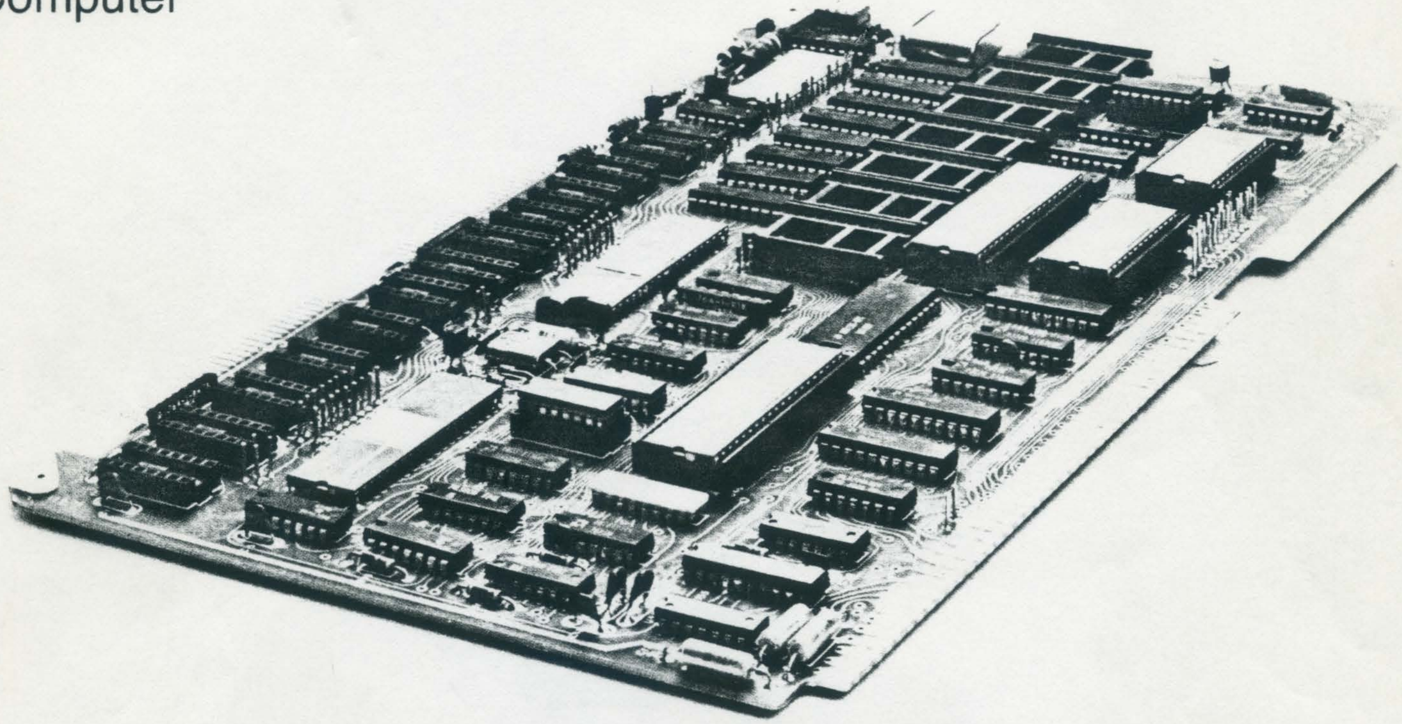
Advanced
Micro
Computers
An affiliate of Siemens

AMC 95/4000
MonoBoard
Computer



Features

- Central Processor Unit (CPU) Provides Much Higher Throughput than Available on Other Single Board Computers. Standard 2MHz or Optional 4MHz Versions Available
- Arithmetic Processor Unit (APU) Provides Both Fixed and Floating Point Computational Capability at 2MHz and 4MHz Clock Rates
- Direct Memory Access (DMA) Controller Provides Four Fully Independent Channels with a Built-In Memory-To-Memory Transfer Capability as well as Software Initiated DMA Request
- Eight Fully-Programmable Vectored Priority Interrupt Channels with Provision for Software-Generated Interrupts
- Current Loop and RS232C Interfaces with Switch Selectable Rates (50-9600 Baud)
- 48 Parallel I/O Signals at Top Edge Connector
- 4K Bytes of Read/Write Random Access Memory (RAM)
- Sockets for Up To 12K Bytes of Read-Only-Memory (ROM) or Erasable Programmable Read-Only-Memory (E-PROM)
- Provisions for Selected Portions of On-Board RAM or ROM/E-PROM to be Disabled and their Address Space Allocated to Off-Board Memory According to the User's Needs
- Signal and Plug Compatible with SBC 80 Series Bus
- System Expandable to 64K Bytes of Memory

Description

The AMC 95/4000 MonoBoard Computer (MBC) is a complete single board microcomputer system. The board itself is fully form-factor and bus compatible with Intel SBC 80 single board products. However, while maintaining mechanical and interface compatibility with the SBC 80 series, the AMC 95/4000 offers substantially more functions and twice the throughput of the older generation SBC 80 products.

By combining either a 2MHz or 4MHz Am9080A processor chip with an on-board clock generator, the MBC provides throughputs that are much greater than are available on other board products. The Am9080A CPU is completely 8080A compatible and yet offers a substantial performance gain to the user. All of the functions available on the MBC, such as the arithmetic processor, direct memory access (DMA), serial and parallel input/output, and the priority interrupt controller, are capable of operating at up to a 4MHz clock rate.

To satisfy user requirements, both a 20 milliampere current loop interface and a standard RS232C communications interface are provided on the serial communications port. The communications port is fully programmable and supports synchronous or asynchronous communication at baud rates of up to 9600 bits per second. A full duplex communication capability is provided by the completely independent receiver and transmitter channels.

Parallel input/output ports are provided which, through user program selection, allow 48 bits of input or output to be divided into six 8-bit ports. Each of these ports can be configured for unidirectional or bidirectional operation, with or without handshaking control signals. Thus, the parallel input/output ports simplify communication with peripheral devices that require an 8-bit parallel interface, such as line printers, graphic displays, or A/D and D/A converters.

The MBC is expandable to 64K bytes of memory through the use of additional memory boards. This allows the MBC to be configured for various data processing applications.

The on-board memory system of the AMC 95/4000 provides sockets for up to 12 kilobytes of read-only (ROM or E-PROM) memory. There are also 4 kilobytes of read/write random-access memory on the board. By replacing a single address decoder PROM, the entire 16 kilobytes of address space can be reorganized, thereby permitting memory selection to be distributed to the user's own (external) boards. This feature allows users to establish an all RAM system, or intermix ROM and RAM in any combination to satisfy their system memory requirements.

Four completely independent direct memory access (DMA) channels, utilizing an AMD Am9517 direct memory access controller, are incorporated within the MBC. Each DMA channel can be programmed to perform input-to-memory, or memory-to-output, operations. A memory-to-memory transfer capability is also included in the MBC to enable the user to perform high-speed block data transfer operations. Each of the DMA channels can be programmed to initialize automatically at the end of the specified transfer interval. Autoinitialization allows repetitive DMA operations, for CRT display refresh or memory buffer transfers to/from high-speed disk, to be accomplished without reprogramming the DMA channel. Direct memory access transfers can be performed at a maximum 2 megabytes per second rate. In addition, each DMA channel can be programmed to increment or decrement addresses in block, demand, or single data transfer mode. Block data transfer mode allows an entire data block to be transferred without interruption. Demand transfer mode causes data transfers to continue without interruptions whenever the demand signal is present, be interrupted when the demand signal is removed, and to resume when the demand signal returns. Single transfer mode allows the input or output and CPU to interleave memory cycles. Direct memory access transfers, initiated under either hardware or software control, can be used to incorporate diagnostic and maintenance routines into the user's system to ensure maintainability.

A vectored priority interrupt system in the AMC 95/4000 allows the user to specify an interrupt activity associated with each of the eight interrupt channels. Each channel can be programmed to respond to an interrupt acknowledge from the CPU with any 1-byte to 4-byte Am9080A instruction. The CPU will execute any instruction given to it by the interrupt controller and then continue processing at the next address in the program counter; most often, a jump to subroutine, or other branch instruction is used to facilitate the servicing of real-time processes. The eight interrupt channels can be programmed to perform priority resolution on either a fixed or rotating basis. This feature permits users to establish interrupt servicing priorities based upon their unique requirements. Software initiated interrupts can be used to incorporate maintenance and diagnostic programs into the user's system, or allow the implementation and management of hardware-prioritized software tasks. Therefore, the user's software development effort required to implement an event-driven multi-task system is reduced through hardware design.

Arithmetic Capability

The AMC 95/4000 features a specially designed arithmetic processor that utilizes the AMD Am9511 Arithmetic Processor Unit. This arithmetic processor allows arithmetic computation to be processed concurrently with the operation of the central processing unit. Both fixed point and floating point arithmetic operations are supported with hardware provided features. They include:

- 16-bit and 32-bit two's complement arithmetic operations including: Add, subtract, multiply and divide.
- 32-bit floating point operations including: Add, subtract, multiply, divide, and square root.
- Transcendental functions including: Sine, cosine, tangent, logarithms, exponential, and inverse trigonometric funcitions.
- Data manipulation functions including: Change sign of result, exchange operands on the internal data stack, operand duplication, . . . etc.

Arithmetic computations are performed by the special purpose processor to realize a throughput that is up to a hundred times faster than comparable software approaches without the expense of memory normally needed to contain the necessary software routines. Since the arithmetic processor operates concurrently with the CPU, the user can elect to generate an interrupt to the CPU at the end of each command operation. Execution times for the various arithmetic operations are given in Table 1.

This feature, combined with the substantial computation capability available on the AMC 95/4000, allows the user to design for process control, numerical control, data acquisition, navigation, or data communication applications with a single board product.

As shown, the Advanced Micro Computer's (AMC) MonoBoard Computer offers the single board computer user a new level in processing capability, with functions that are unavailable anywhere else in the market place, for implementation of sophisticated system level products that rival present day mini-computers in performance and at a fraction of the usual cost.

System Operation

The AMC 95/4000 MonoBoard Computer is a powerful microcomputer built on a single four-layer printed circuit board. A block diagram of the major functional elements of the MonoBoard Computer is shown in Figure 1.

Central Processing Unit (CPU)

At the heart of the MonoBoard Computer is the popular Am9080A MOS microprocessor; it is a general-purpose, monolithic digital processor with a fixed-instruction set and 8-bit parallel arithmetic logic and registers.

Arithmetic Processor Unit (APU)

The Am9511 arithmetic processing unit (APU) in the MonoBoard Computer supplements the mathematical processing ability of the Am9080A by providing a fixed-point and floating-point arithmetic capability. In addition to performing 16-bit and 32-bit fixed-point and floating-point calculations, the Am9511 enhances the MonoBoard Computer with its ability to do addition, subtraction, multiplication and division as well as transcendental derived functions and conversion operations. The addition of the Am9511 gives the AMC 95/4000 the most powerful arithmetic processing capability of any board computer currently available.

Direct Memory Access (DMA) Controller

Arithmetic processing performance, as well as I/O throughput, is further enhanced by the direct memory access capability provided by the Am9517 direct memory access (DMA) controller; it allows the APU and external devices to transfer information directly to and from the system memory. When the APU, an input/output device, or the program desires to make a direct memory data transfer, it sends a direct memory access request to the DMA controller. The DMA Controller acknowledges the request and, in turn, issues a request signal to the CPU. As soon as the CPU completes the current operation, it enters the Hold state until the DMA controller completes the direct memory data transfer. Depending on the DMA operation selected, the CPU will remain in Hold until a single byte, block, or multiple block data transfer is completed. The ability of the DMA controller to discontinue CPU operations until a memory transfer has been completed provides great flexibility in the way the micro-computer can be used; program

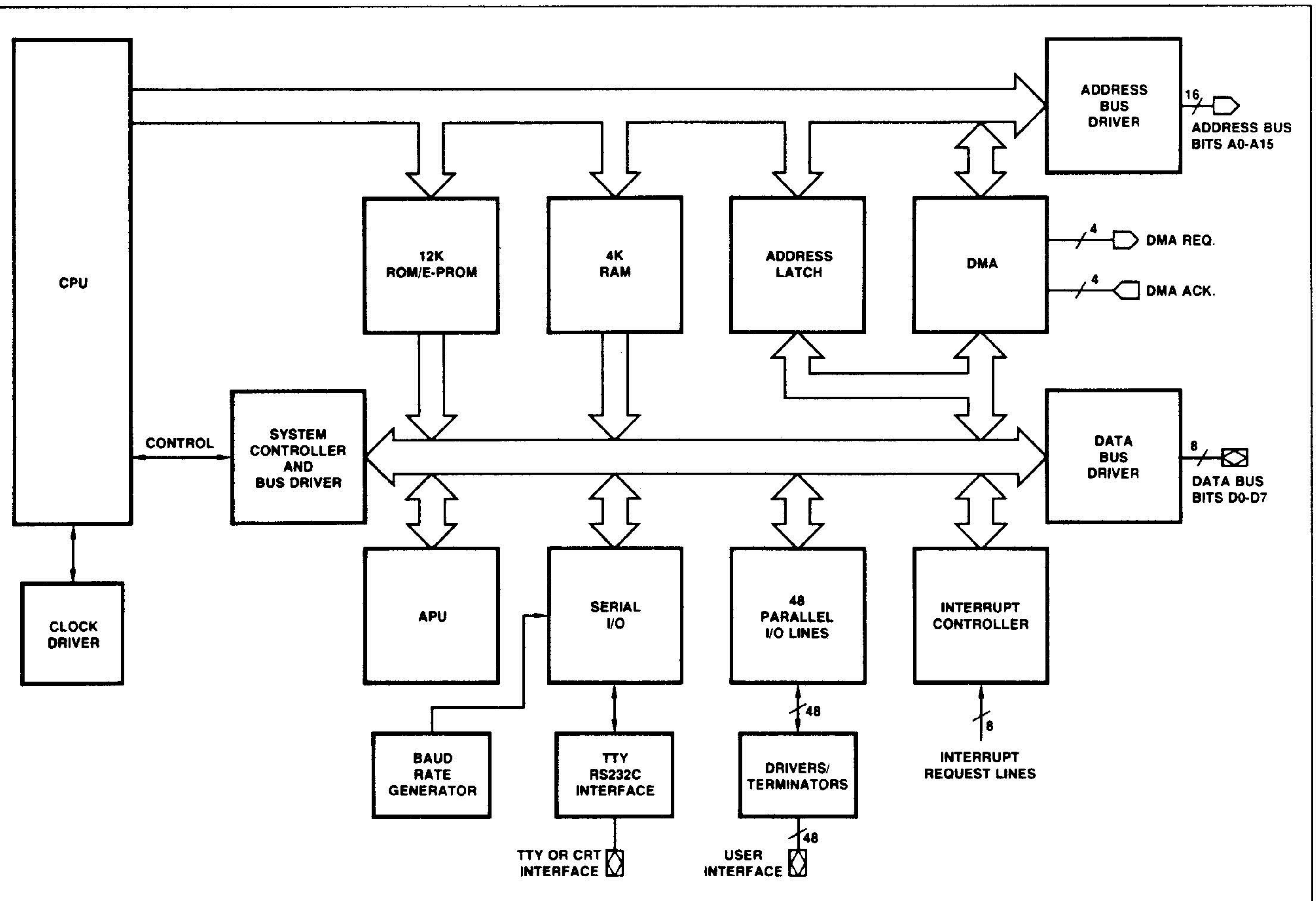


FIGURE 1. AMC 95/4000 MonoBoard Computer Block Diagram.

AMC 95/4000 — The New Industry Leader in Microcomputer Board Power

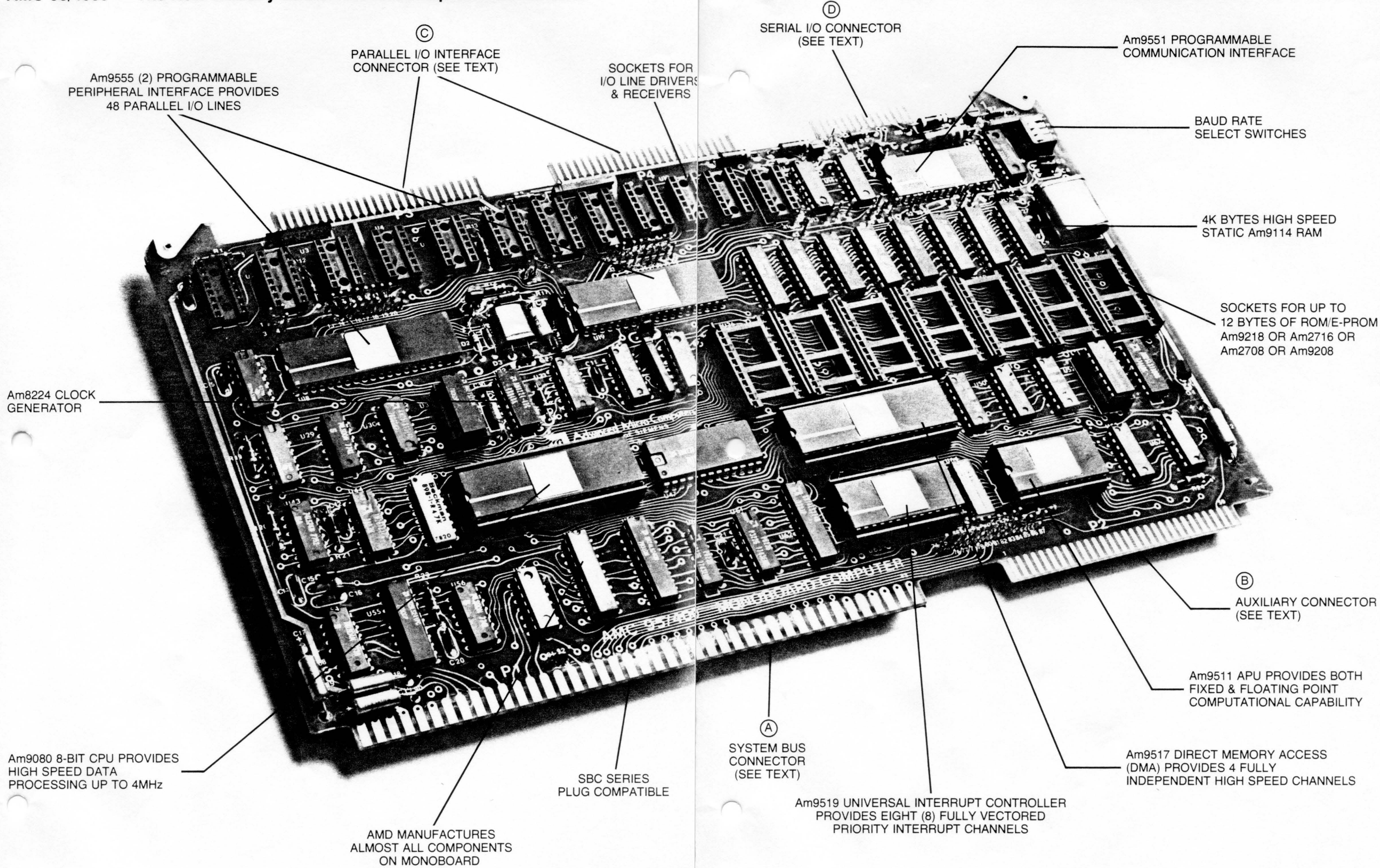


TABLE 1. Command Execution Times.

Command Mnemonic	Description	μSEC 2MHz	4MHz
ACOS	32-bit floating-point inverse cosine	3152–4142	1576–2071
ASIN	32-bit floating-point inverse sine	3116–3970	1558–1985
ATAN	32-bit floating-point inverse tangent	2496–3268	1248–1634
CHSD	32-bit fixed-point sign change	12–14	6–7
CHSF	32-bit floating-point sign change	8–10	4–5
CHSS	16-bit fixed-point sign change	10–12	5–6
COS	32-bit floating-point cosine	1920–2440	960–1220
DADD	32-bit fixed-point add	10–12	5–6
DDIV	32-bit fixed-point divide	98–106	49–53
DMUL	32-bit fixed-point multiply, lower	96–106	48–53
DMUU	32-bit fixed-point multiply, upper	92–112	46–56
DSUB	32-bit fixed-point subtract	18–20	9–10
EXP	32-bit floating-point exponentiation	1898–2440	949–1220
FADD	32-bit floating-point add	28–184	14–92
FDIV	32-bit floating-point divide	78–92	39–46
FIXD	32-bit floating-point to 32-bit fixed-point conversion	46–168	23–84
FIXS	32-bit floating-point to 16-bit fixed-point conversion	46–108	23–54
FLTD	32-bit fixed-point to 32-bit floating-point conversion	28–172	14–86
FLTS	16-bit fixed-point to 32-bit floating-point conversion	32–78	16–39
FMUL	32-bit floating-point multiply	74–84	37–42
FSUB	32-bit floating-point subtraction	36–186	18–93
LOG	32-bit floating-point common logarithm	2238–3566	1119–1783
LN	32-bit floating-point natural logarithm	2140–3478	1075–1739
NOP	No operation	2	1
POPD	32-bit stack pop	6	3
POPF	32-bit stack pop	6	3
POPS	16-bit stack pop	5	2.5
PTOD	Push 32-bit TOS onto stack	10	5
PTOF	Push 32-bit TOS onto stack	10	5
PTOS	Push 16-bit TOS onto stack	8	4
PUPI	Push 32-bit floating-point π onto TOS	8	4
PWR	32-bit floating-point X to the Y power	4146–6016	2073–3008
SADD	16-bit fixed-point add	8–9	4–4.5
SDIV	16-bit fixed-point divide	42–48	21–24
SIN	32-bit floating-point sine	1898–2404	949–1202
SMUL	16-bit fixed-point multiply, lower	42–48	21–24
SMUU	16-bit fixed-point multiply, upper	40–49	20–24.5
SQRT	32-bit floating-point square root	392–436	196–218
SSUB	16-bit fixed-point subtract	14–16	7–8
TAN	32-bit floating-point tangent	2448–2944	1224–1472
XCHD	Exchange 32-bit stack operands	13	6.5
XCHS	Exchange 16-bit stack operands	9	4.5

System Operation (Cont.)

overlays can be loaded from disk, data arrays can be loaded from peripherals, or advanced mathematical computations can be done between instruction cycles. The address latch shown in the block diagram works with the DMA controller to generate a 16-bit bus address. Since the Am9517 can directly generate only an 8-bit address to the address bus, it places the upper eight address bits on the data bus. The address latch takes the byte from the data bus and applies it, as the eight most significant bits, to the 16-bit address bus.

Read Only Memory (ROM/E-PROM)

The operating system, utilities, and other library routines used to control the microcomputer can be resident in ROM. Sockets for up to 12 kilobytes of read-only-memory (ROM) or erasable programmable read-only-memory (E-PROM) are available for use on the board. Up to five 2K by 8-bit devices (Am9218 or Am2716) and up to two 1K by 8-bit devices (Am9208 or Am2708) can be installed on the board.

Random Access Memory (RAM)

The MBC contains 4 kilobytes of random access memory (RAM). If more memory is required, a single address decoder PROM can be used to disable on-board memory selection; additional ROM or RAM boards can then be used as desired by the user.

Interrupt Controller

Advanced and efficient input/output processing is achieved on the MonoBoard Computer by using the Am9519 universal interrupt controller. The interrupt controller can generate vectored interrupts under either hardware or software control. When the interrupt controller recognizes an enabled interrupt request, it generates an interrupt request to the CPU. Upon completion of its current instruction cycle, the CPU acknowledges the interrupt request and waits for an instruction from the Am9519. The interrupt controller determines which interrupt has the highest priority and sends to the CPU an instruction that is subsequently processed. When the interrupt has been completed, the CPU continues execution with the instruction that was next in the program before the interrupt occurred. The user has full control of what is done during an interrupt routine. A common use of interrupts is to service peripheral devices; however, it need not be limited to peripheral servicing. Interrupts can be used to acquire real-time data, run diagnostic routines, sense alarms, initiate DMA operations, or even generate conditional software branches.

Input/Output Interface

The input/output interface portion of the MonoBoard Computer consists of 48 parallel input/output lines and a serial communication line. A switch-selectable baud rate generator determines the operating rate of the serial communication port. The serial communication port provides a direct interface to RS232C compatible terminals and communications devices. The 48 parallel input/output lines are grouped into six 8-bit ports. Each port can be software configured for either input or output operation. Driver/terminator blocks provided on the board make it easy to insert line drives or terminators as necessary to customize the MonoBoard Computer to each application. The parallel communication ports provide a versatile interface to the many peripheral devices that require an 8-bit parallel interface.

As shown on the block diagram, the AMC 95/4000 is a complete and powerful microcomputer; it offers a fast CPU, advanced APU, stored program ROM, sophisticated interrupt processor, remappable memory, access capability, and a versatile input/output interface.

System Edge Connectors

The AMC 95/4000 features the use of five edge connectors to provide off-board signal interface. These edge connectors are shown in the photograph on the preceding pages. The circled letter introducing each of the following paragraphs corresponds to the circled letter on the photograph, which indicates the location of the edge connectors.

Ⓐ System Bus Connector P1

Connector P1 is an 86-pin double sided edge connector that provides the interface for system expansion; it is pin compatible with Intel MDS and SBC 80 series products.

Interface signals provided by connector P1 include 16 address lines, 8 data lines, power inputs, clock, and control signals. All signals and pin assignments are compatible with the Intel MDS and SBC 80 system bus; however, the BPRO, BREQ, and the constant clock signals are not provided. The Am8224 Clock Driver $\phi 2$ TTL Clock replaces the constant clock on pin 31.

Ⓑ Auxiliary Connector P2

Connector P2 is a 60-pin double sided edge connector that provides interface to the DMA controller and an acknowledge signal to the Am8224 Clock Driver. All of the DMA request signals and DMA acknowledge signals are brought out to pins on P2. P2 also provides an external End-of-Process (EOP) input to the DMA controller.

Ⓒ Parallel Input/Output Interface Connectors P3 And P4

The Parallel I/O Interface communicates with external I/O devices via two 50-pin double sided edge connectors P3 and P4. Connector P3 provides the eight signal lines and eight ground lines for I/O ports E4, E5, and E6; connector P4 provides the signal and ground lines for I/O ports E8, EA, and EB.

Ⓓ Serial Input/Output Interface Connector P5

The serial I/O Interface communicates with an external device via a 26 pin edge Connector P5. Connector P5 provides either a 20mA current loop or an RS232C interface.

Specifications:

Word Size

Instruction: 8 or 16 bits
Data: 8 bits

Memory Addressing

On-Board ROM/E-PROM: 0-2FFFH
On-Board RAM: 3000-3FFFH

Memory Capacity

On-Board ROM/E-PROM: Sockets for 12K bytes with five Am9218 or Am2716 and two Am2708 or Am9208 chips

On-Board RAM: 4K bytes with eight Am9114 chips

Off-Board Expansion: Up to 64 bytes (less on board memory) in any combination of RAM, ROM, or E-PROM.

Bus and Connector Compatibility

Intel MDS-800
Intel SCB-80 series
Intel Model 210, 220, and 230 MDSs

Serial Baud Rates: 50 to 9600 Baud

Serial Communications Characteristics

Synchronous: 5-8 bit characters Internal or External Character Synchronization Automatic Sync Insertion

Asynchronous: 5-8 bit Characters Break Character Generation 1, 1½ or 2 Stop bits False start bit detector

Environmental Requirements

Operating Temperature: 0°C to +55°C Ambient in free air

Relative Humidity: Up to 90% without condensation

Dimensions

Width: 30.48 cm (12.00 in.)
Depth: 17.15 cm (6.75 in.)
Thickness: 1.27 cm (0.5 in.)

Power Requirements†

V_{AA} −12V ±5%
V_{BB} −5V ±5%
V_{CC} +5V ±5%
V_{DD} +12V ±5%

Current	Monoboard		W/2 9208		W/5 9218		W/2 2708		W/5 2716	
	Typ.	Max.	Typ.	Max.	Typ.	Max.	Typ.	Max.	Typ.	Max.
I_{AA}, mA	20	25	20	25	20	25	20	25	20	25
I_{BB}, mA	1	1	1	1	1	1	61	91	1	1
I_{CC}, A	2.0	3.2	2.0	3.23	2.3	3.6	2.01	3.22	2.1	3.4
I_{DD}, mA	190	300	190	406	190	300	290	430	190	300

†4MHz test values.

Ordering Information

Part Number	Option	Description
AMC 95/4000	000	2MHz MonoBoard Computer; with 4KB RAM, DMA, Interrupt Controller, 2MHz Fixed Point and Floating Point Processor, TTY & RS232C I/O, and 48 Programmable I/O Lines.
	100	Same as Option 000 except 4MHz.

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