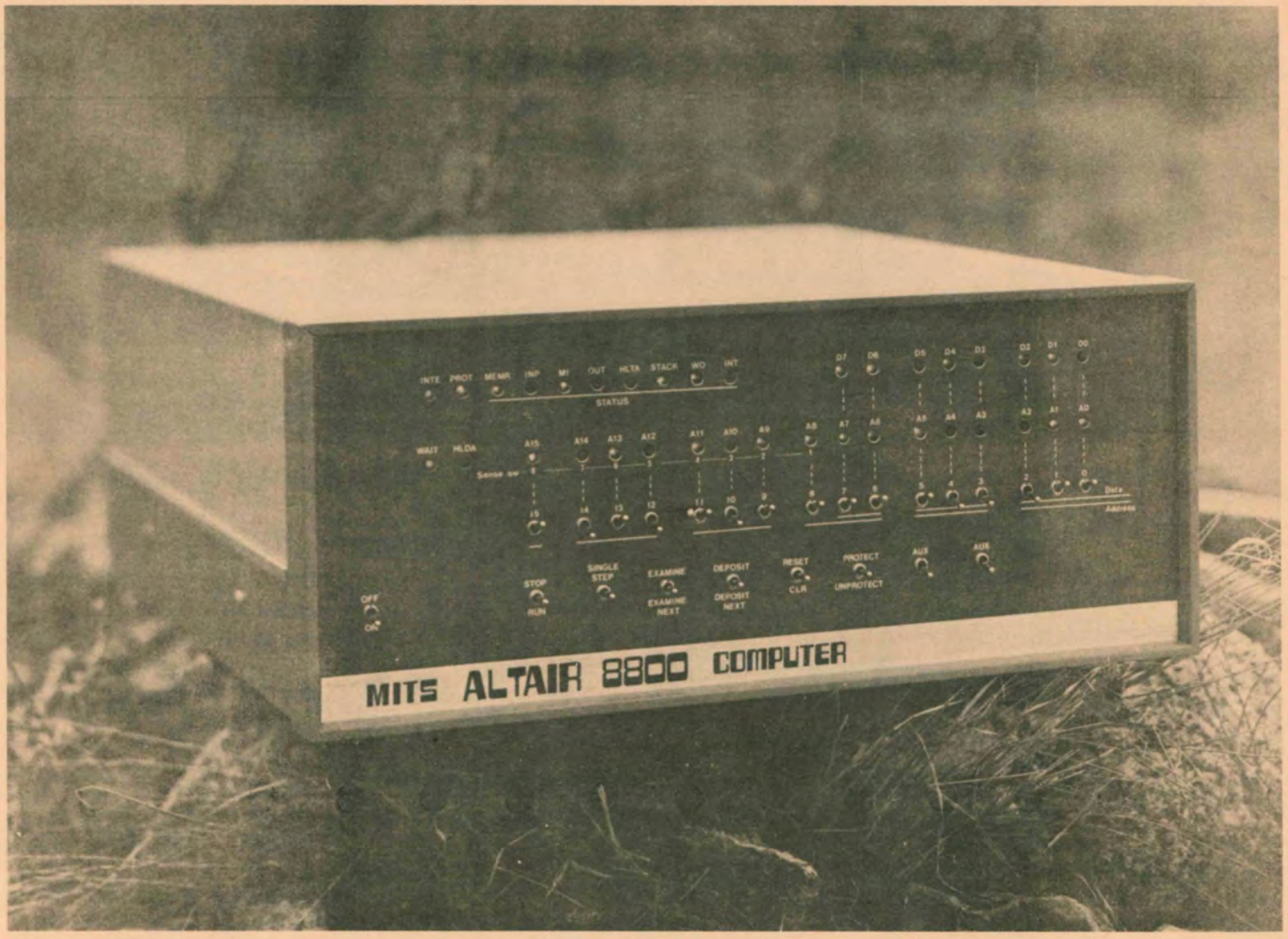
MITS ALTAIR 8800

COMPUTER SYSTEMS BROCHURE



A Computer Concept Becomes an exciting reality.

Contents

Introduction.....3
Altair Systems.....5
The Ultimate System.....7
The Possibilities.....8
User Applications.....10
Altair Options.....11
Processor Description.....14
Processor Instructions.....15
Questions & Answers.....17

MITS® INC.
"Creative Electronics"

Warranty: 90 days on parts and labor for assembled units. 90 days on parts for kits.

Prices, specifications and delivery subject to change without notice.

6328 LINN, N.E., P.O. BOX 8636, ALBUQUERQUE, N.M. 87108

505/265-7553

PIPE DREAM?

Not too long ago, the thought of an honest, full-blown, high-quality computer that sells for less than $500 would have been considered a mere pipe dream.

Everyone knows that computers are monstrous, box-shaped machines that sell for 10's and 100's of thousands of dollars.

Pipe dream or not, *MITS,* the quality engineering company that pioneered the calculator market, has made the *Altair 8800* a reality. It is the realization of that day when computers are accessible to almost anyone, who wants one.

The heart (and the secret) of the *MITS Altair 8800* is the *Intel 8080* processor chip. Thanks to rapid advances in integrated circuit technology, this one IC chip can now do what once took thousands of electronic components (including 100's of IC's) and miles of wire.

Make no mistake about it. The *MITS Altair 8800* is a lot of brain power. Its parallel, 8-bit processor uses a 16-bit address. It has 78 basic machine instructions with variances up to 200 instructions. That's enough to program all the traffic lights in a major city.

And the *MITS Altair 8800 Computer* is fast. Very fast. Its basic instruction cycle time is 2 microseconds.

Combine this speed and power with the *Altair's* flexibility (it can directly address 256 input and 256 output devices) and you have a computer that's competitive with most mini's on the market today. And sells for a fraction of their cost.

FLEXIBILITY

The *Altair 8800* has been designed to fulfill a wide variety of computer needs. It is ideal for the hobbyist who wants to get involved with computers. Yet, it has the power and versatility for the most advanced data processing requirements.

You can begin with a basic memory of 256 words of static RAM memory or you can expand the *Altair 8800* to 65,000 words of directly addressable memory. Static or dynamic or PROM or ROM memory. Or a floppy disc system. All supplied by *MITS*.

Thanks to buss orientation and standard interface cards provided by *MITS*, the *Altair 8800* requires almost no design changes to connect with most external devices. Any card can be plugged into any slot and the correct address, etc., for that card will be picked up off the buss system.

Since up to 300 peripherals can be added to the *Altair 8800* without any additional buffering, the custom designer can interface to almost any number of imaginable devices simultaneously. All *MITS* peripherals are supplied with software handlers to make interfacing easy.

INDIVIDUAL NEEDS

MITS wants to service your individual computer needs.

You can buy an assembled *Altair 8800*. Or you can start by building the computer yourself. The *MITS Altair 8800* is the ultimate kit. Its assembly isn't much more difficult than assembling a desktop calculator. And it's made double-easy with the aid of a straightforward, accurate assembly manual.

Or you can start with an *Altair 8800* complete data processing system. *Altair Systems* come in 5 basic configurations.

For those users who are not familiar with computers, *MITS* offers free consultation service. Just describe your requirements to our engineering staff and we will specify the additional cards and the system configuration you need to do the job.

The *MITS Altair 8800* is backed by complete peripheral and software development programs.

5 ALTAIR SYSTEMS

SYSTEM ONE
Altair 8800 Computer
88-MCS Static Memory Card
with 256 words of memory
(expandable to 1000 words)

SYSTEM TWO
Altair 8800 Computer
88-MCS Static Memory Card
with 256 words of memory
88-MM Memory Module
(256 extra words of memory)
88-PIO 8 Bit Parallel
Input/Output Card
88-LCT Computer Terminal

SYSTEM THREE
Altair 8800 Computer
88-4MCD Dynamic Memory Card
with 4000 words of memory
88-SIOA Serial
Input/Output Card
Comter 256 Computer Terminal

SYSTEM FOUR
Altair 8800 Computer
Three 88-4MCD Dynamic Memory
Cards with 12,000 words of
Memory
88-ACR Audio-Cassette
Record Interface
88-SIOA Serial
Input/Output Card
Comter 256 Computer Terminal

SYSTEM FIVE
Altair 8800 Computer
Four 88-4MCD Dynamic Memory
Cards with 16,000 words of memory
88-DC Disc Controller
Two 88-DDM Disc Drives & Discs
88-SIOA Serial Input/Output Card
Comter 256 Computer Terminal

SYSTEM ONE

System One is the *Altair 8800 Computer* plus 256 words of static memory. That's enough memory to do many machine language procedures and some control applications. The *Altair 8800 Computer* includes the CPU (Central Processing Unit), front panel control board, front panel lights and switches, power supply and expander board (with room for two extra cards) all enclosed in a handsome, aluminum case from Optima.

SYSTEM TWO

System Two consists of the basic *Altair 8800* plus enough memory to do simple machine language programming. The VLCT Computer Terminal converts octal input to binary format, thus making programming faster and easier. The Parallel I/O Card contains all the required addressing circuitry to address anywhere from location 0 to location 255.

SYSTEM THREE

System Three includes 4000 words of dynamic memory with a basic access time of 415 nanoseconds (twice as fast as static memory) and a memory protect feature that prevents accidental writing into memory. The Serial I/O Card is a full RS232 interface card with the necessary divider logic to allow for a broad range of presettable baud rates.

The Comter 256 Computer Terminal allows you to "talk" to the computer using full Alpha-numeric format. The Comter 256 is a surprisingly versatile computer terminal. Its basic memory of 256 characters with expandability to 1024 characters combines with a 32 character Self-Scan display to provide ease of operation.

SYSTEM FOUR

System Four has the power and memory for establishing complete accounting procedures to say nothing of its 1000's of other applications. The Audio Cassette Interface gives you virtually unlimited memory. 12,000 words of dynamic memory allows you to program in assembler, basic or any of the higher level programming languages.

SYSTEM FIVE

System Five is one powerful configuration. Dual Disc system includes the 88-DC Disc Controller which is capable of controlling over 200 flexible disc drives. Each of the disc drives included with System Five are capable of storing up to 262,000 words of data. This system is for the most advanced data processing applications.

THE ULTIMATE SYSTEM

The list of options (either available or in development) goes on and on. The five *Altair Systems* are only the beginning. You can buy one of these systems and take advantage of the *Systems' Discount* (see enclosed price list) or you can custom design a system that fits your individual needs.

The *Altair 8800* has very few, if any limitations. You may begin at the "low end" of the data processing scale and over the years wind up with the "ultimate" system.

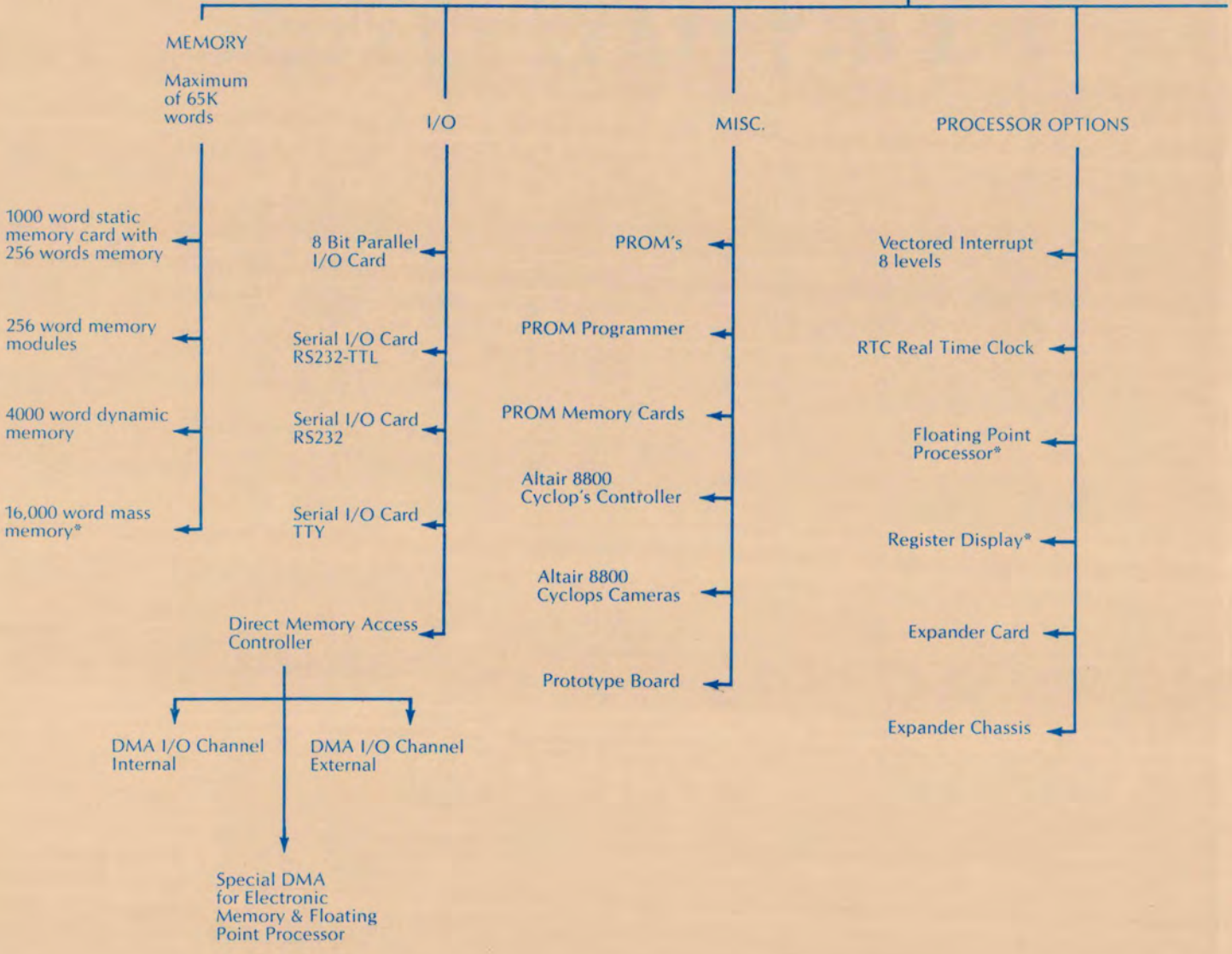
Using standard *MITS* interface cards, the *Altair 8800* can be connected to *MITS* peripherals (computer terminals, I/O cards, audio-cassette interface, line printers, etc.) to form the core of a sophisticated time-share system.

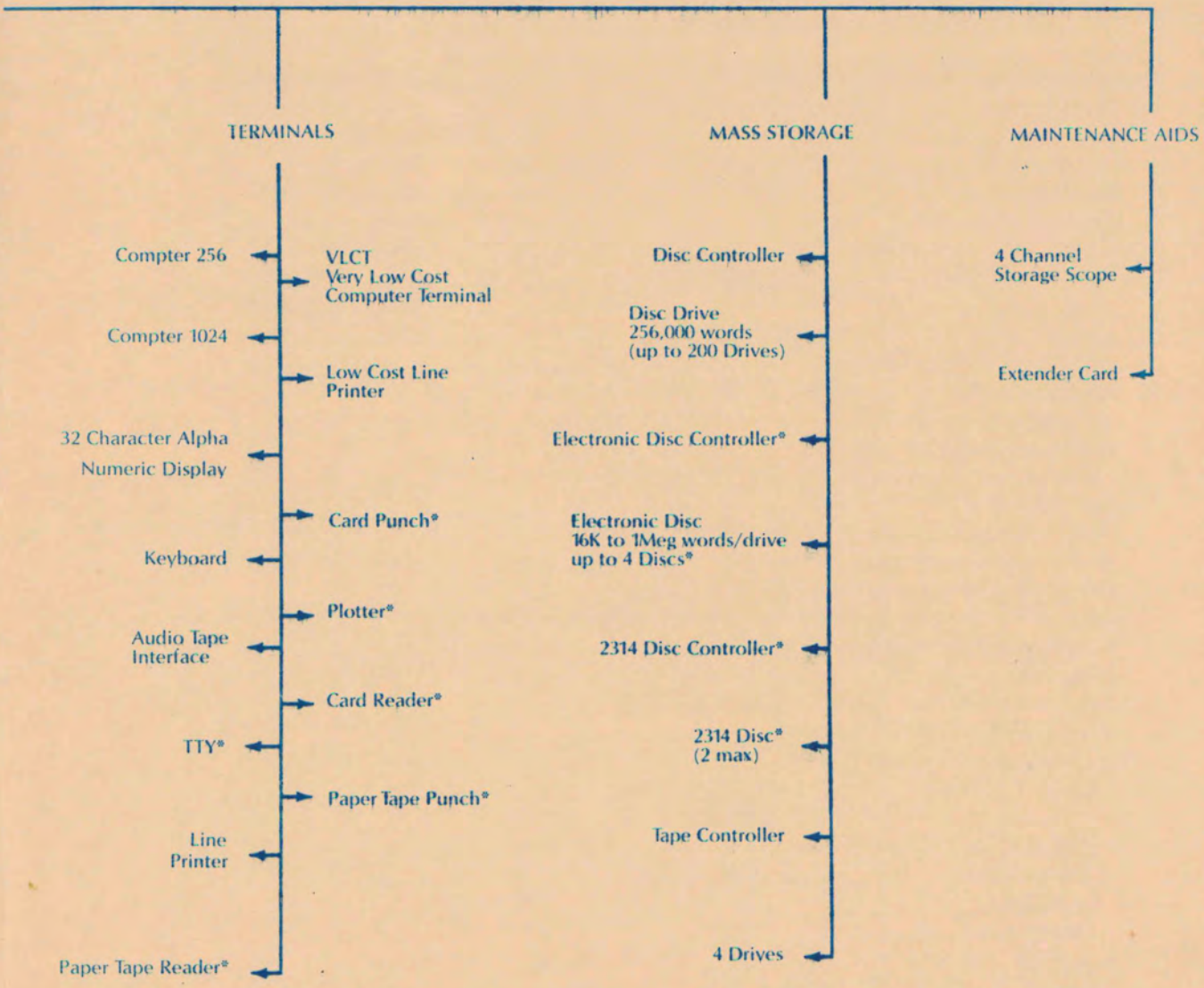
The *Altair 8800* can be a process controller. It can be an educational device. Or, it can be expanded to be an advanced, custom intrustion system. A programmable scientific calculator. Automatic IC tester. Automated automobile test analyzer. Complete accounting system. "Smart" computer terminal. Sound and light control system.

Or it can be all of these things at the same time. It could be the beginning of new business opportunities. The list of applications is literally endless.

Just think of the possibilities.....

ALTAIR 8800


MEMORY
Maximum of 65K words
1000 word static memory card with 256 words memory
256 word memory modules
4000 word dynamic memory
16,000 word mass memory*
I/O
8 Bit Parallel I/O Card
Serial I/O Card RS232-TTL
Serial I/O Card RS232
Serial I/O Card TTY
Direct Memory Access Controller
DMA I/O Channel Internal
DMA I/O Channel External
Special DMA for Electronic Memory & Floating Point Processor
MISC.
PROM's
PROM Programmer
PROM Memory Cards
Altair 8800 Cyclop's Controller
Altair 8800 Cyclops Cameras
Prototype Board
PROCESSOR OPTIONS
Vectored Interrupt 8 levels
RTC Real Time Clock
Floating Point Processor*
Register Display*
Expander Card
Expander Chassis



*In planning stage. All other peripherals are available or are in a development stage.

POSSIBLE USER APPLICATIONS

(This list is a small % of the possibilities)

programmable scientific calculator
multichannel data acquisition system
automatic control for ham station
sophisticated intrusion alarm system
automatic IC tester
machine controller
digital clock with all time-zone conversion
high-speed I/O device for large computer
digital signal generator
automated automobile test analyzer
on-board mobile controller
autopilot for planes, boats, etc.
navigation computer
time-share computer system
"smart" computer terminal
brain for robot
pattern-recognition device
printed matter-to-Braille converter
automatic drafting machine
automatic controller for heat, air conditioning, dehumidifying
controller for sound systems
digital filter
signal analyzer
stock market analysis
complete accounting system
- credit card sales
- cash sales
- markdowns
- charge sales
- gross profit
- labor costs
- average cash sale
- payroll
- inventory
- etc.

control applications
- pumps
- motors
- valves
- set points
- fans
- solenoids
- stepping motors
- drive contractors
- etc.

the OPTIONS

NAME & NUMBER	DESCRIPTION	APPLICATION	INTERFACE REQUIREMENT	SPACE REQUIREMENT
88-MCS Static Memory Card	This Static Memory Card comes with 256 words of memory and is expandable to 1024 words. Contains provisions for disabling the ready to compensate for the speed of the card. It also contains memory protect features. The static memory on this card has a maximum access time of 850 nanoseconds.	Systems that require small memory, such as control applications.	none	one slot
88-MM Memory Module	Plugs into the 88C-MCS Memory Card adding 256 words memory. Three modules can be added to each Static Memory Card for a total 1024 words of memory.	Expand static memory in a minimum processor configuration.	Space on a 88-MCS card.	
88-1MCS Full 1000 Word Static Memory Card	88-MCS Static Memory Card with full 1000 words of memory. See price list for discount price.			
88-4MCD 4K Dynamic Memory Card	This Dynamic Memory Card contains 4,096 words of memory. Maximum access time is 420 nanoseconds. An automatic refresh cycle is performed every 32 clock pulses at sync time. If the card is addressed at the same time that refresh occurs, the computer is given one or two wait states during refresh. Otherwise, the processor is unaware that refresh is occuring. Has write protect capability. Variable address circuitry allows user to provide a starting address in memory at any one of 16 locations—4K, 8K, 12K, 16K, etc.	Systems that require medium to large amounts of memory with fast access time.	none	one slot
88-DMAC Direct Memory Access Controller	This Direct Memory Access Controller will control 8 Dynamic Input/Output Cards. The controller generates a priority for each of the 8 cards and can generate either an interrupt or be sampled by the processor for job completion. Selects the channel to have access to the address buss and control buss when a DMA is to occur. Required in any system with DMA.	Systems that require rapid transfer of data into the CPU or out of the CPU. Allows for simplified software.	none	one slot
88-DMAE Direct Memory I/O Channel for External Devices	Full parallel Input/Output channel used for Direct Memory Access transfers between the processor and external devices. With one DMA I/O channel operating, data transfer rate is 300K bytes per second, while the processor continues to operate at approximately 80% speed.	Systems that require rapid transfer of data between the CPU memory and external devices. Also for slow speed, high quantity transfer.	88-DMAC	one slot
88-DMAI Direct Memory Access I/O Channel for Internal Transfers	Allows for high speed transfer of data blocks within the system's memory, without software intervention after set-up.	Data acquisition and logging systems.	88-DMAC	one slot
88-DDM Disc Drive & Multiplexer	Consists of standard flexible disc drive and the necessary interface or multiplex cards to communicate with the disc controller. Over 200 such drives can be controlled by one disc controller. Capable of storing up to 262,000 bytes on a flexible disc. Disc included. First two disc drives installed in the 88P-DC Disc Controller chassis. Separate chassis supplied with each two additional disc drives (including power supply).	Any application where mass memory is required.	88-DC	First two drives installed on Disc controller.

NAME & NUMBER	DESCRIPTION	APPLICATION	INTERFACE REQUIRE-MENT	SPACE REQUIRE-MENT
88-DC Disc Controller	The 88-DC Disc Controller contains a basic Altair CPU and special control logic and interface to control over 200 flexible disc drives. It is designed specifically to control flexible disc drives using standard IBM format. Each drive can contain 262 K bytes (words) of storage organized on 73 tracts with 26 sectors per tract. Controller comes in cabinet with provisions for 2 drives. Additional drives can be installed in separate cabinets.	Any application where mass memory is required.	slot on 88-EC	10" rack space
88-PROM PROM kit	Two bipolar 256 x 4 Shottky PROM's. Access time of 70 nanoseconds.	Control applications.	88-PPC PROM Programmer Card	
88-PIO Parallel Input/Output Card	Full parallel input/output card with necessary handshake flags for conventional parallel interface. Contains all required addressing circuitry to allow each card to be addressed anywhere from location 0 to location 255. Both input and output data has their own 8 bit latch for buffering. Includes necessary logic to allow an adjacent channel to be a control channel. Thus, adjacent channel can be used to set up flags and also clear flags and interrupts.	Any application where data is available in parallel or the external interface requires parallel data.	has standard TTL drives & accepts standard TTL signals	one slot
88-SIOA Serial Input/Output Card RS232	Full RS232 interface card with signal compatibility to conventional RS232 interface. Uses a UART and has divider logic to allow for presettable baud rates from 110 to 19,200. Uses adjacent channel for control if desired. If the card was selected to have an address of 1, adjacent I/O channel 0 would be the control card for setting up the required flags.	Interfacing any conventional RS232 type peripherals	Conventional RS232	one slot
88-SIOB Serial Input/Output Card TTL	Same as 88-SIOA except all signals are TTL levels (both in and out).	transmission of data with serial format	Standard TTL signals	one slot
88-SIOC Serial Input/Output Card TTY	Same as 88-SIOA except that it is for interfacing with conventional teletypes.	interfacing to teletypes	Standard TTY signals	one slot
88-VI Vectored Interrupt	Gives user 8 levels of hardware vectored interrupt. Automatically establishes restart addresses for interrupts.	Any type of interrupt structured system. Especially useful in real time applications.	All MITS standard I/O channels have provisions to interface to vectored interrupt.	one slot
88-RTC Real Time Clock	Provides interrupts to the processor at user selected rate of once every 100 microseconds, 1000 microseconds, 10 milliseconds or 100 milliseconds.	Any real time system or data logging system	Requires Vectored Interrupt	fits on Vectored Interrupt card.
88-ACC Altair Cyclops Camera	Digital, solid state TV camera. 1024 elements in a 32 x 32 array. Each detector is capable of 16 gray levels and automatic electronic stops are adjustable by the software. Up to 16 cameras can be controlled by one Cyclops Controller. Multiple controllers can be used.	Computer with eyes such as an intrusion system, production line control, automatic inspection stations.	88-CCC Cyclops Controller Card	Camera is 2" x 3" x 8".
88-CCC Altair Cyclops Controller Card	Will support up to 16 cameras simultaneously. Contains buffer memory and all 8 stop controls to communicate with the camera. Provides all interfacing for Altair Cyclops Camera.			one slot

NAME & NUMBER	DESCRIPTION	APPLICATION	INTERFACE REQUIREMENT	SPACE REQUIREMENT
88-KB ASCII Keyboard	Keyboard and case. Contains all logic and debounce circuitry for 96 ASCII characters. Controller is contained in 88-32DU 32 Character Alpha-numeric Display.	Any application requiring alpha-numeric data.	88-32DU Alpha-numeric Display.	external cables
*88-14ND 14 Digit Numeric Display	14 Digit Numeric Display mounted in its own case. Includes controller card.	Any application requiring numeric readout.		one slot plus external cable
88-VLCT Low Cost Terminal	Allows user to convert from octal format to binary and back to octal, decimal, or hexadecimal.	Machine Language programming	88-PIO Parallel I/O	
88-PPC PROM Programmer Card	Allows blocks of memory to be automatically programmed into Programmable Read Only Memories. The PROM's normally used in the Altair 8800 are bipolar Schottky PROM's with 70 nanosecond access time. Each PROM is organized as a 256 x 4 memory. Thus, two PROM's are required to achieve a 256 x 8 memory. Card includes external test socket for programming.	Particularly useful in control applications		one slot
88-32DU 32 Character Alpha-numeric Display	32 character alpha-numeric Burroughs Self-Scan display mounted in its own case. Includes controller with interface logic and power supply. Displays 64 ASCII characters and has 32 character memory.	Any application needing alpha-numeric display	none	1 slot plus external cabinet (may be mounted)
88-ACR Audio-Cassette Record Interface	Allows virtually unlimited memory storage for data or software. Operates by modulating audio frequencies in the record mode. Demodulates recorded data in playback mode.	Connects to any medium quality cassette tape recorder		
CT256 Computer Terminal	Basic memory of 256 characters with expandability to 1024 characters combines with a 32 character display to provide ease of operation. Special function keys for data retrieval and display format. ASCII coded keyboard and 110/300 baud rates. Auto-transmit and tape play/record features.	Computer terminal with Alpha-numeric display	88-SIOA Serial I/O	
88-PPCB Prototype Printed Circuit Board	Double-sided, plated through board for designing custom interfaces to the Altair 8800. Includes 5 volt regulator and associated filters.	Developing Custom Interfaces	Defined by user	one slot
88-EC Expander Board	Expander Board comes with space for four edge connector sockets to allow for the addition of four cards to the Altair 8800. The Altair comes with one Expander Board. Three additional boards can be added, making provisions for 16 cards. Expander Chassis needed for additional expansion.	Expand the 8800	Space in Altair 8800 chassis or Expander chassis	
88-EXC Extender Card	Double-sided circuit board with edge connector to allow all cards on the buss to be extended out of the card rack for easy maintenance.	Where extensive development or maintenance is anticipated		
Cases	A wide assortment of cases is available for adding external devices.			
88-EBC Expander Board Chassis	Power supply, Optima cabinet and four Expander Cards allows for an expansion of 16 cards to the Altair 8800. All necessary interface logic included.	Expanded system	One slot in basic Altair	8" rack space

ALTAIR 8800
PROCESSOR DESCRIPTION

Processor: 8 bit parallel
Max. memory: 65,000 words (all directly addressable)
Instruction cycle time: 2 microseconds
Inputs and outputs: 256 (all directly addressable)
Number of basic machine instructions:
78 (181 with variants)
Add/subtract time: 2 microseconds
Number of subroutine levels: 65,000
Interrupt structure: 8 hardwire vectored levels plus software levels
Number of auxiliary registers: 8 plus stack pointer, program counter and accumulator
Memory type: semiconductor (dynamic or static RAM, ROM, PROM)
Memory access time: 850 ns static RAM; 420 or 150 ns dynamic RAM

INSTRUCTION SET

Summary of Processor Instructions

Mnemonic	Description	Instruction Code[1] D_7	D_6	D_5	D_4	D_3	D_2	D_1	D_0	Clock[2] Cycles
$MOV_{r1,r2}$	Move register to register	0	1	D	D	D	S	S	S	5
MOV M, r	Move register to memory	0	1	1	1	0	S	S	S	7
MOV r, M	Move memory to register	0	1	D	D	D	1	1	0	7
HLT	Halt	0	1	1	1	0	1	1	0	7
MVI r	Move immediate register	0	0	D	D	D	1	1	0	7
MVI M	Move immediate memory	0	0	1	1	0	1	1	0	10
INR r	Increment register	0	0	D	D	D	1	0	0	5
DCR r	Decrement register	0	0	D	D	D	1	0	1	5
INR M	Increment memory	0	0	1	1	0	1	0	0	10
DCR M	Decrement memory	0	0	1	1	0	1	0	1	10
ADD r	Add register to A	1	0	0	0	0	S	S	S	4
ADC r	Add register to A with carry	1	0	0	0	1	S	S	S	4
SUB r	Subtract register from A	1	0	0	1	0	S	S	S	4
SBB r	Subtract register from A with borrow	1	0	0	1	1	S	S	S	4
ANA r	And register with A	1	0	1	0	0	S	S	S	4
XRA r	Exclusive Or register with A	1	0	1	0	1	S	S	S	4
ORA r	Or register with A	1	0	1	1	0	S	S	S	4
CMP r	Compare register with A	1	0	1	1	1	S	S	S	4
ADD M	Add memory to A	1	0	0	0	0	1	1	0	7
ADC M	Add memory to A with carry	1	0	0	0	1	1	1	0	7
SUB M	Subtract memory from A	1	0	0	1	0	1	1	0	7
SBB M	Subtract memory from A with borrow	1	0	0	1	1	1	1	0	7
ANA M	And memory with A	1	0	1	0	0	1	1	0	7
XRA M	Exclusive Or memory with A	1	0	1	0	1	1	1	0	7
ORA M	Or memory with A	1	0	1	1	0	1	1	0	7
CMP M	Compare memory with A	1	0	1	1	1	1	1	0	7
ADI	Add immediate to A	1	1	0	0	0	1	1	0	7
ACI	Add immediate to A with carry	1	1	0	0	1	1	1	0	7
SUI	Subtract immediate from A	1	1	0	1	0	1	1	0	7
SBI	Subtract immediate from A with borrow	1	1	0	1	1	1	1	0	7
ANI	And immediate with A	1	1	1	0	0	1	1	0	7
XRI	Exclusive Or immediate with A	1	1	1	0	1	1	1	0	7
ORI	Or immediate with A	1	1	1	1	0	1	1	0	7
CPI	Compare immediate with A	1	1	1	1	1	1	1	0	7
RLC	Rotate A left	0	0	0	0	0	1	1	1	4
RRC	Rotate A right	0	0	0	0	1	1	1	1	4
RAL	Rotate A left through carry	0	0	0	1	0	1	1	1	4
RAR	Rotate A right through carry	0	0	0	1	1	1	1	1	4
JMP	Jump unconditional	1	1	0	0	0	0	1	1	10
JC	Jump on carry	1	1	0	1	1	0	1	0	10
JNC	Jump on no carry	1	1	0	1	0	0	1	0	10
JZ	Jump on zero	1	1	0	0	1	0	1	0	10
JNZ	Jump on no zero	1	1	0	0	0	0	1	0	10
JP	Jump on positive	1	1	1	1	0	0	1	0	10
JM	Jump on minus	1	1	1	1	1	0	1	0	10
JPE	Jump on parity even	1	1	1	0	1	0	1	0	10
JPO	Jump on parity odd	1	1	1	0	0	0	1	0	10
CALL	Call unconditional	1	1	0	0	1	1	0	1	17
CC	Call on carry	1	1	0	1	1	1	0	0	11/17
CNC	Call on no carry	1	1	0	1	0	1	0	0	11/17
CZ	Call on zero	1	1	0	0	1	1	0	0	11/17
CNZ	Call on no zero	1	1	0	0	0	1	0	0	11/17
CP	Call on positive	1	1	1	1	0	1	0	0	11/17
CM	Call on minus	1	1	1	1	1	1	0	0	11/17
CPE	Call on parity even	1	1	1	0	1	1	0	0	11/17
CPO	Call on parity odd	1	1	1	0	0	1	0	0	11/17
RET	Return	1	1	0	0	1	0	0	1	10
RC	Return on carry	1	1	0	1	1	0	0	0	5/11
RNC	Return on no carry	1	1	0	1	0	0	0	0	5/11

Mnemonic	Description	Instruction Code[1] D_7	D_6	D_5	D_4	D_3	D_2	D_1	D_0	Clock[2] Cycles
RZ	Return on zero	1	1	0	0	1	0	0	0	5/11
RNZ	Return on no zero	1	1	0	0	0	0	0	0	5/11
RP	Return on positive	1	1	1	1	0	0	0	0	5/11
RM	Return on minus	1	1	1	1	1	0	0	0	5/11
RPE	Return on parity even	1	1	1	0	1	0	0	0	5/11
RPO	Return on parity odd	1	1	1	0	0	0	0	0	5/11
RST	Restart	1	1	A	A	A	1	1	1	11
IN	Input	1	1	0	1	1	0	1	1	10
OUT	Output	1	1	0	1	0	0	1	1	10
LXI B	Load immediate register Pair B & C	0	0	0	0	0	0	0	1	10
LXI D	Load immediate register Pair D & E	0	0	0	1	0	0	0	1	10
LXI H	Load immediate register Pair H & L	0	0	1	0	0	0	0	1	10
LXI SP	Load immediate stack pointer	0	0	1	1	0	0	0	1	10
PUSH B	Push register Pair B & C on stack	1	1	0	0	0	1	0	1	11
PUSH D	Push register Pair D & E on stack	1	1	0	1	0	1	0	1	11
PUSH H	Push register Pair H & L on stack	1	1	1	0	0	1	0	1	11
PUSH PSW	Push A and Flags on stack	1	1	1	1	0	1	0	1	11
POP B	Pop register pair B & C off stack	1	1	0	0	0	0	0	1	10
POP D	Pop register pair D & E off stack	1	1	0	1	0	0	0	1	10
POP H	Pop register pair H & L off stack	1	1	1	0	0	0	0	1	10
POP PSW	Pop A and Flags off stack	1	1	1	1	0	0	0	1	10
STA	Store A direct	0	0	1	1	0	0	1	0	13
LDA	Load A direct	0	0	1	1	1	0	1	0	13
XCHG	Exchange D & E, H & L Registers	1	1	1	0	1	0	1	1	4
XTHL	Exchange top of stack, H & L	1	1	1	0	0	0	1	1	18
SPHL	H & L to stack pointer	1	1	1	1	1	0	0	1	5
PCHL	H & L to program counter	1	1	1	0	1	0	0	1	5
DAD B	Add B & C to H & L	0	0	0	0	1	0	0	1	10
DAD D	Add D & E to H & L	0	0	0	1	1	0	0	1	10
DAD H	Add H & L to H & L	0	0	1	0	1	0	0	1	10
DAD SP	Add stack pointer to H & L	0	0	1	1	1	0	0	1	10
STAX B	Store A indirect	0	0	0	0	0	0	1	0	7
STAX D	Store A indirect	0	0	0	1	0	0	1	0	7
LDAX B	Load A indirect	0	0	0	0	1	0	1	0	7
LDAX D	Load A indirect	0	0	0	1	1	0	1	0	7
INX B	Increment B & C registers	0	0	0	0	0	0	1	1	5
INX D	Increment D & E registers	0	0	0	1	0	0	1	1	5
INX H	Increment H & L registers	0	0	1	0	0	0	1	1	5
INX SP	Increment stack pointer	0	0	1	1	0	0	1	1	5
DCX B	Decrement B & C	0	0	0	0	1	0	1	1	5
DCX D	Decrement D & E	0	0	0	1	1	0	1	1	5
DCX H	Decrement H & L	0	0	1	0	1	0	1	1	5
DCX SP	Decrement stack pointer	0	0	1	1	1	0	1	1	5
CMA	Compliment A	0	0	1	0	1	1	1	1	4
STC	Set carry	0	0	1	1	0	1	1	1	4
CMC	Compliment carry	0	0	1	1	1	1	1	1	4
DAA	Decimal adjust A	0	0	1	0	0	1	1	1	4
SHLD	Store H & L direct	0	0	1	0	0	0	1	0	16
LHLD	Load H & L direct	0	0	1	0	1	0	1	0	16
EI	Enable Interrupts	1	1	1	1	1	0	1	1	4
DI	Disable interrupt	1	1	1	1	0	0	1	1	4
NOP	No-operation	0	0	0	0	0	0	0	0	4

NOTES: 1. DDS or SSS – 000 B – 001 C – 010 D – 011 E – 100 H – 101 L – 110 Memory – 111 A.

2. Two possible cycle times, (5/11) indicate instruction cycles dependent on condition flags.

QUESTIONS AND ANSWERS

Already we have received 100's of questions from our customers about the Altair 8800 Computer, Altair Systems and Peripherals. The following section is designed to answer most of the common questions. If you have any additional questions, comments or thoughts related to the Altair 8800, please feel free to contact MITS at any time.

How powerful is the Altair 8800 and how does it compare to other computers?

The term "power" in a computer is related to a number of different items and it tends to be a nebulous measurement. In any case, the most easily identifiable performance criteria includes cycle speed, memory size and I/O capability. The basic cycle time of the *MITS Altair 8800* is 2 microseconds; it can directly address 65,000 words (8 bit bytes); and it can connect to 256 input and 256 output devices. Its cycle time is comparable to most small computers on the market today (they range from .8 microseconds to several microseconds). As for memory size and I/O capability, the *Altair 8800* beats the socks off most mini's. Most small computers can directly address 64 or fewer input/output channels and only 512 words of memory. An indirect connection to a base page is usually required for bigger memories.

If the Altair 8800 has such great specifications, why is it so inexpensive?

In developing the *Altair 8800*, *MITS* engineers made extensive use of large scale integrated circuit technology. This is the same technology that brought down the price of calculators. As we state in our ad literature, the secret of the *8800* is the *Intel 8080* processor chip. This one integrated circuit contains a complete 8-bit parallel central processing unit.

MITS was one of the first companies to manufacture high volume, low cost calculators. Our experience with large scale integrated circuits and volume production facilities has enabled us to build a computer at a very low cost.

How does the quality of the Altair 8800 Computer compare with other computers?

We'd like to stress that the low cost of the *Altair 8800* was not achieved by compromising the quality. Quality wise, the *Altair 8800* is as good as any other commercial computer that we are aware of. An illustration of this is the front panel indicator lamps. In most computers, these lamps are incandescent bulbs which burn out frequently. The *Altair 8800* uses LED's which have an almost infinite life. The front panel switches are high quality, miniature toggle switches as opposed to slide switches and low cost rocker switches available on some processors. The circuit boards are all fiberglass plated boards and each card in the *Altair System* has its own power regulator. The case, which is made by *Optima*, is all aluminum construction complete with sub-chassis and a false front panel.

How large a memory should I order with my Altair 8800 Computer?

In general, this is a difficult question to answer. If you plan on using your *Altair System* for relatively simple control applications, the 256 words of static memory provided with *System One* may prove to be adequate. Most control applications shouldn't take more than a few thousand words of memory. If you use your *Altair 8800* for more sophisticated accounting and engineering applications, you will of course need a larger memory. The memory in these applications could go as high as 65,000 words. But, in the case of a user who does a large amount of software development in machine or assembly language, 8,000 words should be adequate.

Again, if you have any questions concerning a particular application, feel free to contact *MITS* for deailed information and specific suggestions.

How simple is it to interface external devices to the Altair 8800 Computer?

The *Altair 8800* has been designed with a buss system that allows for relatively simple interfacing to external electronic equipment. Any electronics engineer or technician with a basic knowledge of logic design should be able to interface the *Altair 8800* to external systems in a minimum amount of time. Consulting time for custom projects is available from *MITS*. Questions concerning specific design problems will be answered at no cost.

I am not familiar with basic computer technology, but I do have a basic understanding of electronics. How long will it take me to become familiar enough with the Altair 8800 in order to interface it into a custom system?

This too, is a difficult question. The average electronic engineer, technician, or hobbyist should be able to write

simple machine programming in a matter of a few hours after first being exposed to the *Altair*. The amount of time after that to actually generate an operating program, of course, will depend on how complex and how large the program is and will also be related to the creativity of the individual doing the programming.

Anyone with a basic amount of assembly language or machine language programming experience should be able to write programs for the computer almost instantly.

I have done a considerable amount of computer programming, but I know almost nothing about electronics. How long will it take me to learn enough electronics to do my job?

If *Altair 8800* standard interfaces are used, no knowledge of electronics is required in order to use the *Altair 8800*. This statement doesn't apply if you want to design an electronic interface for some type of unique electronic device or electro-mechanical device. If desired, *MITS* will provide required engineering or software support for any project at a nominal cost.

The literature I have read concerning small processors contains a large amount of information on using the computer as a control device for external electo-mechanical systems. Does this mean that small computers are incapable of doing business, accounting, and engineering calculations?

Absolutely not. The main reason that small processors are closely associated with controllers is that the cost of the processor is low enough that it can be used as a system controller. For example, if you wanted to control a lathe with a computer, it's clear that a 3 million dollar computer installation wouldn't be a very good way to go. But, if we are talking about a computer system in the '1-2 thousand dollar range, then computer control becomes a very interesting application. The controller term is used frequently with small processors because the implications are overwhelming.

What are the business opportunities for someone who would like to design custom systems using the Altair 8800?

There are literally thousands of custom applications that require or could use a computer. We strongly encourage anyone interested in this sort of business opportunity to look into it in some depth.

MITS INC.
"Creative Electronics"

6328 LINN, N.E., P.O. BOX 8636, ALBUQUERQUE, N.M. 87108 U.S.A. 505/265-7553