.9				
(Jump)	5.1	1.0	1.0				
IJEQ							
(No Jump)	3.7	0.9	0.9				
(Jump)	3.7	0.9	0.9				

NOTE: Addressing Mode Overhead in microseconds:

Relative	0.95	0.00	0.00
Indexed	0.1	0.05	0.00
Indirect (1 level)	3.8	0.85	0.65

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MEMORIES

INTRODUCTION

Consistent with the philosophy the broadest range of fully compatible, lowest priced computer configurations. Computer Automation offers an extensive array of supporting hardware. Special emphasis is placed on memories. Semi-conductor RAMs are in 8, 16, 32, 64 and 128K byte half-cards and 16K, 32K, or 64K byte full-cards. Core memories are in 16K half-cards or 8K, 16K and 32K byte fullcards. RAM/E/P/ROM combinations are also available with up to 4K bytes or RAM in increments as small as 512 bytes, and up to 16K bytes of ROM, PROM or EPROM. All semi-conductor memories have battery backup to provide data protection in the event of a power failure. Parity is also available as an option on all RAM memories.

Full-card memories are capable of being interleaved so that successive memory access can occur on physically different memory modules, thereby increasing effective memory throughput. They also may be banked in 64K byte modules or increments to provide expansion beyond the 128K byte logical address limit of the machine.

4/10 ON-BOARD MEMORY

The 4/10 computer is unique in that it contains up to 8K bytes of memory and four I/O channels on a single half card.

The memory is available in several configurations of RAM, and RAM or PROM sockets, for up to 8K bytes of on-board memory. Specific configurations are:
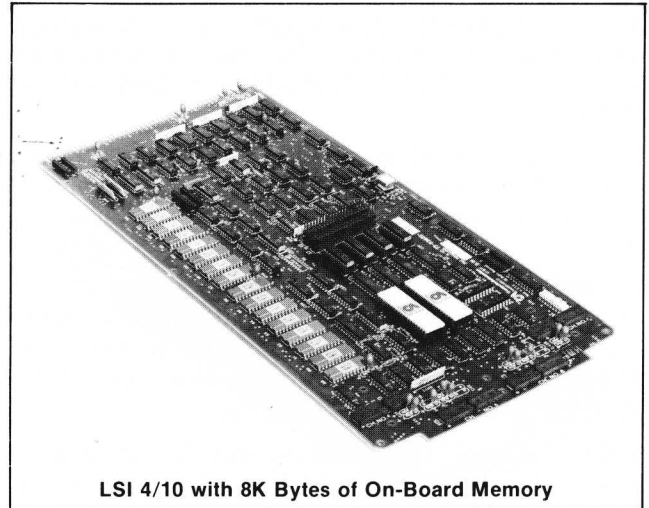
  8KB RAM only
  2KB RAM/6KB PROM sockets

The RAM is 550 ηsec, static MOS RAM. The PROM sockets accept user-supplied Intel 3625 or equivalent 1K x 4 PROM's.

RAM MEMORIES

8KB, 16KB, Half-card RAM

The Computer Automation half-card RAM memory is a high-speed, low cost, dynamic MOS RAM memory designed for use with all computers in the NAKED MINI 4 Family.

LSI 4/10 with 8K Bytes of On-Board Memory

Dynamic MOS RAM memory chips automatically receive refresh cycles at regular intervals to regenerate data storage. The refresh cycles normally are transparent to the CPU, which is never locked out for more than one memory cycle.

RAM memories include invalid-data detect sensing logic, which provides protection from accessing unreliable data resulting from power failures. Read access to RAM memories is inhibited when input power has dropped below the minimum required to sustain the contents of memory.

Half-Card RAM Memory
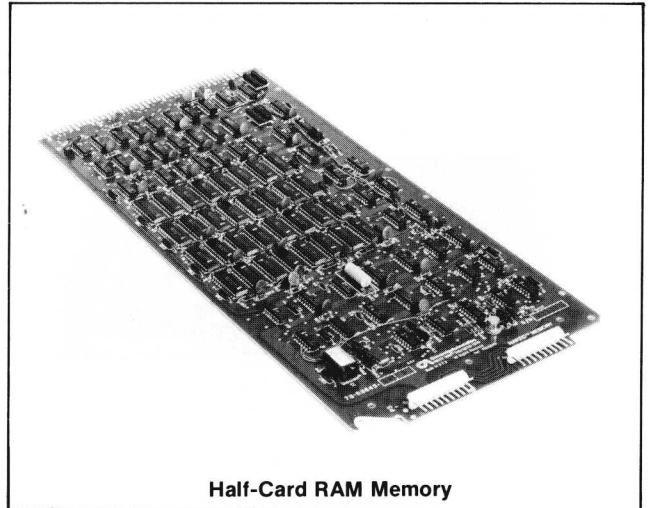
ComputerAutomation
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16KB, 32KB, 64KB Full-Card RAM

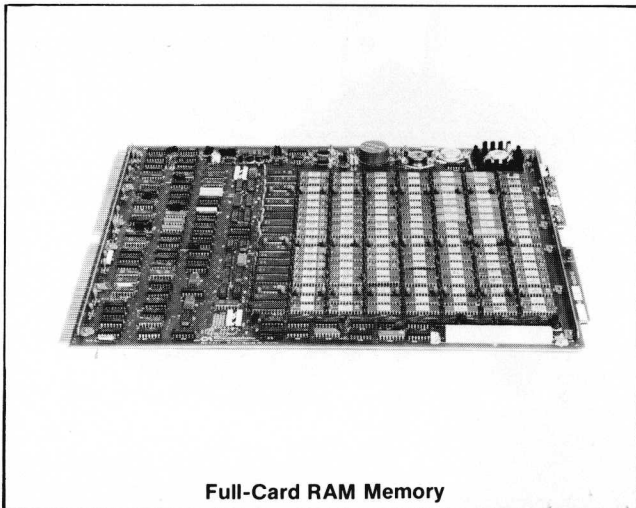Computer Automation's full-card RAM memory provides the OEM with a high-speed, low-cost memory module that is compatible with any NAKED MINI 4 Family computer. Packaged on a standard full-card, this module contains up to 64K bytes of memory.

The memory interleaving capability permits memory modules to be paired for alternate memory accessing, resulting in higher memory transfer rates.

Dynamic MOS RAM memory chips automatically receive refresh cycles at regular intervals to regenerate data storage. The refresh cycles normally are transparent to the CPU, which is never locked out for more than one memory cycle.

RAM memories include invalid-data detect sensing logic, which provides protection from accessing unreliable data resulting from power failures. Read access to RAM memories is inhibited when input power has dropped below the minimum required to sustain the contents of the memory. RAM memories are supplied with factory-installed, on-card battery backup, thereby preserving data integrity for a minimum of two minutes.

The parity option allows the verification of data to and from memory. When data is written into memory, the parity of each byte is calculated and stored in bits 16 and 17. When data is read back from memory, the parity is verified against these bits.

**Full-Card RAM Memory**

32KB, 64KB and 128KB Half-Card RAM

Computer Automation's 32/64/128KB half-card RAM provides the lowest cost minicomputer memory available. Memory features include automatic refresh and automatic start up. Battery backup is a standard feature. Cycle time is 580 ns.

CORE MEMORIES

8KB or 16KB Half-Card Core

Half-card core memories offer compact, reliable, low-cost data storage compatible with any NAKED MINI 4 computer. These memory modules provide 8K or 16K bytes of directly addressable core memory.

Half-card core memories are compatible with any NAKED MINI 4 chassis. When used in a full-card processor chassis, a half-card core memory can be joined to the adjacent half-card, so that only one full slot is required for the pair.
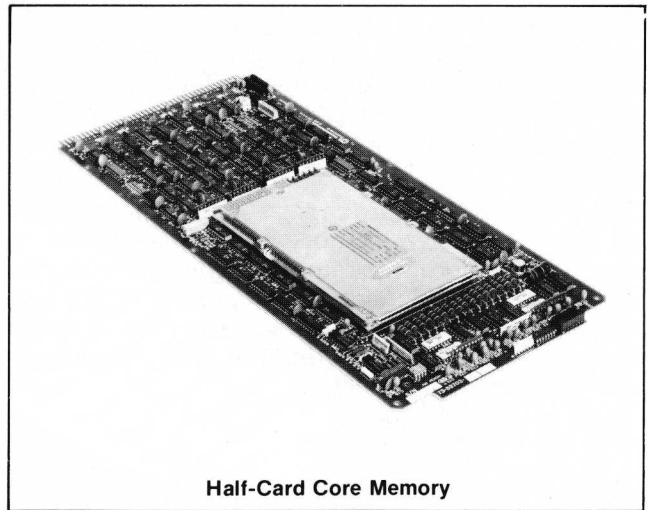
Half-Card Core Memory

8KB, 16KB, 32KB Full-Card Core

Full-card core memories offer reliable, compact, low-cost memories that are compatible with any NAKED MINI 4 computer. These memory modules provide 8K, 16K or 32K bytes of directly addressable memory.

Memory interleaving capability permits memory modules to be paired for alternate memory accessing, resulting in higher transfer rates.

Full-Card Core Memory

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RAM/ROM/PROM/EPROM MEMORIES

RAM/ROM/PROM/EPROM memories provide a wide choice of memory configurations on a single half-card. Static MOS RAM memory is available in 0, 512, or 4K bytes. The RAM/ROM/PROM/EPROM memory also contains 16 sockets which accept up to 16K bytes of user supplied ROM, PROM, or EPROM.

ROM, PROM, or EPROM may be implemented or mixed in 4K increments, thereby providing a choice between EPROM, which allows multiple erasure and reprogramming to accommodate design changes, and PROM or ROM, which provides low unit cost for volume production. RAM/ROM/PROM/EPROM memories offer flexibility in development and production systems, resulting in low product costs for OEM users.

RAM/ROM/PROM/EPROM memories include invalid data detect sensing logic, which offers protection from accessing "bad data" resulting from power failures. Read access to RAM memory is inhibited when input power has dropped below the minimum required to sustain the contents of memory. RAM/ROM/PROM/EPROM memories are supplied with standard factory-installed on-card battery backup, which protects the memory contents for a minimum of two minutes. Additional protection can be provided by external batteries.

RAM/ROM/PROM/EPROM Memories
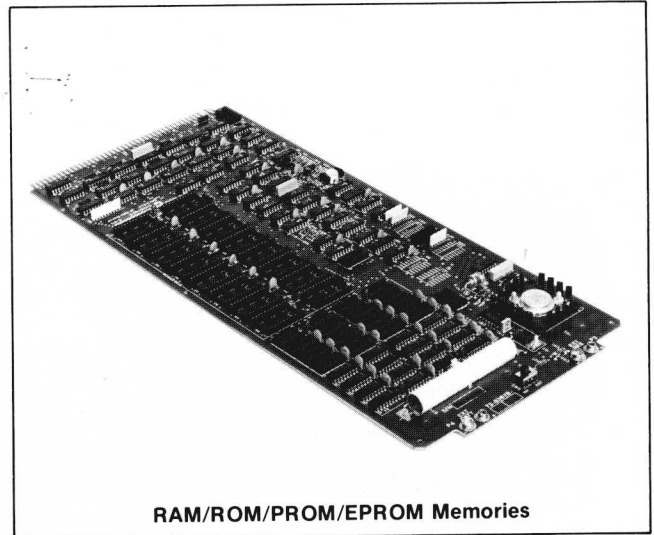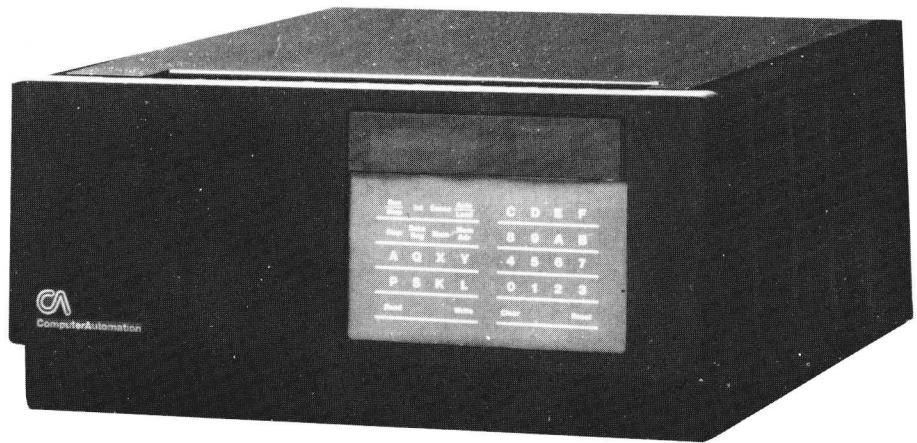
CONSOLES

INTRODUCTION

There are three control consoles available to the NAKED MINI 4 user: the operator's, programmer's, and remote programmer's consoles.

The low-cost operator's console provides enable, reset, start and interrupt functions, which are usually sufficient for dedicated application environments.

The sophisticated programmer's console provides full control of, and interaction with, the computer and includes data display and entry capabilities for any environment.

The remote programmer's console connects to the operator's console and provides full programmer's console capabilities. This console is an ideal solution to the problem of having a number of dispersed systems that normally require only an operator's console, but occasionally must have more capability. In addition, the remote programmer's console is portable and conveniently sized, allowing the programmer or engineer to carry the console from site to site.

PROGRAMMER'S CONSOLE

Computer Automation's Programmer's Console provides a low-cost control and display panel that facilitates initial start-up, program debugging, and troubleshooting on any NAKED MINI 4 computer.

The Programmer's Console provides a comprehensive set of control switches to read data from, or write data to, selected memory addresses or registers. The console also provides interrupt, Auto Load, single step, and halt capability.

Special features include AutoScan, AutoDisplay, Alphanumeric Display, and an Enable/Disable Switch.

AutoScan allows scanning through memory or register contents and reading or writing successive locations by touching a single key. The Alphanueric Display provides system status information for the selected register or memory address when the Read or Write keys are depressed and displays the register

or memory contents when the key is released.

The AutoDisplay feature allows the programmer to examine the contents of a register or memory location while the program is executing. Locations selected for display are read at the rate of approximately five times a second throughout the running of the program.

The console can read or write into the registers or memory locations at any time (including during program execution).

The concealed Enable/Disable Switch prevents accidental entry of data or change of the machine state.

OPERATOR'S CONSOLE

The Operator's Console is a low-cost control panel that provides facilities for the control of basic computer facilities for the control of basic computer functions for any of the NAKED MINI 4 Family of computers. Standard features of the Operator's Console include switches to reset, interrupt and start the processor. The Operator's Console provides a plug for the Optional Remote Programmer's Console.

REMOTE PROGRAMMER'S CONSOLE

Computer Automation's Remote Programmer's Console is the ideal solution to the typical OEM problem of many dispersed systems, which normally require only an Operator's Console but occasionally need more capability.

The Remote Programmer's Console is similar in size to a desk-top calculator and connects to the Operator's Console, providing the full capabilities of a standard Programmer's Console. An important feature of the Remote Programmer's Console is that the console may be attached without powering down or stopping the processor.

The Remote Programmer's Console provides a comprehensive set of control switches to read data from or write data to, selected memory addresses or registers.

DISTRIBUTED I/O SYSTEM

INTRODUCTION

The Distributed I/O System is the most dramatic advance in I/O technology in recent years. By combining distributed firmware-controlled I/O processors with a unique packaging technique, the Distributed I/O System provides a multiple-device interface offering high performance, low total cost and small physical size.

One I/O Distributor can control up to eight I/O devices or four direct-memory-access (DMA) devices via Intelligent Cables. Each Intelligent Cable contains a microprogrammed PICOPROCESSOR, which provides all data transfer conditions unique to that device. Intelligent Cables are available for teletype, paper tape, card reader, line printers, CRT, modems, and magnetic tape peripherals. In addition, several special purpose cables have been developed, including 16- and 32-Bit General Purpose Cables (for handshake or strobed I/O devices), and IEEE Programmable Instrumentation Digital Interface (IEEE Standard 488-1976), and a BiSynchronous Intelligent Cable. To control more than eight devices, multiple I/O Distributors may be included in a single system.

I/O Distributor

The Input/Output Distributor is the central element of a unique distributed intelligence concept: the Distributed I/O System (DIO). The DIO provides the most cost-effective solution to I/O interface problems by combining all common MAXI-BUS logic into the I/O Distributor and all unique device-oriented logic into the Intelligent Cables. This system enables the user to eliminate the high cost of individual I/O controllers and to improve system throughput by using the unique auto I/O mode.

The I/O Distributor is a half-card module that is compatible with any NAKED MINI 4 Family computer. Multiple I/O Distributors can be installed in a single computer system, each providing control for up to four or eight Intelligent Cables. Each I/O device is connected to the I/O Distributor by an Intelligent Cable.

An Intelligent Cable consists of a flat ribbon cable containing an exclusive firmware-controlled PICO-PROCESSOR housed in a small plastic case embedded in the cable. The PICOPROCESSOR is a microprogrammed miniature computer that controls data transfers to and from the I/O device, generates device control signals, monitors device status, and initiates computer interrupt requests.

Each Intelligent Cable initiates interrupts to two unique memory locations, a data interrupt and an end-of-block interrupt.

The standard I/O Distributor works in the auto I/O or programmed I/O mode. The exclusive auto I/O instructions transfer one character per interrupt automatically and calculate memory address and byte count. Parity can be standardized on input by software control.

Automatic carriage return character detection, which allows simplified programming for variable length input data blocks, is another important highlight of the I/O Distributor alternately, any 8-bit character also can be detected by software control for each channel independently as a special character detection feature. Other advanced capabilities are high noise immunity, concurrent input/output and serial/parallel data transfers in any mix, and automatic I/O data transfers directly to and from memory under interrupt control.
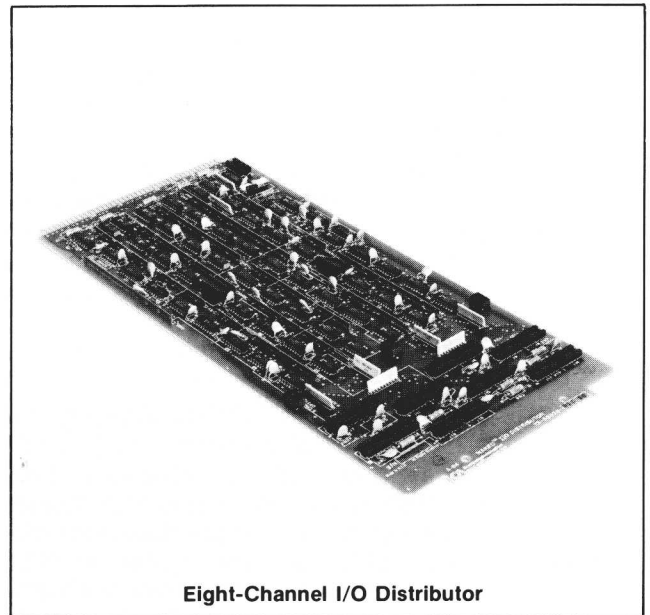
Eight-Channel I/O Distributor

LSI 4/10 On-Board Integrated I/O Distributor

The on-board 4-channel I/O capability of the LSI 4/10 consists of an Integrated Distributed Input/Output controller. This on-board DIO controller can accept up to four Intelligent Cables, each of which connects to one or more I/O devices. The DIO system features parity bit standardization and software-enabled detection of ASCII carriage return, or any special character, on a per channel basis.

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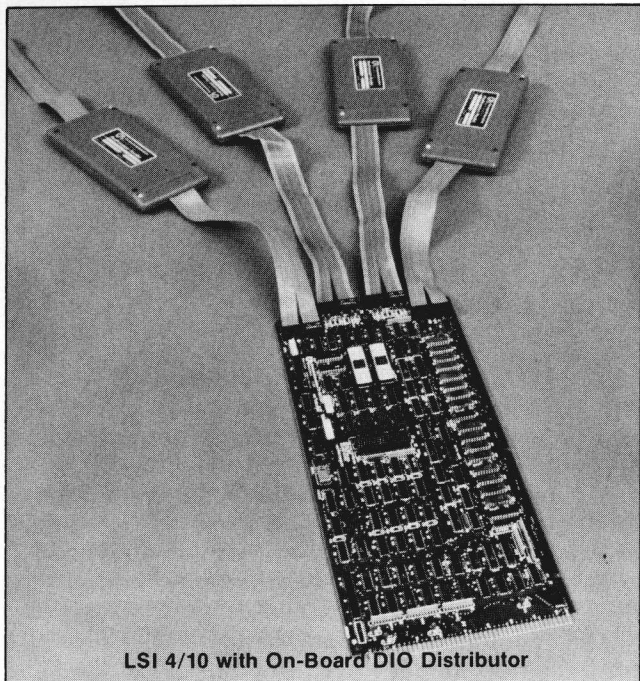
LSI 4/10 with On-Board DIO Distributor

Each I/O device is connected to the DMA I/O Distributor by an Intelligent Cable, which is a flat ribbon cable with a microprogrammed PICO-PROCESSOR housed in a small plastic case imbedded in the cable. The DMA I/O Distributor is hardware and software compatible with all standard Intelligent Cables and permits mode selection under software control for DMA or programmed I/O.

The DMA I/O Distributor can control up to four Intelligent Cables with any mix of serial or parallel devices. Multiple DMA I/O Distributors can be installed in a single system and operate concurrently with standard I/O Distributors.

Other advanced capabilities supported by the DMA I/O Distributor include selectable parity bit standardization, automatic ASCII carriage return character detection, detection of any 8-bit character per channel under software control, concurrent input/output and serial/parallel data transfers in any mix, and an exclusive microdiagnostic capability for self-test and system verification.

Jumpers allow selection of standard baud rates from 75 to 19,200. The DIO system generates two interrupts (data transfer and end-of-block) for each Intelligent Cable.

The 4/10 Integrated Distributed I/O Controller has all the capability of the standard four-channel, half-card DIO Controller, except device addresses are set to Computer Automation standards (are not jumper-selectable).
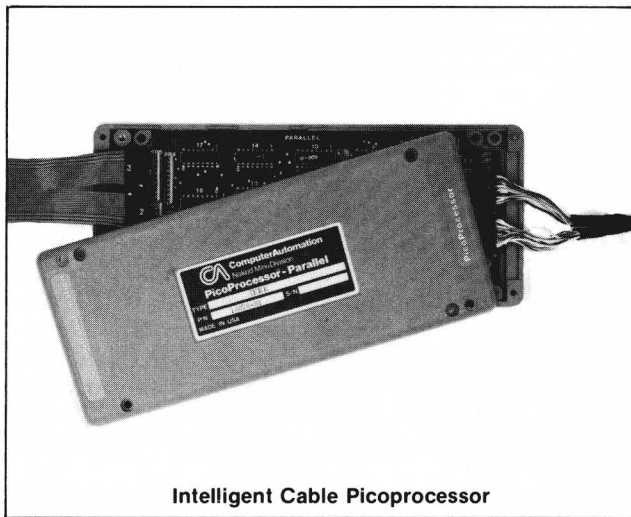
DMA I/O Distributor

For system requiring higher data throughput, the standard DIO Controller may be replaced by a DMA DIO, with no change in Intelligent Cables or user software. This system provides low-cost, highly efficient interface for up to four high-data-rate DMA devices via Intelligent Cables. This system enables the user to eliminate the high cost of individual DMA interfaces, to increase I/O throughput, and to reduce computer overhead.

The DMA I/O Distributor supports throughput rates of up to 250K bytes per second without CPU intervention and is particularly useful in applications involving numerous slow and medium speed devices where combined throughput exceeds a computer's programmed I/O or interrupt bandwidth. High performance requirements such as computer-to-computer communications can be supported easily.

Intelligent Cable Picoprocessor

INTELLIGENT CABLES

CRT Intelligent Cable

The CRT Intelligent Cable is a low-cost serial interface between an RS232-C compatible CRT terminal and any NAKED MINI 4 Family computer employing the Distributed I/O System. The Intelligent Cable is used in conjunction with any I/O Distributor to provide the OEM with a cost-effective, high-performance CRT interface and cabling with microprogrammed control and automatic error checking.

The CRT Intelligent cable is compatible with all NAKED MINI 4 computers and all I/O Distributors and provides complete CRT interface with cables and connectors. Other features include a microprogrammed PICOPROCESSOR embedded in the cable • asynchronous, half-duplex data transfer • automatic status and error detection • automatic carriage return character detection • input auto-echo • jumper selectable word length, number of stop bits, and odd, even, or no parity • two individually vectored interrupts • simplified mounting and installation • and RS232-C compatible drivers and receivers.

Paper-Tape Reader Intelligent Cable

The Paper-Tape Reader Intelligent Cable is a low-cost parallel interface between a standard Paper-Tape Reader and any NAKED MINI 4 Family computer employing the Distributed I/O System. The Intelligent Cable is used in conjunction with any I/O Distributor to provide the OEM with a cost-effective, high-performance Paper-Tape-Reader interface and cabling with microprogrammed control and automatic error checking.

The Paper-Tape Reader Intelligent Cable is compatible with all NAKED MINI 4 Family computers and all I/O Distributors. It is a complete Paper-Tape Reader interface with cables and connectors. Other features include a microprogrammed PICO-PROCESSOR embedded in the cable • direct-to-memory from reader data transfers • automatic status and error detection includes no paper tape, no power, reader in run mode, and data ready • read left, read right control • two individually vectored interrupts • simplified mounting and installation • TTL-compatible positive-true logic • handshaking I/O discipline • and the Paper-Tape Reader Intelligent Cable is supported by OS4, RTX4/IOS4, and diagnostic software.

Paper-Tape Punch Intelligent Cable

The Paper-Tape Punch Intelligent Cable is a low-cost parallel interface between a standard Paper-Tape Punch and any NAKED MINI 4 Family computer employing the Distributed I/O System. The Intelligent Cable is used in conjunction with any I/O Distributor to provide the OEM with a cost-effective, high-performance Paper-Tape Punch interface and cabling with microprogrammed control and automatic error checking.

It is a complete Paper-Tape Punch interface with cables and connectors. Other features include a microprogrammed PICOPROCESSOR embedded in the cable • direct-from-memory to punch data transfers • automatic status and error detection

®Teletype is a registered trademark of the Teletype Corporation.

includes system ready, chad drawer full, tape loose, tight or broken, paper tape low, and no power • two individually vectored interrupts • TTL-compatible postive-true logic • handshaking I/O discipline • and the Paper Tape Punch Intelligent Cable is supported by OS4, RTX4/IOS4, and diagnostic software.

Teletype® Intelligent Cable

The Teletype Intelligent Cable is a low-cost serial interface between standard asynchronous TTY devices and any NAKED MINI 4 Family computer employing the Distributed I/O System. The Intelligent Cable is used in conjunction with any I/O Distributor to provide the OEM with a cost-effective, high-performance TTY interface and cabling with microprogrammed control and automatic error checking.

The Teletype Intelligent Cable is compatible with all NAKED MINI 4 Family computers and all I/O Distributors. It is a complete teletype interface with cables and connectors. Other features include a microprogrammed PICOPROCESSOR embedded in the cable • asynchronous 20mA current-loop data transfer • software controlled paper-tape reader step and motor on/off • automatic status and error detection includes: TTY motor on/off, transmitter empty, framing error and complete character received • two individually vectored interrupts • simplified mounting and installation • automatic special character detection and input auto-echo.

Card Reader Intelligent Cable

The Card Reader Intelligent Cable is a low-cost parallel interface between a standard Card Reader and any NAKED MINI 4 Family computer employing the Distributed I/O System. The Intelligent Cable is used in conjunction with any I/O Distributor to provide the OEM with a cost-effective, high-performance Card Reader interface and cabling with microprogrammed control and automatic error checking.

The Card Reader Intelligent Cable is compatible with all NAKED MINI 4 Family computers and all I/O Distributors. It is a complete Card Reader interface with cables and connector. Other features include a microprogrammed PICOPROCESSOR embedded in the cable • direct-to-memory from reader data transfers • automatic status and error detection includes reader busy, ready for pick command, hopper empty, and error condition in reader • two individually vectored interrupts • simplified mounting and installation • device connector • TTL-compatible positive-true logic • strobed I/O discipline • and the Card Reader Intelligent Cable is supported by OS4, RTX4/IOS4, and diagnostic software.

Line Printer Intelligent Cable

The Line Printer Intelligent Cable is a low-cost parallel interface between a standard Line Printer and any NAKED MINI 4 Family computer employing the Distributed I/O System. The Intelligent Cable is used in conjunction with any I/O Distributor to provide the OEM with a cost effective, high-performance Line Printer interface and cabling with microprogrammed control and automatic error checking.

The Line Printer Intelligent Cable is compatible with all NAKED MINI 4 Family computers and all I/O Distributors. It is a complete line printer interface with cables and connectors. Other features include a microprogrammed PICOPROCESSOR embedded in the cable • direct-from-memory to line printer data transfers • automatic status and error detection includes paper low, printer not connected, no power and busy • two individually vectored interrupts • simplified mounting and installation • TTL-compatible positive-true logic • strobed I/O discipline • and the Line Printer Intelligent Cable is supported by OS4, RTX4/IOS4, and diagnostic software.

Modem Intelligent Cable

The Modem Intelligent Cable is compatible with all NAKED MINI 4 Family computers and all I/O Distributors. It is a complete modem interface with cables and connectors. Other features include a microprogrammed PICOPROCESSOR embedded in the cable • asynchronous, half-duplex data transfer • automatic status and error detection • input auto-echo • jumper selectable word length, number of stop bits, and odd, even, or no parity • two individually vectored interrupts • simplified mounting and installation • and RS232-C compatible drivers and receivers.

The BiSynchronous Intelligent Cable is a communications controller that interfaces a NAKED MINI 4 Family computer, via an I/O Distributor, to local or remote devices that use Binary Synchronous Communications Protocol. The BiSynchronous Intelligent Cable connects to any standard, DMA, or Integrated I/O Distributor. The Cable is equipped with a programmable option table that provides control over BiSynchronous Protocol operations.

General Purpose Intelligent Cable

The General Purpose Intelligent Cables are standard, low-cost parallel interfaces for any NAKED MINI 4 Family computer employing a Distributed I/O System. This system frees the OEM designer from the complex problems and costly development time usually associated with peripheral interfacing. Many low to medium speed peripherals and special purpose devices can be attached to a General Purpose Intelligent Cable, completely eliminating the need for higher-cost, special purpose interfaces.

The General Purpose Intelligent Cable is ideally suited for interfacing NAKED MINI 4 Family computers to special user-devices, non-standard peripherals, digital-to-analog and analog-to-digital converters, switch/indicator panels, and computer-to-computer configurations without the need for costly additional logic.

The General Purpose Intelligent Cable is compatible with all NAKED MINI 4 Family computers. Other features include TTL-compatible logic • low-power Schottky design • high noise immunity • handshaking or strobed I/O discipline • controls multiple devices • half-duplex or simplex operation • microprogrammed interface control • automatic error detection • two standard I/O programming modes • two individually vectored interrupts • standard ribbon cabling • simplified mounting • and positive-true or negative-true logic.

32-Bit General Purpose Intelligent Cable

The 32-Bit General Purpose Intelligent Cable (GPIC) provides the OEM user with a low-cost means of interfacing parallel, multi-byte-wide devices to any NAKED MINI 4 Family computer. The 32-bit GPIC is designed to interface with most low-to-medium-speed devices without the need to design and implement special interface logic. Word size of the 32-bit GPIC is selectable in 8-bit increments up to 32-bits. Output data into the 32-bit GPIC is stored in a full 32-bit buffer, which is controlled by the PICO-PROCESSOR, a self-contained, high-speed, miniature digital processor, microprogrammed in PROM to provide the handshake sequencing used with automatic I/O programming. 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 PICO-PROCESSOR firmware control.

The 32-Bit General Purpose Intelligent Cable is compatible with all NAKED MINI 4 Family computers, with standard I/O Distributor and DMA I/O Distributor. Other features include a full 32-bit buffer storage on the PICOPROCESSOR • word size selectable for 8, 16, 24, and 32 bits • TTL-compatible • low power Schottky design with high noise immunity • handshake or strobed I/O device protocol • microprogrammed interface control • and programmed I/O and auto I/O.

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Magnetic-Tape Intelligent Cable

The Magnetic-Tape Intelligent Cable provides a low-cost parallel interface for up to four magnetic-tape drives to any NAKED MINI 4 Family computer using the Distributed I/O System. The Intelligent Cable is used in conjunction with any I/O Distributor and an external magnetic-tape formatter. This combination provides the user with a high-performance, cost-effective magnetic tape system and automatic error checking.

Because an external magnetic-tape formatter is used with the Intelligent Cable, both low- or high-speed Non-Return-to-Zero (NRZ) and Phase-Encoded (PE) tape drives can be interfaced to any NAKED MINI 4 Family computer without additional logic.

The Magnetic Tape Intelligent Cable is compatible with all NAKED MINI 4 Family computers and all I/O Distributors. It supports up to four magnetic-tape drives. Other features incude interfaces Non-Return-to-Zero (NRZ) and Phase-Encoded (PE) 7 and 9-track units • control commands include write/sense file mark, write forward, read forward/reverse, skip forward/reverse, rewind, sense ready, edit, erase, and command selected transport off-line • two status bytes identify end of tape, end of file, load point (BOT), tape drive file protected, ready (to accept remote commands), formatter busy, read or write in progress, transport is rewinding, and error detected • direct data transfers to and from memory • two individually vectored interrupts • and the Magnetic Tape Intelligent Cable is supported by OS4, RTX4/IOS4, and diagnostic software.

IEEE Intelligent Cable

The IEEE Intelligent Cable conforms to the requirements for an IEEE Interface Bus System Controller defined by the IEEE 488-1975 specification. Used with the standard or DMA I/O Distributors, this Intelligent Cable provides the OEM user with a high-performance, low-cost controller to which up to fourteen IEEE 488 compatible peripherals can be attached.

The IEEE Interface Bus controlled by this Intelligent Cable provides a simplified means of physically connecting IEEE 488 compatible digital multimeters, scanners, counters, power meters, signal and sweep generators, timing generators, and printers to any NAKED MINI 4 Family computer. The standard bus interconnections are made using IEEE 488 cables which support daisy-chain system configurations.

The IEEE Intelligent Cable is compatible with all NAKED MINI 4 Family computers and all I/O Distributors. It can control up to 14 IEEE 488-1975 interface bus compatible peripherals. It also manages the IEEE interface bus in both single-talk/single-listen and single-talk/multiple-listen configurations. The IEEE Intelligent Cable is capable of operating as a controller only or participating in an information exchange. Other features include response to device service requests • polling device status serially or in parallel • data transfer rates up to 80K bytes per second • direct data transferred to and from memory • and two individually vectored interrupts.

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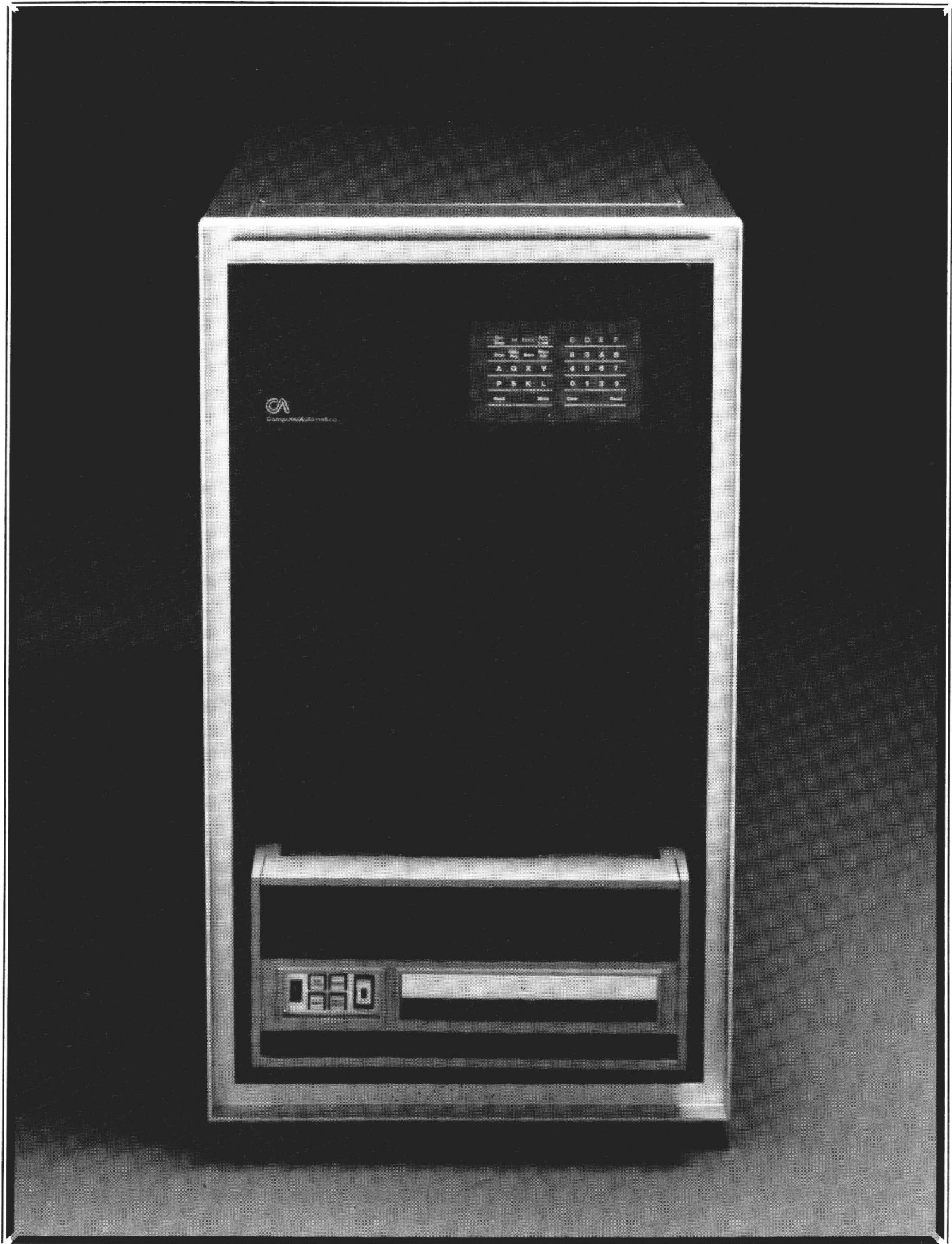
MASS STORAGE

INTRODUCTION

Mass storage is becoming increasingly important in minicomputer applications, especially direct-access storage. In response to this trend, Computer Automation offers a range of controllers and subsystems with magnetic tape and floppy, medium- and high-capacity disk drives.

The Magnetic Tape Subsystem uses the Distributed I/O system, and may operate in Auto I/O or DMA I/O modes.

Floppy, medium- and high-capacity disk controllers all operate in the DMA mode. Available devices range from 71 KB miniflexible diskette drives through 300 megabyte storage modules. Full operating system and Real-Time Executive support is provided for all floppy disk subsystems.

MINI FLEXIBLE DISK SUBSYSTEM

The Mini-Flexible Disk Subsystem consists of a cost-effective minidiskette-drive mechanism and an interface to a Computer Automation NAKED MINI 4 computer, providing storage for data and user application programs.

The Diskette Subsystem could be an effective replacement to the paper-tape reader/punch in many systems where the diskette is more versatile and much faster than the paper tape.

The Mini-Flexible Disk Subsystem is available in two versions. The desk-top model is compact, resulting in a portable program and data loader. Up to three add-on drives per desk-top subsystem are supported. The 19-inch, rack-mountable version includes two drives and may not be expanded with add-on drives. The capacity of each drive is 71.6K bytes.

FLOPPY DISK CONTROLLER

The Floppy Disk Controller is a low-cost, microprogrammed controller designed to support up to four floppy disk drives. This controller is implemented on a standard half-card, designed for simple installation and operation with any NAKED MINI 4 Family computer. Recording and media are compatible with those of the IBM 3740, providing interchangeability of diskettes with any IBM-Compatible floppy disk drives.

FLOPPY DISK SUBSYSTEM

The Floppy Disk Subsystem is a low-cost random-access subsystem designed to operate with any computer in the NAKED MINI 4 Family (MAXI-BUS). Each subsystem consists of a half-card controller, a rack-mountable chassis with power supply and cables, and one or two floppy disk drives. Up to two additional drives can be added on the same controller utilizing an expansion chassis. Recording and media are compatible with those of the IBM 3740. Each drive has a capacity of 243K bytes.

DUAL-SIDED, DOUBLE-DENSITY FLOPPY DISK SUBSYSTEM

The Dual-Sided, Double-Density Floppy Disk Subsystem is a low-cost, mass storage subsystem designed to operate with any NAKED MINI 4/10, 4/30, or 4/90 computer. The subsystem consists of a half-card controller, a rack-mountable chassis with power supply, cables, and two dual-head floppy disk drives. Each drive supports a capacity of one megabyte in dual-sided, double-density mode. Single-density diskettes may be read and written by this subsystem. Recording formats are IBM 3740 on a single density, and IBM System 34 on double density.
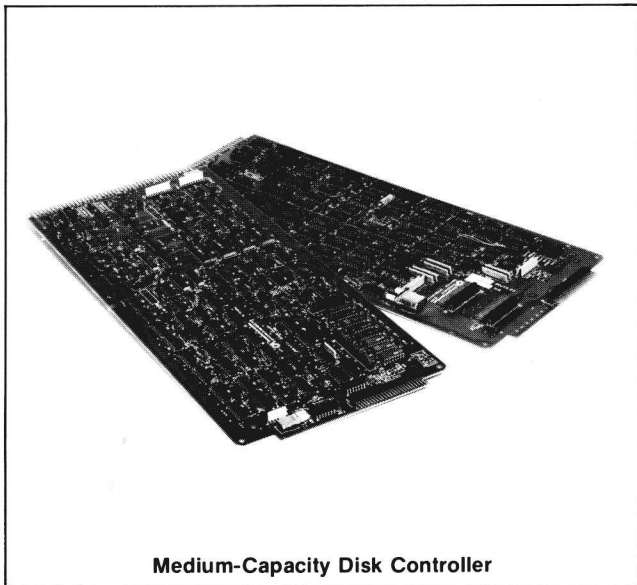
MEDIUM-CAPACITY DISK CONTROLLER

The Medium-Capacity Disk Controller (MCDC) provides the OEM with the ability to interface up to 80 megabytes of on-line random-access disk storage to the NAKED MINI 4 Family of computers. The controller interfaces up to four drives of 5, 10, or 20 megabytes each.

The MCDC consists of two half-card control modules: the Peripheral Micro Engine (PME) and the Peripheral Logic Unit (PLU). The PME is a microprogrammed controller with a DMA interface to the MAXI-BUS. The PLU contains all the logic necessary to drive the disk. Providing throughput transfer rates up to 625 Kilobytes per second, these half-cards fit in the processor chassis. Two PMEs can connect to the same PLU allowing two processors to share the same disk drive. All data commands and status transfers between the computer and the MCDC are accomplished in a Direct Memory Access (DMA) mode.

The Medium-Capacity Disk Controller will interface to Pertec disks or their equivalent. Other features include overlapping seek operations • data chaining • full interrupt capabilities • read-verify data operations • control block-oriented instructions • status and error reporting upon completion of operation • software control of sector size and addressing • disk sharing capabilities • and full RTX4 and OS4 support.

Medium-Capacity Disk Controller

MEDIUM-CAPACITY DISK SUBSYSTEM

The NAKED MINI 4 Family Medium-Capacity Disk Subsystem provides the OEM user with high-performance and random-access storage for up to 80 megabytes of information at a low entry cost. It consists of a controller, cables, and from one to four disk drive units. Each disk drive contains one removable cartridge and one fixed disk, offering a total usable capacity of up to 20 megabytes. The Medium-Capacity Disk is fully supported by OS4 and RTX4 software, plus the diagnostics and format utility.

Medium-Capacity Disk Drive

HIGH-CAPACITY DISK CONTROLLER

The High-Capacity Disk Controller (HCDC) provides Computer Automation customers with the ability to interface up to 1,200 megabytes of on-line, random-access disk storage to the NAKED MINI 4 Family of computers.

The High-Capacity Disk Controller can interface with up to 1,200 megabytes of on-line random-access data. Other features include • overlapping seek operations • data chaining • full interrupt

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High-Capacity Disk Controller
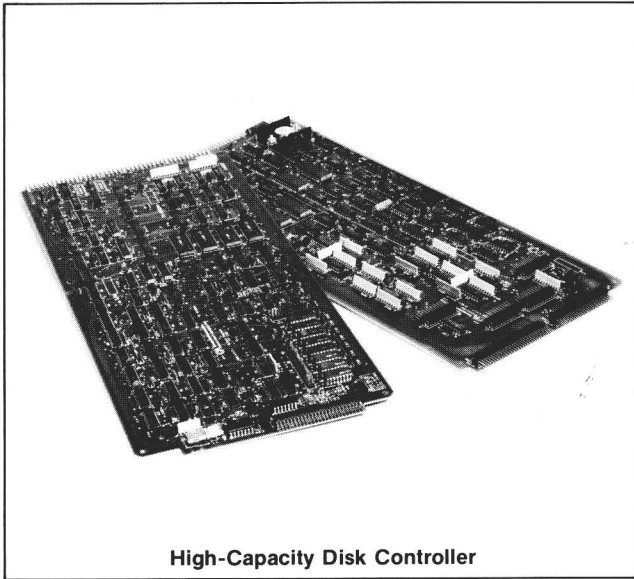
High-Capacity Disk Drive

capabilities • read-verify data operations • control block-oriented instructions • status and error reporting upon completion of operation • complete software control of sector size and addressing • disk sharing capabilities (dual controllers and/or dual processors) • internal diagnostics • and MAXI-BUS

interface, compatible with all NAKED MINI 4 Family products.

HIGH-CAPACITY DISK SUBSYSTEM

The High-Capacity Disk Subsystem contains a controller and from one to four 40, 80, 150, or 300 megabyte disk drives. The High-Capacity Disk is fully supported by OS4 and RTX4 software, plus diagnostic and format utility.

MAGNETIC TAPE SUBSYSTEM
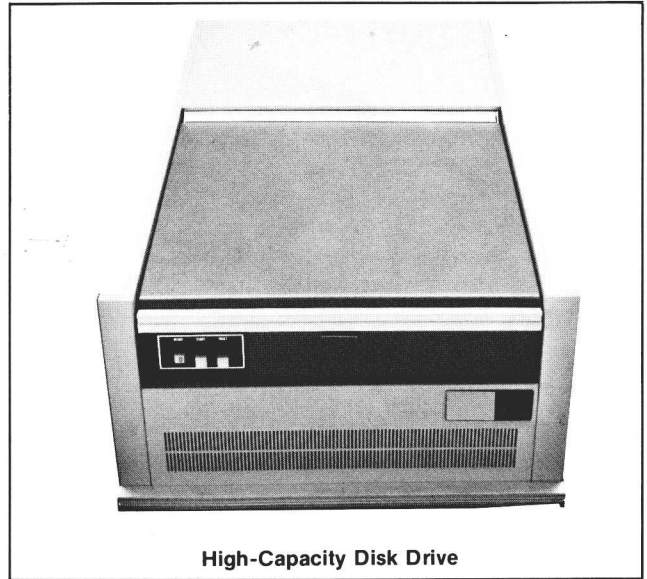
The Computer Automation Magnetic Tape Subsystem provides economical, reliable mass storage for sequential data files. The Magnetic Tape Subsystem contains an Intelligent Cable and formatter and one 9-track, 25 ips, 800 bpi, tape drive.

Magnetic Tape Drive

The Magnetic Tape Subsystem includes tape cleaner • forward and reverse read • capstan speed disk • pressure sensitized take-up reel • read/write single-gap head • 20,000-character-per-second transfer rate • dynamic electrical braking.

A wide variety of other tape drives -- from the Pertec 5000, 6000, and 7000 series -- may be interfaced by use of the Magnetic Tape Intelligent Cable described in the distributed I/O Cable section and the appropriate Pertec formatter.

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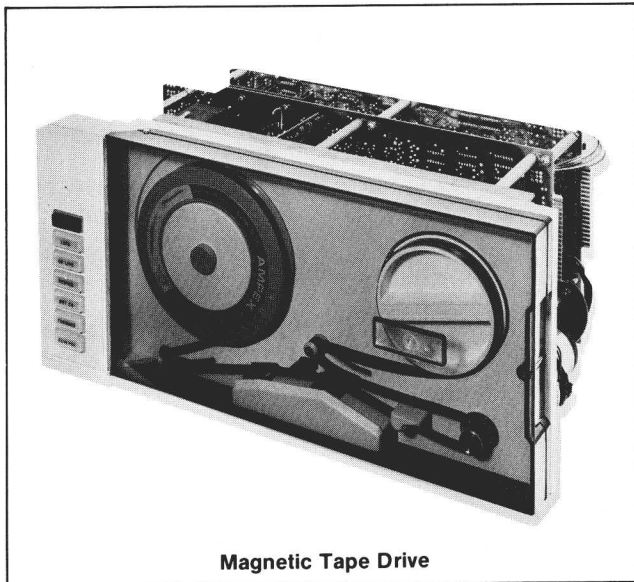
COMMUNICATIONS

INTRODUCTION

To meet the rapidly increasing demand for communications equipment in a wide variety of environments, Computer Automation offers a programmable Asynchronous Multiplexer, a Bi-Synchronous Intelligent Cable, and an automatic calling unit (ACU) multiplexer.

Asynchronous Multiplexer

The Asynchronous Multiplexer is an intelligent, four- or eight-channel communication interface designed to facilitate asynchronous data transfers between any NAKED MINI 4 computer and local or remote RS232 compatible devices. The multiplexer provides an interface panel with standard connectors for the device cables. Data transfers through the Asynchronous Multiplexer are interrupt driven.

The Asynchronous Multiplexer has 16 programmable baud rates from 50 to 19,200 baud. The Asynchronous Multiplexer supports Auto I/O operations under interrupt control with separate receive and transmit vectors for each channel. It also features full modem control, full- and half-duplex transmission, parity bit standardization and programmable parity for odd, even, or no parity. Programmable character sizes of 5, 6, 7 or 8 bits as well as programmable stop codes of 1, 1½, or 2 bits are standard.

The Asynchronous Multiplexer also features range detection from 0 to hexelecimal 1F, and special character detection of two programmable characters for each channel.

The Asynchronous Multiplexer consists of a standard half card which fits in any NAKED MINI 4 chassis, an Interface Panel on a separate card which mounts on a 19-inch retma rack, a mounting kit, and a cable to connect the two boards.

AUTO CALL UNIT MULTIPLEXER

The Automatic Calling Unit (ACU) Multiplexer module simultaneously interfaces up to four RS232/CCITT compatible Bell 801 automatic calling units or equivalent devices to any NAKED MINI 4 Family Computer. The ACU Multiplexer can be used in conjunction with any Computer Automation interface device.

Full-digit buffering and the capability to sense data line occupancy are standard features. Three separate vectored interrupts for each Automatic Calling
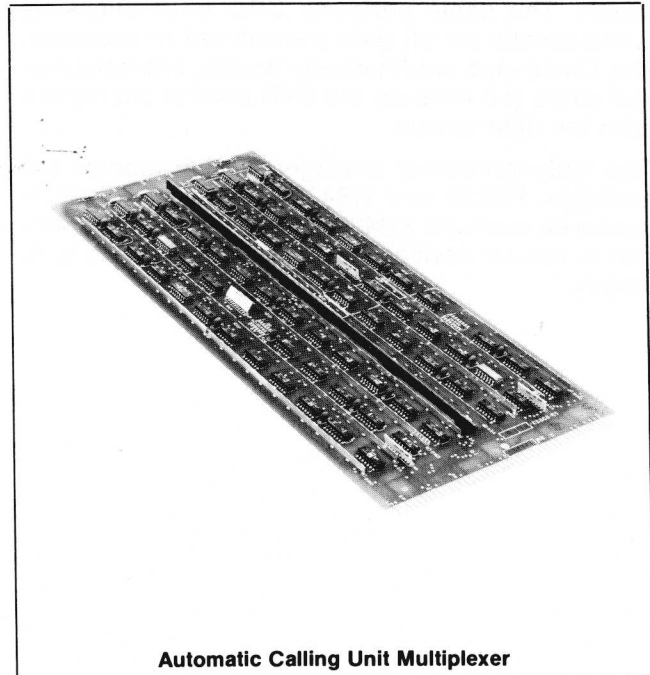
Automatic Calling Unit Multiplexer

Unit allow both exclusive interrupt operation in addition to Auto I/O operation. The ACU Multiplexer includes a diagnostic loop-back for self-testing capability without an Automatic Calling Unit attached to the line. Thirty-one jumper-selectable device addresses are available on the module to permit the user to tailor a communications system for his specific application.

The ACU Multiplexer is configured on a single half-card and can be inserted into any half-slot motherboard I/O connector.

BISYNCHRONOUS INTELLIGENT CABLE

The BiSynchronous Intelligent Cable is a communications controller that interfaces a NAKED MINI 4 Family computer to local or remote devices that use Binary Synchronous Communications Protocol.

The BiSynchronous Intelligent Cable connects to an I/O Distributor. The Cable is equipped with a programmable option table that provides control over BiSynchronous Protocol operatons. These include normal or transparent modes, synchronizing characters, and error checking. The option table entries also determine parity control and character length. The option table feature frees the CPU from control of routine I/O operations, allowing the CPU to perform other functions while the I/O operation proceeds.

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The BiSynchronous Intelligent Cable has a maximum transmission rate of 4800 baud. It transmits and receives characters ranging from 5 to 8 bits in length. The cable performs CRC error checking automatically on all data transmitted or received. The Cable also automatically inserts (on transmit) and strips (on receive) the SYN control characters from the data stream.

Two BiSynchronous Intelligent Cable models are available: RS232 and RS422 interfaces. RS232 is used with modems, RS422 is used for direct connection to remote devices over cables up to 4000 ft. in length.

BiSynchronous Intelligent Cable

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PERIPHERALS

INTRODUCTION

Recognizing that a true OEM supplier must respond to the full scope of users' needs, a broad range of reliable, high performance peripherals is available to support the NAKED MINI 4 Family processors. These include:

- CRT Terminal
- Teletype
- Paper-Tape Reader
- Paper-Tape Reader/Punch Combinations
- Card Readers
- Character Printers
- Line Printers
- Magnetic Tape Subsystem
- Floppy Disk Subsystem
- Medium-Capacity Disk Subsystem
- High-Capacity Disk Subsystem

All peripherals are available with I/O controller and cables, and supported by RTX4, OS4 and diagnostic software.

CRT TERMINAL

The CRT Terminal is a self-contained desk-top terminal designed for use as a control console or as a data entry and display terminal for any computer in the NAKED MINI 4 Family. Packaged in an attractive housing, the CRT Terminal offers a cost-effective, easy-to-use solution to OEM terminal problems.

CRT Terminal users will enjoy the benefits of an easy-to-read screen of light characters on a dark background that can accommodate up to 1920 characters — 24 lines of 80 characters each. The CRT supports the full 128 character ASCII set, including 96 upper and lower case characters. Interactive applications are facilitated by the terminal's automatic scroll feature; when the screen fills, the whole display automatically moves up one line so that a new line can be entered at the bottom.

Functionally, the CRT Terminal uses a micro-programmed digital processor and is packaged in two distinct modules: the terminal control section and CRT monitor are housed in a single cabinet, and the keyboard is a separate unit connected to the monitor cabinet by a retractable cable. The two cabinets are designed to fit together with the appearance of being a single unit. The retractable cable permits the operator to conveniently move the keyboard to a more comfortable position if desired.

In addition to being movable, the keyboard module offers a functional simplicity that eliminates extensive and expensive employee training. The type-writer keyboard area provides the sculptured keys, key style, and shape of the popular IBM Selectric office typewriter. Operator performance is further enhanced by an "n-key" rollover feature, which allows typing at full speed without locking the keyboard or dropping characters.

The numeric key pad on the CRT Terminal is also easier to use than the pad on a conventional terminal. Designed to resemble a typical adding machine key pad, "decimal" and "minus" keys have been added, and the "enter" and "field-cancel" keys have been enlarged to eliminate errors. Special function keys, which provide additional terminal functions, are arranged in a single row across the top of the keyboard module, permitting the operator to have complete control over image display and cursor positioning. Other special function keys are available for software use.

Communication with the interface controller/modem (or CPU) is achieved via an asynchronous, bit-serial, half- or full-duplex interface which is EIA RS232C/CCITT compatible. Direct or remote communications with any NAKED MINI 4 Family computer can be economically achieved through the use of Computer Automation's unique Distributed I/O System, which provides a cost-effective, high-performance CRT interface and cabling with microprogrammed control and automatic error checking.

The CRT Terminal is equipped with a socket for the optional attachment of a bit-serial, asynchronous EIA printer to permit selective printing of display information. An interface is also provided to transfer a copy of the displayed image to another video unit for viewer presentation.

TELETYPE®

The Computer Automation Teletype® is a modified Automatic Send-Receive (ASR) 33 Teletype® Terminal. The ASR 33 is a low-cost, standard duty data terminal that provides facilities for entering, transmitting, receiving, and recording data locally or via communications lines. Half- or full-duplex data entry can be accomplished manually by keyboard or automatically by punched tape. The Terminal receives data as printed page copy with or without punching tape.

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The modified ASR 33 Teletype® has a 20mA current-loop interface and includes remote reader control and programmed motor on/off capability. Terminals are available with 50 or 60 Hz motors. ASR 33 Teletypes® can use inexpensive tele-typewriter paper (friction feed) or accommodate multiple-copy business forms (sprocket feed). Standard features include automatic carriage return and line feed.

PAPER-TAPE PERIPHERALS

Computer Automation offers its customers a high-performance Paper-Tape Reader and Paper-Tape Reader/Punch as economical input/output devices. The standard 19" rack-mountable Paper Tape Reader reads up to 300 characters per second, continuously or asynchronously. The Paper-Tape Reader/Punch consists of a 300-character-per-second reader and an independent 75-character-per-second punch in a single chassis.

Standard 1/2" 8-track or 6-track teletypesetter tapes can be read and punched bidirectionally. Other Mylar-based tapes can also be accommodated, subject to thickness and width specifications. The Paper-Tape Peripherals are highly reliable, based on a simple mechanical design with a minimum number of moving parts. Highly modular construction simplifies maintenance. A wide range of input power specifications are available.

CARD READERS

The Computer Automation Card Reader processes up to 285 standard 80-column cards per minute. Standard features include a 550 card hopper/stacker. Card input is an economical and efficient means to process large amounts of data and read programs into main memory. The card medium's durability makes it a very effective turn-around document.

A phototransistor sensor array reads standard 12-row, 80-column punched cards in serial, column-by-column fashion. The control electronics monitors card movement to insure that card damage will not be caused by the reader mechanism. A straight-through card track makes the reader inherently jam-resistant. A sophisticated vacuum picker mechanism has the capability of segregating multilated, warped, and edge-damaged cards and rejecting stapled cards without damage to the cards.

CHARACTER PRINTERS

Computer Automation offers its customers two models of economical matrix printers which provide

CRT Terminal

a wide range of performance in support of the NAKED MINI 4 Family:

Char/Sec	Char/Line	Lines/Minute
120	132	50 to 260
165	132	70 to 340

Each printer is a self-contained unit which includes mechanical and electro-mechanical components, control logic, character pattern generation, single line buffer, and power supply (115 volts, 60 Hz). A serial impact printing method is used. Character printers utilize a 5 x 7 dot matrix head; a 9 x 7 dot matrix head is optional. Character sets can be increased up to 128 characters as an option. Standard features include elongated bold-face characters (line-by-line) and parallel data input. Each printer is capable of producing an original plus up to four clear carbon copies. Manual controls are provided for form thickness and paper advance. Printers are supplied in a cabinet with Computer Automation colors.

LINE PRINTERS

For situations requiring a greater volume of printed output, Computer Automation provides two reliable high-speed line printers: a 300- and a 600-line per minute model.

Each printer is a self-contained unit which includes mechanical components, control logic, character pattern generation, single line buffer and power supply. Both highly reliable drum printers support the 64 character ASCII set, and provide 132 columns per line.

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PACKAGED COMPUTERS

INTRODUCTION

The NAKED MINI 4 Family of computers is offered in a variety of configurations, ranging from individual modules, through subsystems, to complete packaged computer systems. There are two basic types of packaged computers: ALPHA configurations and Software Development Systems.

ALPHA Configurations

ALPHA configurations are packaged systems containing a processor, RAM memory, and a four-or-eight-channel I/O distributor, chassis, power supply, and operator's console. Options available include programmer's console, parity, battery backup, and eight-channel I/O distributor.
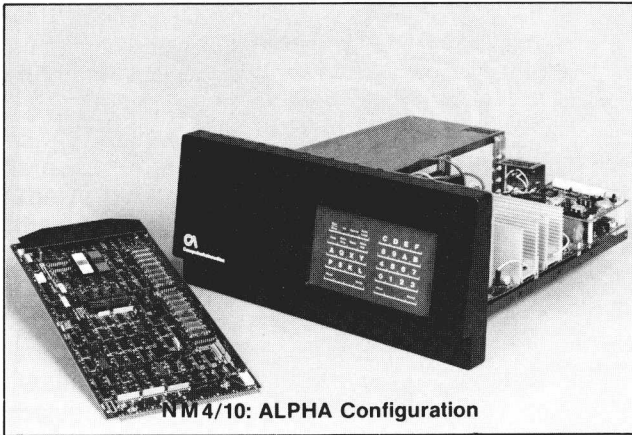
NM4/10: ALPHA Configuration

Software Development Systems

The Software Development Systems consist of 5 prepackaged NAKED MINI 4 configurations. These systems are used for the creation and development of software that will run on target production systems.

The five packages consist of one NM4/10 system, two NM4/30 systems, and two NM4/90 configurations. All systems are provided as complete, ready to use packages with all hardware, software, diagnostics and documentation included. All systems utilize OMEGA4 PLUS software; the 4/30 and 4/90 systems utilize OS4 and FORTRAN IV development software.

All systems are fully integrated and tested at the factory as a system. Installation assistance is provided by a CA Systems Analyst.

The NAKED MINI 4 Bus Monitor (see MC 97-53718-01A1) is included in all five packages as a unique software debugging aid.

Table 1-7. Software Development Systems Configurations

| ITEM | CONFIGURATION | | | | |
	DS-410-A	DS-430-A	DS-430-B	DS-490-A	DS-490-B
NM4/10	X				
NM4/30		X	X		
NM4/90				X	X
Systems Memory	128KB	128KB	128KB	128KB	128KB
No. of DIO Channels	4	8	8	8	8
Cabinet	Desk	Vertical	Vertical	Vertical	Vertical
Terminal	Teletype	Teletype	CRT	CRT	CRT
Centronics 702 Line Printer (120CPS)			X	X	X
Dual Floppy Subsystem	X	X	X	X	X
Pertec 10MB Disk Subsystem					X
Bus Monitor	X	X	X	X	
Software	OS4, RTX4, FORTRAN	OS4, RTX4, FORTRAN	OS4, RTX4, FORTRAN	OS4, RTX4, FORTRAN	OS4, RTX4, FORTRAN
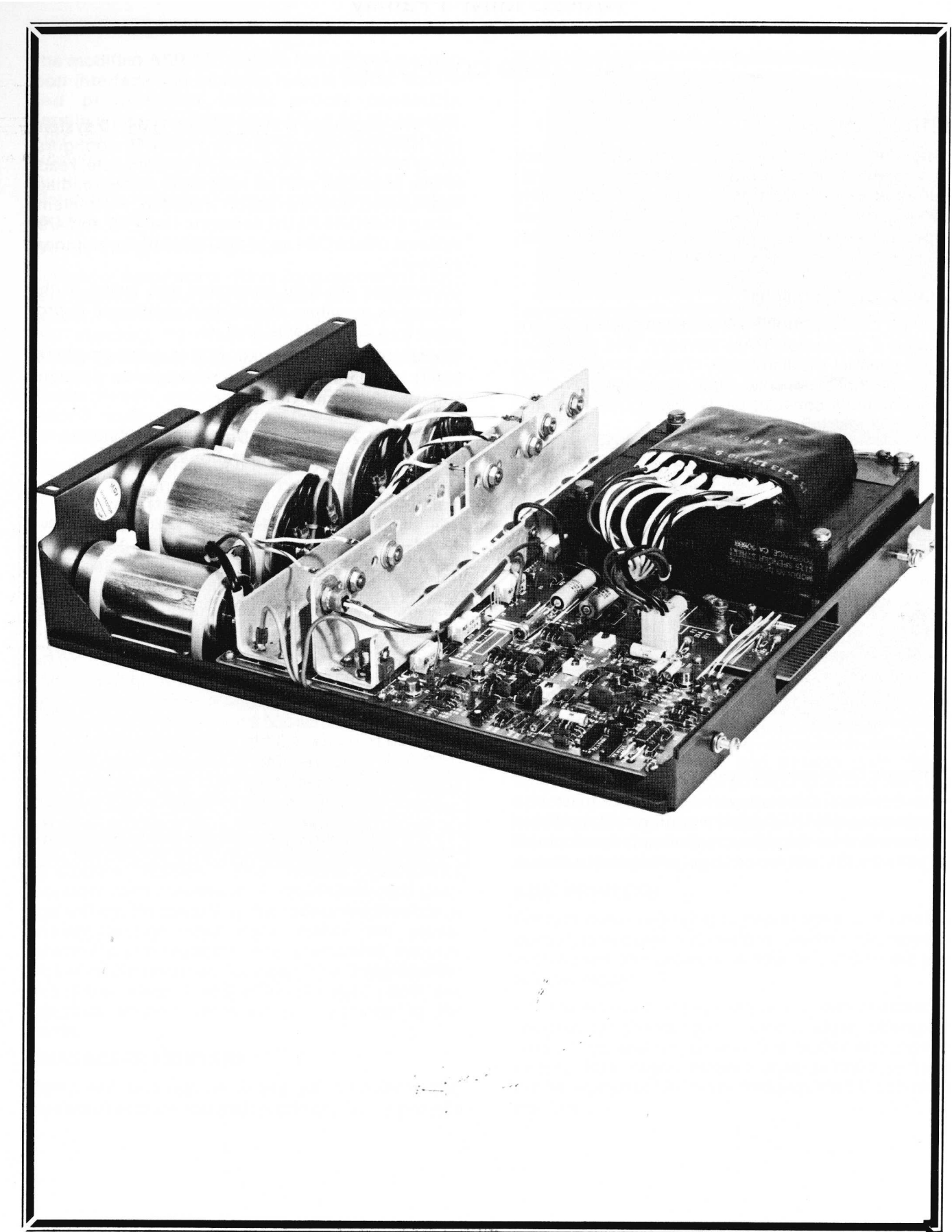
HOUSINGS

INTRODUCTION

A variety of card cages, chassis, and power supplies are provided to ensure flexibility in system configuration and packaging.

Three and five half-card card cages, and 10 and 17 Ampere open-frame power supplies are provided for half-card configurations.

Five and nine full-card chassis with 25, 36, and 60 amp modular power supplies are offered for full-card configurations. Half-card modules may 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.

All standard power supplies feature power fail detection, which allows the computer to come to an orderly halt prior to power failure and to restart when power is restored.
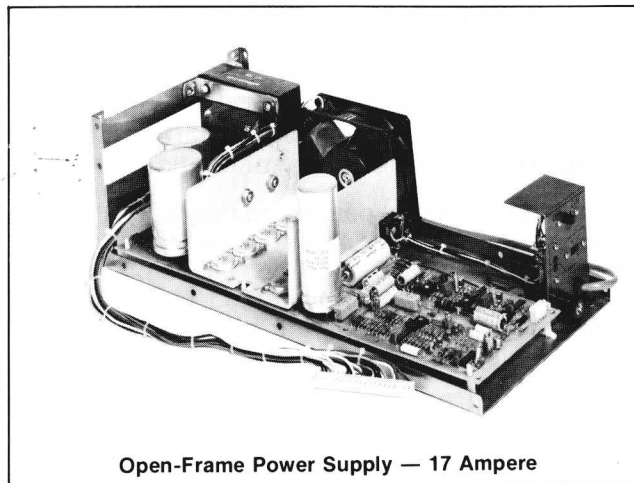
POWER SUPPLIES

Open-Frame Power Supplies

The open-frame power supplies are designed for maximum packaging versatility at the lowest possible cost. These power supplies are available in 10 and 17 Ampere versions. In typical applications, the 10 Ampere power supply provides sufficient power for most three-slot, card-cage configurations. The 17 Ampere power supply provides sufficient power for most 5 half-card applications. However, either power supply may be used with the three-slot or five-slot card cage, as determined by total power requirements.

Space for the mounting of a fan is provided in the 10 Ampere power supply to accommodate forced air cooling when required by mounting orientation or operating environment. To insure proper cooling, a fan is provided as a standard feature of the 17 Ampere power supply. This fan also provides cooling for the half-card cages when mounted adjacent to the power supply.

An optional rechargeable battery pack mounts on the power supply and provides protection for RAM memories in the event of a power failure.

Open-Frame Power Supply — 17 Ampere

Modular Power Supplies

The modular unit power supplies come in four versions: a 25-Ampere, two 36-Ampere, and a 60-Ampere model. The 25- and one 36-Ampere model mount inside the five full-card chassis. The 60-Ampere model and the other 36-Ampere model mount externally (below) the nine full-card chassis. When mounted in the chassis, the chassis fan panel provides adequate cooling for the power supply. The externally mounted power supplies contain their own cooling fans for adequate cooling. A standard power-failure detection feature allows the computer to come to an orderly halt prior to power failures and to restart when power is restored.
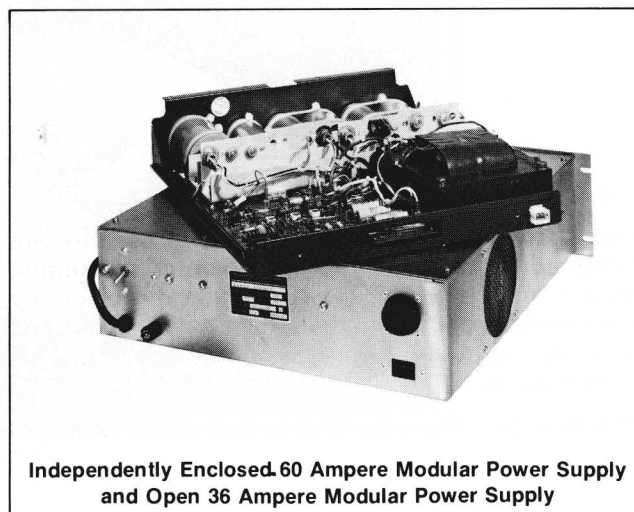
Independently Enclosed 60 Ampere Modular Power Supply and Open 36 Ampere Modular Power Supply
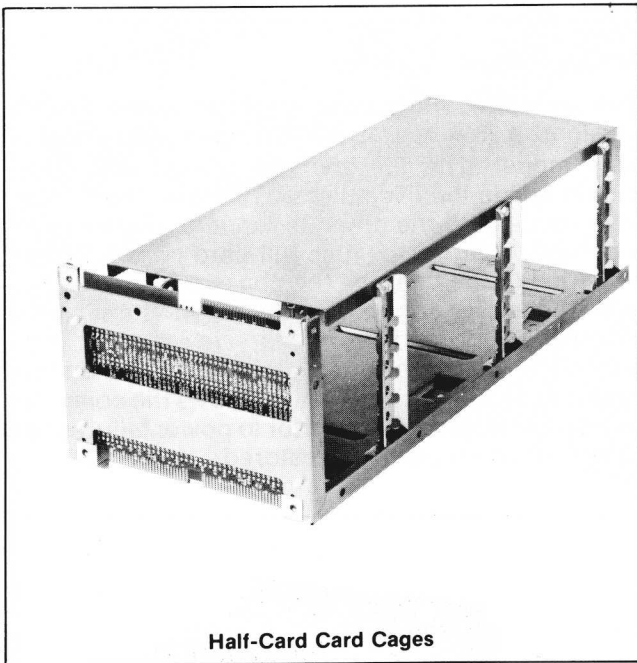
CHASSIS

Half-Card Card Cages

Half-card card cages are designed for OEMs desiring maximum flexibility at minimum cost. These assemblies contain a motherboard, connectors and card guides for standard half cards. Both three card and five-card models are available which accommodate a wide variety of configurations.

To provide maximum packaging flexibility, the card cages are designed for mounting to a flat surface in any plane. Cooling can be accomplished by convection or by external forced air, depending upon environment, mounting orientation, and the power dissipation of installed cards.

Two standard power supplies (10A and 17A) are available for use with half-card card cages.

Half-Card Card Cages

Full-Card Chassis

The standard five and nine full-slot chassis are designed for OEMs requiring maximum packaging density and flexibility. The full-card chassis contain a motherboard, card guides, three cooling fans, and retaining hardware to accommodate any of the full or half-cards in the NAKED MINI 4 Family.

The five full-card chassis provides a connector on

the motherboard for direct connection and installation of a 25 or 36 Ampere internal power supply inside the chassis.

The Full-Card Chassis is a rugged chassis with motherboard card guides, card-retaining hardware, and three cooling fans. It also accommodates an operator's console or programmer's console and allows installation of an external power supply.
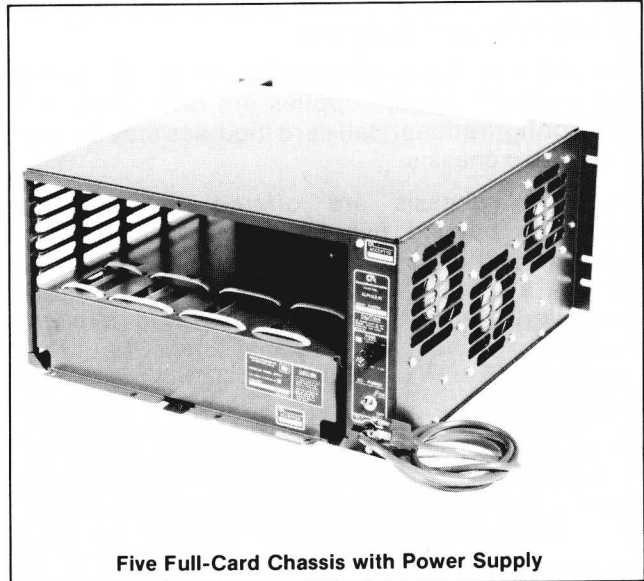
Five Full-Card Chassis with Power Supply

Nine-Full-Card Chassis

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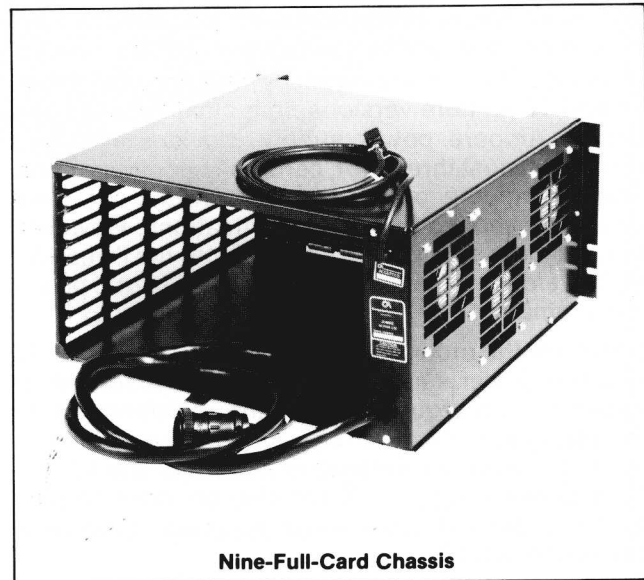
NAKED MINI 4 Family

Section II
Software

ComputerAutomation
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SOFTWARE

INTRODUCTION

The software philosophy of Computer Automation parallels the hardware philosophy in providing high performance per dollar through modular, reliable, easy-to-use products.

Computer Automation's extensive experience in the OEM marketplace has shown that two unique environments exist for systems software. The first is program development, where emphasis is placed on speed and ease of program generation, modification, and testing. This emphasis assures delivery of a finished product at the earliest date and at the lowest development costs. The second environment is program execution (run-time), where the software must provide maximum performance in the minimum hardware configuration, to reduce recurring product costs.

Computer Automation has an in-depth understanding of both environments and offers software products specifically designed for each. To assure optimum performance and expandability, Computer Automation software is designed for reliability, modularity, and compatibility throughout the product line.
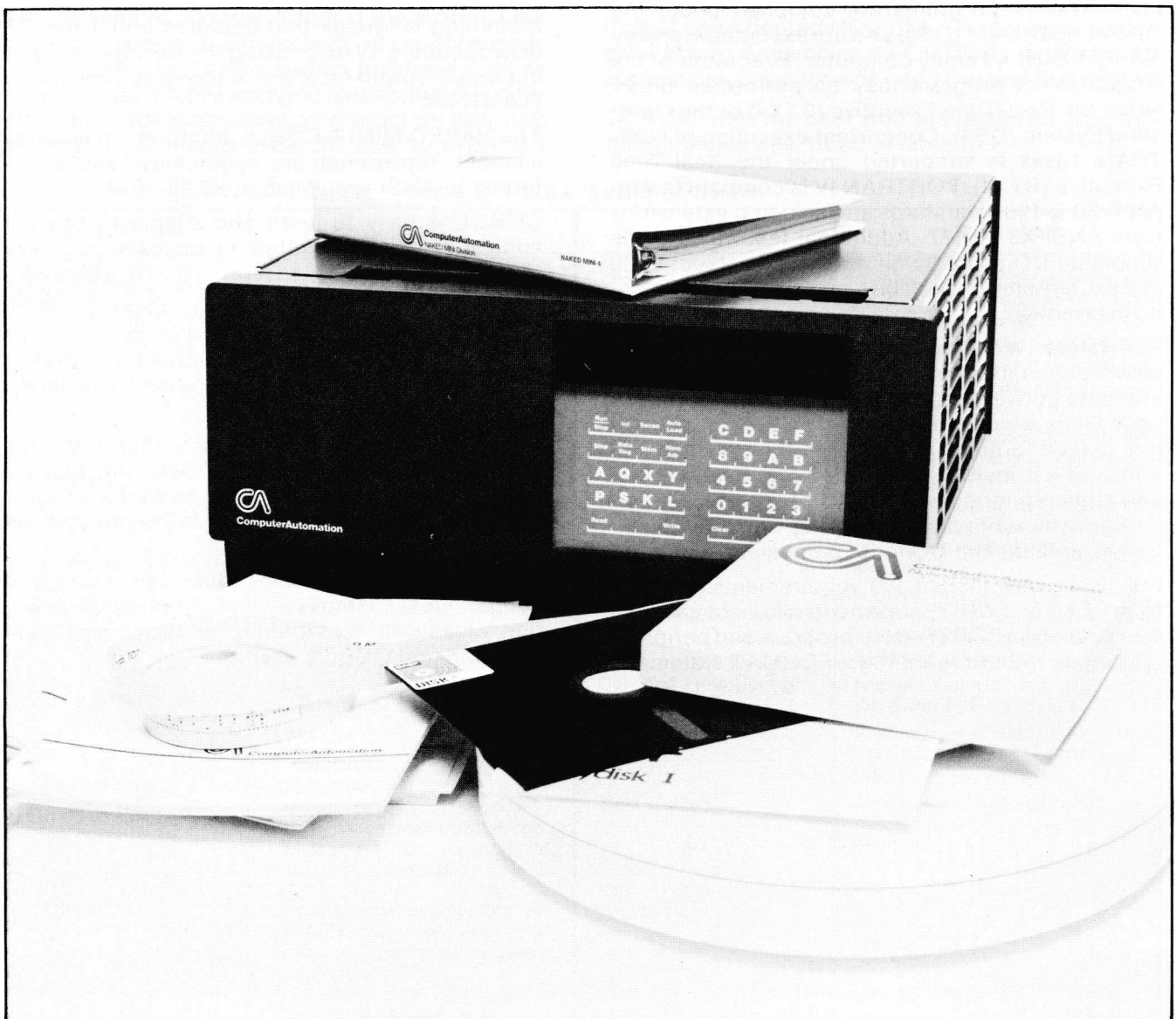
LANGUAGES

NAKED MINI 4 FAMILY ASSEMBLER

The NAKED MINI 4 Family Assembler is a general-purpose development tool which provides the OEM user with a quick and easy means of developing user application programs. It includes a complete set of macro facilities which allow the programmer to define a sequence of operations and invoke them with a single name rather than repeating the entire sequence each time the set of operations is required in the program.

Source program syntax verification is facilitated by automatic printing of easy to understand error codes after each invalid statement.

The Assembler includes numerous assembler directives • relocatable or absolute object code • linkage to separately assembled program modules • conditional assembly • word, byte, and double-word data definitions for integer, floating point, character, and string generation • assembler mnemonics for generating sequences • variable macro call parameters for label, command, or oper and fields • macro parameter and label counts, multiple macro entry points, macro variable labels • supports all standard NM4 instructions plus floating point • and JCL interface for assembler execution and listing control. The Assembler operates with all Computer Automation Operating Systems — OS4, OMEGA4, OMEGA4+ and MULTED.

FORTRAN IV

FORTRAN IV is probably the most widely used programming language. The NAKED MINI 4 Family FORTRAN IV compiler offers the OEM user a powerful, economical tool for the development of application software. FORTRAN IV is ideally suited for scientific, monitoring, and control applications.

Recognizing that the OEM user is concerned with product cost, Computer Automation has implemented a FORTRAN IV compiler that provides powerful, economical production of applications software and efficient memory utilization, without sacrificing execution speed. Special features of the FORTRAN IV compiler include a comprehensive set of diagnostic messages that facilitate debugging of compiled programs.

FORTRAN IV programs are compiled under the Operating System (OS4) and are executable on any NAKED MINI 4 Family computer. Execution of the linked object program may be performed under either the Real-Time Executive (RTX4) or the Operating System (OS4). Concurrent execution of FORTRAN Tasks is supported under the Real-Time Executive (RTX4). FORTRAN IV is compatible with ANSI X3.9-1966 standards and selected extensions from ANSI X3.9-1977. Additional features include simplified I/O programming, readable object-code listings, run-time trace/debug, and complete diagnostic messages.

FORTRAN IV I/O features include: internal files, which permit internal buffer-to-buffer reformatting and data conversion; END=, ERR=, and I/O status parameters, which allow end-of-file and error processing, default format; and extended format specifications, which include a tab function, hexadecimal and alphanumeric string constant I/O, floating dollar sign, asterisk fill, scale factoring, new line specification, and implied DO loop parameters.

For users with limited I/O requirements, the free form READ and WRITE statements allow communication between a FORTRAN IV program and peripheral devices without requiring a FORMAT statement.

This default I/O capability is simple to use and easy to understand.

FORTRAN IV also includes generalized array boundaries, subscripts and DO loop parameters, as well as 16 bit and 32 bit integer variables. Other extensions include n-dimensional arrays, liberalized mixed-mode expressions, the Boolean intrinsic functions IAND, IOR, IEOR, and INOT, any number of continuation lines, signed DO loop parameters and the symbols ">" and "<", as alternative forms of ".GT." and ".LT.".

NAKED MINI 4 COBOL

The NAKED MINI 4 COBOL compiler and object-time system is an optional language processor for NAKED MINI 4 family computers.

NAKED MINI 4 COBOL is a block-structured programming language that operates under the OS4 disk operating system, using the device-independent Input/Output facilities of the Real Time Executive (RTX4).

The NAKED MINI 4 COBOL conforms in language element, representation, symbology, and coding format to ANSI specification X3.23-1974.

COBOL is easy to learn and simple to use with control structures written in logically organized English-like phrases.

Because of its inherent heirarchical structure, COBOL lends itself to structured program designs. Program development is facilitated by modular block-oriented program organization and extensive data structuring capabilities.

The compiler is a single-pass processor which accepts ANSI X3.23-1974 COBOL programs as input and produces a listing of the source program, a summary listing of the library object program, and an optional cross reference.

COBOL is useful in business data processing applications. OEM customers who require report generation of payroll, accounting, or order processing data, will find COBOL useful.

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OPERATING SYSTEMS AND EXECUTIVES

OPERATING SYSTEM (OS4)

The NAKED MINI 4 operating system (OS4) is a disk-oriented programming system that includes a comprehensive set of software for developing and executing programs on NAKED MINI 4 Family puters. OS4 is designed to eliminate costly, time-consuming tasks normally associated with the preparation, debugging, execution, and maintenance of programs. Modularity of design permits the user to generate systems tailored to his needs.

OS4 includes all software necessary for developing and maintaining user application programs. All executive services and input/output facilities are available to the application program through easy-to-use calls and control blocks. OS4 includes the NM4 Assembler, Source Editor, Line Editor, Link Editor, and debug. A comprehensive set of facilities is included for requesting system functions such as assigning logical units, copying files, listing disk contents, and loading and executing program files. Job file control commands allow the user to execute a sequence of OS4 commands in a noninteractive mode.

OS4 can be expanded into a multi-user development system with the Multi-Terminal Editor (MULTED) system.

The OS4 package is available complete as a ready-to-use autoloadable system with all components needed to generate any unique system required. The complete system is delivered on disk or diskettes. Documentation includes comprehensive system language and utility manuals, and appropriate system load maps.

OS4 features include total programming support for the NAKED MINI 4 Family • rapid program development and maintenance • support for batch or interactive processing modes • device-independent, logical unit oriented I/O • disk file manager • powerful Macro Assembler • FORTRAN language for applications development • and line and text editors.

OS4 provides the user with the powerful programming utilities described in Table II-1.

Table II-1. OS4 System Utilities.

Module Name	Description	Module Name	Description
NM4 Family Assembler	A powerful, general-purpose assembler providing support for all NAKED MINI 4 Family computers. Features include: a full MACRO capability, full arithmetic and logical expression, literal pooling, and multiple location counters for ease of re-entrant code generation.	Logical Unit Assignment	A utility that assigns logical units, lists the assignments, and restores logical units.
		Job File Control	A utility that allows the user to store a sequence of commands on a file for later execution in non-interactive mode.
LINK Editor	A utility for resolving external references, linking user and library programs into executable files.	Data Transfer	A utility that allows data to be copied from one medium to another.
Source Editor	A flexible line-oriented text editor for easy generation and maintenance of source programs permitting the user to add, replace, or delete source lines or character strings within source lines. Text editor includes command looping features and string search and replacement functions.	Disk Maintenance	A maintenance utility to initialize a disk directory, view the contents of a disk, and dump selected sectors.
		Disk Pack Mounting/Dismounting	A utility that notifies the system when a disk is about to be dismounted and when a new disk has been mounted.
		Date and Time Control	A utility that sets and/or obtains the current date and time.
Line Editor	A powerful, line-oriented editor for source file creation and maintenance which allows add, replacement, or deletion of source on a line basis.	Label Utility	A utility used to label file-oriented devices in Standard File Manager format.
		Help Utility	A utility that provides a mechanism for obtaining documentation via OS4.
DEBUG	Conversational debug programs to allow alteration and controlled execution of a user's program.		

MULTI-USER DEVELOPMENT SYSTEM

The Multi-Terminal Editor (MULTED) system is a multi-terminal editor that operates on any NAKED MINI 4 Family computer as a superset of OS4. It provides support for up to eight editing stations (CRTs) while maintaining an OS4 batch background partition.

MULTED is a development system designed to allow more than one user to edit or create source files concurrently while simultaneously allowing assemblies or other batch jobs to execute in the background. Up to eight edit CRTs are supported on one NAKED MINI 4 Family computer. A console CRT provides for interaction with the batch partition and operator control program.

The Source Editor is a line-oriented text editor that provides insertion and deletion operations on source text. Character editing, including string search and string replacement functions, also is provided. With the Source Editor, the user can create or edit text for use as source input to the NAKED MINI 4 Assembler or compilers.

OMEGA4

OMEGA4 is a general purpose, memory-based software development system for NAKED MINI 4 Family computers. The system includes all software required to easily and efficiently create, assemble, edit, and debug assembly language user programs in small, memory-based environments. OMEGA4 operates in as little as 12K words of memory; available modules may be configured in a variety of ways to best satisfy the specific requirements of the user.

All system functions are interactive through the system terminal (TTY or CRT). An interactive command processor module provides the communication linkage between the user and other OMEGA4 modules. The system I/O module supports DIO, CRT, TTY, High-Speed Paper Tape, Card Reader, and Line Printer peripherals.

The OMEGA4 Development system includes: an editor, two assemblers (one with macro capability), a relocating object loader, and an interactive debug program. The line editor, assemblers, command processor, and I/O module may be combined to produce a standalone editor or assembler, a combination editor/assembler, an editor/macro assembler, or other combinations as required by specific user hardware configurations. The debug module is usable free-standing or may be combined with a user application as required.

The OMEGA4 Software Development System consists of the following:

Table II-2. OMEGA4 Modules

Module	Description
Line Editor Module	A line-oriented text editor supporting insert, delete and replacement operations on the source input.
Assembler Module	A two-pass assembler supporting all standard NAKED MINI 4 Family instructions. This same assembler executes under the OS4 Operating System. The assembler includes arithmetic and logical expression processing, literal pooling, and most macro directives and features necessary to generate user tasks and standard I/O handlers for RTX4- and IOS4-based applications.
Macro Assembler Module	An extended version of the assembler module which includes all the features of the Assembler module, plus an easy-to-use macro instruction facility. The macro facility includes macros to support all standard RTX4 and IOS4 calling sequences and table generation requirements.

OMEGA4 PLUS

OMEGA4 Plus is designed to provide a range of system capabilities utilizing Floppy Disk Resident utilities. OMEGA4 Plus includes all of the capabilities of OMEGA4 with the addition of a file management module and Floppy Disk I/O Drivers. OMEGA4 Plus supports execution of programs from the floppy disk, saving and retrieval of source files from the floppy disk, and the storing of binary programs on the floppy.

All system functions and commands are interactive with the system terminal. A single command processor module provides the communication modules. OMEGA4 Plus modules use standard IOS4 calling sequences, and a set of logical units are assigned to each module.

The OMEGA4 Plus features include floppy disk resident editor, assembler, LAMBDA loader, and debug programs • interactive command processor • file management services • macro assembler capability • and line-oriented Text Editor.

Files created by the OS4 operating system and OMEGA4 PLUS are fully compatible for file accessing and program execution.

REAL-TIME EXECUTIVE (RTX4)

The Real-Time Executive for the NAKED MINI4 Family of computers (RTX4) provides the basic tools necessary for building real time application programs. It contains dispatching, queueing, interrupt, clock and task control services, which simplify application program design and implementation. Additional subsystems based on RTX4 provide I/O, file management, and communication services.

RTX4 is implemented in a modular fashion, which allows the user to select only the services that his application requires. This is particularly important in supporting small memory configurations.

The user writes tasks, which include program instructions, data and descriptions of the required resources. Each time a new task is begun, a new activity is created. If more than one activity can exist for a task at one time, the task is reentrant. Reentrant programming is supported by stacks and Y-scratchpad, which may be allocated by the user or by dynamic allocation services. All tasks execute in an environment that controls all non-CPU resources. Task execution may be coordinated by using semaphores or exchanging messages through a mailbox. The tick clock and wall clock provide timer, clock and calendar services.

Table II-3. OMEGA4 PLUS Modules.

Module	Description	Module	Description
Line Editor	A line-oriented text editor supporting insert, delete and replacement operations on the source input	Command Processor (continued)	prompting and line editing for all editor and assembler combinations.
Assembler	A two-pass assembler supporting all standard NAKED MINI 4 instructions. The assembler includes arithmetic and logical expression processing, literal pooling and most features necessary to generate user tasks and standard I/O handlers for RTX4- and IOS4- based applications.	LAMBDA4 Relocating Object Loader	LAMBDA4 is a free-standing linking loader which links binary or object format paper tapes directly into memory. LAMBDA4 accepts object output from the OMEGA4 assembler modules, links it with Computer Automation- or user-supplied object libraries, resolves external references and creates a load map on the system command device. LAMBDA4 supports selective loading of object modules loading only those required. LAMBDA4 also includes a binary dump and verify capability which allows the creation of an autoloadable memory image binary tape.
Macro Assembler	An extended version of the assembler module which includes all the features of the assembler, plus an easy-to-use macro instruction facility. The macro facility includes macros to support all standard RTX4 and IOS4 calling sequences and table generation requirements.		
Distributed I/O	An interrupt-driven I/O module supporting the following DIO devices: TTY, CRT, High-Speed Paper Tape Reader/Punch, Card Reader and Line Printer. The Distributed I/O module supports a compatible subset of IOS4 I/O calls and may be used as a small I/O package by user applications. The I/O module is designed to be easily extended to support non-standard devices.	DEBUG4 utility	A free-standing interactive debug which supports inspection/ modification of memory locations and CPU registers, multiple breakpoints, memory listing and copy features. DEBUG4 allows the user to control execution of his application program during the debug phase of development. DEBUG4 is binary relocatable and includes a Binary Loader and binary dump and verify capability.
Command Processor	Handles all communication between the system terminal (TTY or CRT) and the assembler and editor modules. This module provides interactive input, including	MDBUG4 utility	A version of DEBUG4 which requires only 1K of memory.
		XDBUG4 utility	An extended version of DEBUG4 that adds support for the hardware Bus Monitor, in addition to all of the capabilities of DEBUG4.

System generation consists of simply linking the user task with the RTX4 library, thereby creating a loadable program. Two libraries are provided: a small production library (L:RTX) and an extended version that provides enhanced debugging services and resource control (L:RTXE). Both libraries offer the same services, so that program checkout can use the larger library while production can use the smaller library.

With RTX4, one executive supports all NAKED MINI 4 Family processors. The RTX4 is modular and fully reentrant and interrupt driven. It includes fast interrupt response • any number of tasks • multiple concurrent tasks • serial or reentrant tasks • priority scheduling of all resources • control-block oriented • dynamic buffer allocation • resource management • IOS4 for all I/O operations • and excellent documentation of functions and concepts.

RTX4 Services

RTX4 provides the user with a variety of services for intertask control and cooperation, and task timing. These services are explained in Table II-4.

Input/Output Subsystem (IOS4)

The Input/Output Subsystem of RTX4 (IOS4) provides I/O services to standard NAKED MINI 4 peripherals and provides a base for handling special peripherals which may be required by the OEM customer. IOS4 consists of overhead functions, queueing mechanisms, interrupt processing, and other routines which make it easy to write peripheral handlers.

IOS4 includes three forms of device-independent I/O: alphanumeric record, binary record, and stream I/O. By using these file types and the unit assignment table, a single program can operate with a wide variety of peripherals, aiding program checkout and production with different peripheral configurations. For all device handlers provided by Computer Automation, unformatted I/O can directly access the physical medium.

To meet the needs of the OEM, great flexibility has been designed into IOS4. The first level of flexibility is the variety of device independent I/O formats that are available. The second level of flexibility is that the device handlers provided by Computer

Table II-4. RTX4 Services.

		Description		Mnemonic	Description
Task Control Services	R:BGIN	Creates a new activity of a task, allocates resources and configures control-blocks	Clock and Timer Services	R:ITIC	Signals a semaphore after a given number of clock interrupts have occurred.
	R:END	Terminates the execution of an activity and returns its resources to the system		R:MTIC	Allows modification of a tick-clock request.
	R:GPRI	Allows an activity to determine its priority		R:CTIC	Cancels a tick-clock timer request.
	R:SPRI	Allows an activity to change its priority; either an absolute or relative priority may be given		R:AWAL	Signals a semaphore when a given time and date have been reached.
Intertask Cooperation Services	R:SIG	Signals a semaphore, indicating the occurence of an event or the availability of a resource		R:IWAL	Initiates a timer to cause a semaphore to be signalled after a specified time interval.
	R:WAIT	Waits until a semiphore is signalled		R:CWAL	Cancels a previous wall-clock or tick-clock request.
	R:SEND	Places a 32-bit message in a mailbox	Other Services	R:CINT	Arms the console interrupt and waits until one occurs.
	R:RECV	Waits for and accepts messages in a mailbox		R:ABUF	Gets a buffer from the environment memory pool.
Wall Clock Services	R:STOD	Sets time of day.		R:RBUF	Returns a buffer to the environment pool.
	R:GTOD	Gets time of day.		R:PAUS	Allows for round-robining of concurrent tasks.

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Automation are control-block oriented, allowing device parameters to be changed by modifying control blocks. The third level of flexibility is that new device handlers can be added to IOS4. The IOS4 User Manual provides a step-by-step explanation of how to design the control blocks and handler code. IOS4 provides a simple structure using features of RTX4, which allows new handlers to operate in a real-time environment, without any special effort in the design or coding of the handlers.

The simplicity and small size of IOS4 is due to the power and elegance of both RTX4 and the NAKED MINI 4 peripherals. All I/O processing is based on interrupts. No time is spent testing for completion, so the processor is available to perform other tasks while I/O operations take place. Variations in device speed are handled by handshaking in the peripheral controllers and the device handlers of IOS4. Data transfers may use either Auto I/O or DMA I/O.

Two basic classes of peripheral devices are supported by standard handlers and control blocks included with IOS4: DMA-only devices and Distributed I/O devices. DMA-only devices include the floppy disk, medium-capacity disk and high-capacity disk. Distributed I/O devices may operate with a standard I/O Distributor using Auto I/O or with a DMA I/O Distributor using DMA. They include the Teletypewriter/CRT console, Teletypewriter/paper tape, high speed paper tape punch and reader, line printer and card reader. In all cases, operation completion and error conditions are reported by separate interrupts.

Standard File Manager (SFM)

The Standard File Manager (SFM) provides the user with a file management capability. Directory and data management capabilities of the SFM support disks and floppy disks. The SFM operates as a driver working in conjunction with RTX4-IOS4. In an application program, the Standard File Manager can communicate directly with a data file by logical name, independent of the physical device on which the file is stored.

Features of the SFM include concurrent access to files by multiple tasks • runtime device assignments • complete disk addressability • files up to $2^{31}-1$ bytes in length • user control of storage space segment size • formatted alphanumeric and binary I/O • formatted and unformatted stream I/O • sequential and random file access.

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