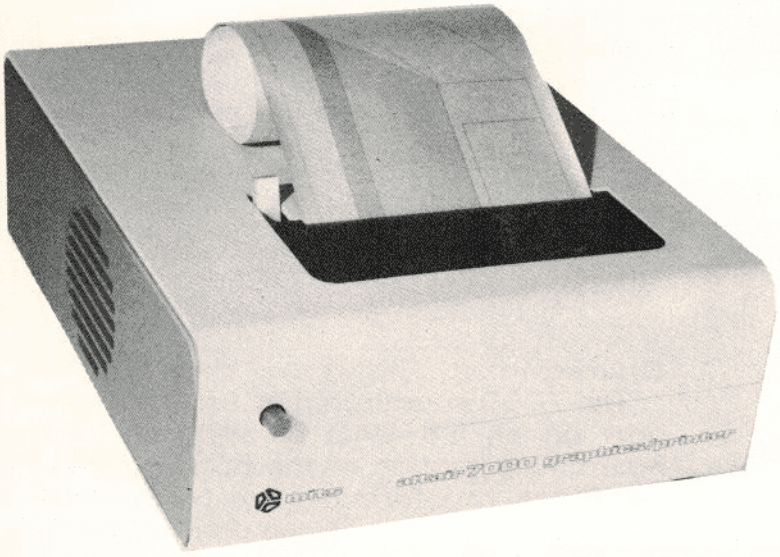
7000 Graphics/Printer

TECHNICAL INFORMATION



The 7000 Graphics/Printer is a multi-function, hard-copy output system which acts as a printer, plotter and graphics device. Its tremendous flexibility makes it one of the fastest and most economical methods of electrostatic printing available. The 7000 uses eight software-driven print electrodes instead of the usual seven found in 5 x 7 matrix printers.

Features

Printed output can be made for about 1 cent per foot of electrosensitive paper.

The 7000 is plug compatible with the 8800 mainframe via one PIO port. For graphics: An extra printing electrode provides symmetry along the horizontal and vertical axes to permit plotting. Either a distinct outline or a sophisticated detailed picture with shaded areas can be produced.

Extended or Disk Extended BASIC with the 7000 option must be used with the 7000 Graphics/Printer. The software for plotting (written entirely in BASIC) allows the user to make custom modifications and save room in memory by removing unnecessary subroutines. Listings of the plotting subroutines are supplied free of charge with the printer.

The BASIC subroutines consist of:

1. performing initialization (setting buffer size, location, etc.)
2. printing the entire buffer
3. clearing the buffer
4. marking a dot
5. writing a character
6. writing a string for a label
7. calculating scaling factors
8. plotting a point
9. drawing a line

Power: 115 VAC, 36 VA
Weight: 14 lbs.
Input Raster: 8-bit parallel

Capabilities

Line widths of 20, 40 or 80 characters within a 4-inch margin (upper and lower case)

Printing Speed: 160 characters per second (80 characters per line) or 120 lines per minute.

Horizontal Resolution:

1. Internal Timing: 80 dots/inch
2. External Timing: better than 128 dots/inch

Vertical Resolution: 65 dots/inch

Printhead Speed: 0.0175 inches/msec. ± 0.1%

Timing Markers:

1. Every 1/80 inch of printhead travel (Dot Timing)
2. Every 1/10 inch of printhead travel (Character Timing)

Plotting Speed: 2 lines per second, 8 dots vertical per line

Operation

The 7000 is controlled by using a single port on an 88-4PIO parallel interface board. One section of the port provides the 8 bits of information to be printed; the other section provides control. Each time a new column of information is to be printed, the appropriate data bits are forced low by the 4PIO. Each low data line causes the related printhead electrode to discharge to the paper, which produces a dot. There is a total of more than 500 8-dot columns in a line.

In the graphics mode, the image to be printed is stored in memory with a buffer. Each bit represents one dot in the picture. A 256-byte memory segment represents the 8 rows of 256 dots printed on one pass of the printhead. Since an 8 x 256 dot picture is far too small for practical purposes, the plot routine uses a number of these 8 x 256 elements to compose a picture. The standard number is 32 which requires an 8K buffer. The number of elements used may be increased or decreased by altering a single BASIC statement.

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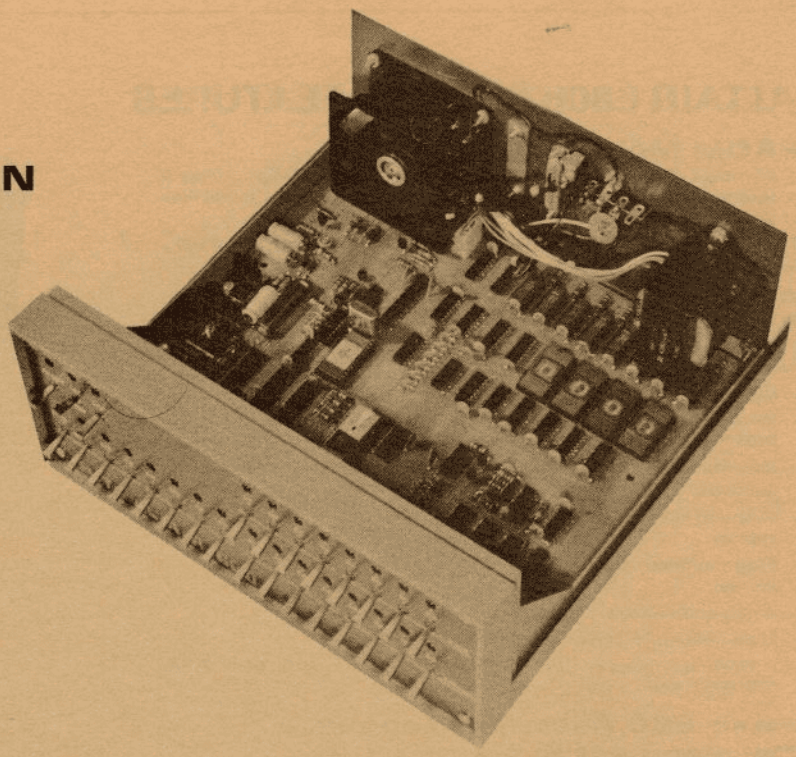
altair T.M. 680b

TECHNICAL INFORMATION



The ALTAIR 680b microcomputer is an excellent compromise between computer power and low cost structure, without sacrificing design reliability. The system is based on the 6800 microprocessing unit, which adapts nicely to a minimum design configuration. The ALTAIR 680b measures 11-1/16" wide x 11-1/16" deep x 4-11/16" high. The ALTAIR 680b is available with a full front panel or a turnkey front panel.

Almost all of the 680b circuitry is contained on a single large printed circuit board, including memory and a built-in I/O port. The full front panel model contains all of the controls necessary to program and operate the computer and includes an additional printed circuit board, which provides all of the logic circuitry necessary to reset, halt or start the processor. Also located on this board are switches and associated LED indicator lights for each of the sixteen address lines and eight data lines. The front panel circuit board mounts directly to the main printed circuit board via a 100-contact edge connector. The power switch is located on the back panel of the unit for safety purposes. A "turn-key" front panel model, which eliminates all control except restarting the processor, is also available.

The basic ALTAIR 680b computer can be subdivided into five functional sections. These are the MPU and clock, the memory, an I/O port, control and indication, and the power supply. The first three of these sections, along with the power supply regulation components, are located on the main printed circuit board.

At the heart of the 680b system is the 6800 Microprocessing Unit, which is largely responsible for the overall simplicity of the 680b design. The 6800 MPU contains three 16-bit registers and three 8-bit registers. The program counter is a two byte register which keeps track of the current address of the program. The stack pointer is also a two byte register which keeps track of the current address of the program and contains the next address in an external, variable length push-down/pop-up stack. The index register is a two byte register used to store data or a memory address for indexed addressing operations. There are two single byte accumulators used for holding operands and results from the arithmetic logic unit (ALU). The 8-bit condition code register indicates the results of an ALU operation. In this register there are two unused bits, kept at a logic one. The remaining six bits are used to indicate the status of the following: carry; half carry; overflow; zero; negative; interrupt.

The 6800 has seven different addressing modes, with the particular mode being a function of both the type of instruction and the actual coding within the instruction. The seven modes include the following: Accumulator Addressing—one byte instructions, specifying either of the two accumulators; Immediate Addressing—two or three byte instructions, with the MPU addressing the location given in the 2nd or 2nd and 3rd bytes when the immediate instruction is fetched; Direct Addressing—two byte instructions which allow the user to directly address the lowest 256 bytes of memory in the machine; Extended Addressing—three byte instructions, the second two bytes referring to an absolute address in memory for the operation; Indexed Addressing—two byte instructions, the second byte being added to the 16-bit index register to give the address of the operand; Implied Addressing—one byte instructions and the instruction itself gives the address; Relative Addressing—two byte instructions where the second byte is added to the lower 8 bits, allowing the user to address memory + 129 to -125 bytes from the location of the present instruction.

There are several timing and control signals required to operate the MPU. Two clock inputs are required, phase 1 and phase 2. These must be nonoverlapping and run at the Vcc voltage level. In the 680b the clock is a 2-MHz crystal controlled oscillator with logic to provide a 500-KHz two phase clock.

Sixteen active high address outputs are used to specify the sections of memory or I/O to be used. These can drive up to one standard TTL load and 130 pf. There are also eight bi-directional data lines with the same drive capability as the address lines.

ALTAIR 680b SPECIAL FEATURES

PROM Monitor

A 256-byte PROM monitor that allows immediate loading/running of programs (no boot loaders necessary) and examining and modifying of memory locations.

The Main board comes with 1K bytes of RAM and an on-board I/O port that may be configured for RS-232 or TTY transmission.

Altair 680 BASIC*

There is a version of Altair BASIC that is available for the Altair 680b. It is a high-level language that offers a number of powerful features including:

- —Boolean operators for bit manipulation
- —Variable length strings of up to 255 characters with LEFT$, RIGHT$ and MID$ functions
- —Concatenation operator for conversion between strings and numbers
- —Ability to read or write a byte from any I/O port or memory location
- —Program interrupt features that allow examination of variable values
- —String and numeric arrays of as many as 30 dimensions
- —Loop nesting limited only by available memory
- —Intrinsic functions of SIN, COS, TAN, LOG, EXP, SQU, SGN, ABS, INT, RRE, RND, POS

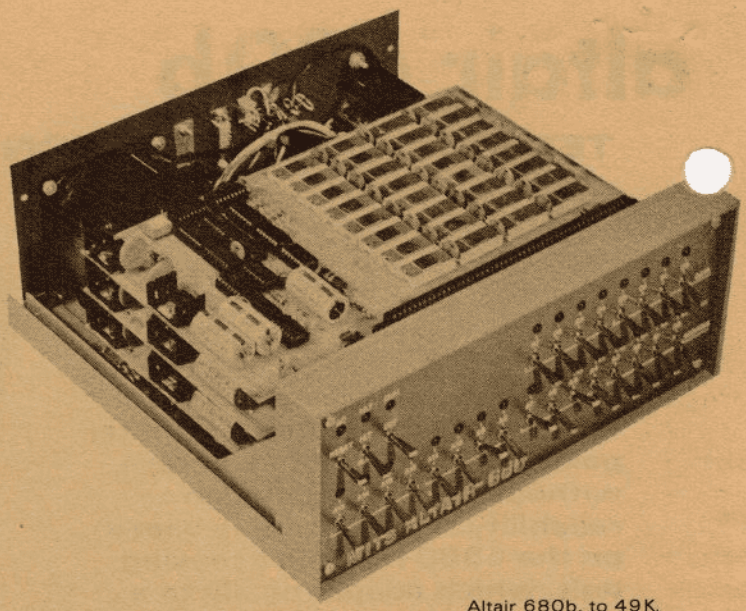
Altair 680 Assembly Language Development System*

A two-pass resident assembler and text editor are available for assembly language programming. This software is compatible with Motorola's format for assembly language programs, text and object files. 8K bytes of memory are required to run this package. The assembler produces a full assembly listing on the second pass, including the hex codes for the location counter and the instruction mnemonics. A symbol table listing is also produced. The text editor has full capabilities for text editing, including the insertion, printing, deletion and modification; as well as commands for changing one string of characters to another and for searching the text buffer for a particular character string.

EXCITING PLUG-IN OPTIONS

- —MITS offers a growing family of peripherals for the Altair 680b, including the 16K Static Memory Board (680b-BSM), 680b-KCACR, Universal Input/Output Board (680b-UI/O), Process Control Interface (680b-PCI) and Altair Minidisk System (680-MDS).

*680 BASIC and 680 Assembly Language Development System purchased separately, or a copy included free with an Altair 680b 16K memory board.



Altair 680b, to 49K.

Altair 680b Specifications

No. of Boards	Up to 3 additional
Microprocessor	
Model	6800
Technology	NMOS
Data Word Size, Bits	8
Instruction Word Size, Bits	8
Clock Frequency,	500KHz
Add Time, Register to Register, Microsec. Per Data Word	2
Number of Instructions	72
Input/Output Control	
I/O Word Size, Bits	8
Number of I/O channels	256 Memory Address Locations Designated
Interrupt Capability	Std.
Type of Interrupt System	Maskable (Interrupt Request) and Non-maskable Interrupt
Software	
Resident Assembler and Editor	Yes
Higher-level language	BASIC
Monitor	Resident System Monitor on PROM
Complete Software Library Separately Priced	Yes

In addition to the full front panel model, the Altair 680b is available in this Turnkey Model. It has a power indicator light and controls for RESET and RUN/HALT on the front panel. The system PROM monitor, when used in conjunction with a terminal, eliminates the necessity for toggling front panel switches to load bootstraps or to examine and change memory contents.

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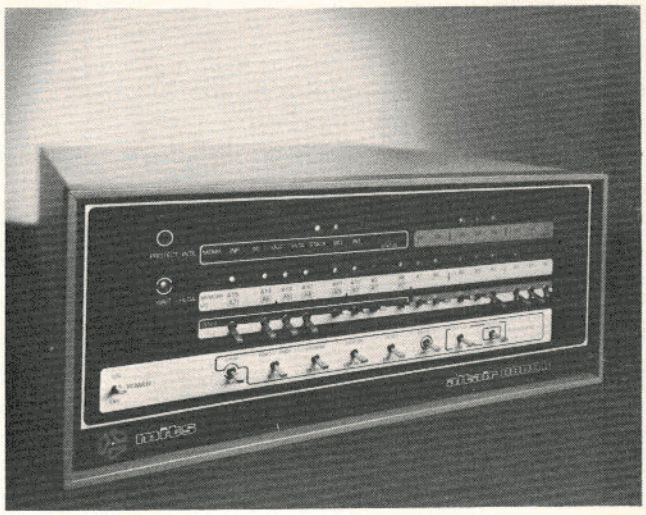
altair™ 8800b
TECHNICAL INFORMATION



The ALTAIR 8800b computer is a general purpose byte-oriented machine (8-bit word). It uses a common 100-pin bus structure that allows for expansion of either standard or custom plug-in modules. It supports up to 64K of directly addressable memory and can address 256 separate input and output devices. The ALTAIR 8800b computer has 78 basic machine language instructions and is comprised of a power supply board, an interface board, a central processing unit (CPU) board, and a display/control board.

Power Supply Board

The Power Supply Board provides two output voltages to the ALTAIR 8800b computer bus, a positive and negative 18 volts. It includes a bridge rectifier circuit and associated filter circuit, a 10-pin terminal block connector, and the regulating transistors for the positive and negative 18 volt supplies.

Interface Board

The Interface Board buffers all signals between the display/control board and the ALTAIR 8800b bus. It also contains eight parallel data lines which transfer data to the CPU from the Display/Control board.

CPU Board

The CPU board controls and processes all instruction data within the ALTAIR 8800b computer. It contains the model 8080A microprocessor circuit, the master timing circuit, eight input and eight output data lines to the ALTAIR bus, and control circuits.

Display/Control Board

The Display/Control Board conditions all ALTAIR 8800b front panel switches and receives information to be displayed on the front panel. It contains a programmable read only memory (PROM), switch and display control circuits, and control circuits to condition the CPU.

NEW DESIGN FEATURES

Several new design features have been incorporated into the electronic and mechanical areas of the ALTAIR 8800b computer. Some of the new design features include additional front panel capabilities, redesigned power supply, and various electronic and mechanical design advancements.

New Front Panel Switches

Five new front panel switch positions have been added to the ALTAIR 8800b computer to expand the front panel capability.

1. SLOW position: Permits execution of a program at a rate of approximately 2 machine cycles per second or slower. The normal machine speed is approximately 500,000 machine cycles per second. The ALTAIR 8800b operates in the slow mode as long as the SLOW switch is depressed on the front panel.
2. DISPLAY ACCUMULATOR position: Displays the contents of the CPU accumulator register on the ALTAIR 8800b front panel.
3. LOAD ACCUMULATOR position: Loads the information present on the lower eight front panel address switches into the CPU accumulator register.
4. INPUT ACCUMULATOR position: Inputs the information present at an Input/Output device into the CPU accumulator register. The Input/Output device is selected on the upper eight front panel address switches.
5. OUTPUT ACCUMULATOR position: Outputs the contents of the CPU accumulator register to a selected input/output device. The input/output device is selected on the upper eight front panel address switches.

New Power Supply

The new power supply in the ALTAIR 8800b contains an 8 volt, 18 ampere tapped secondary supply which permits the addition of up to 16 printed circuit cards, and pre-regulated positive and negative 18 volt, 2 ampere supplies. A multiple tapped primary transformer provides for 110/220 volt operation and a 50/60 Hz operation.

Electronic Design Advancements

The electronic design advancements on the ALTAIR 8800b are in the CPU and front panel circuit boards.

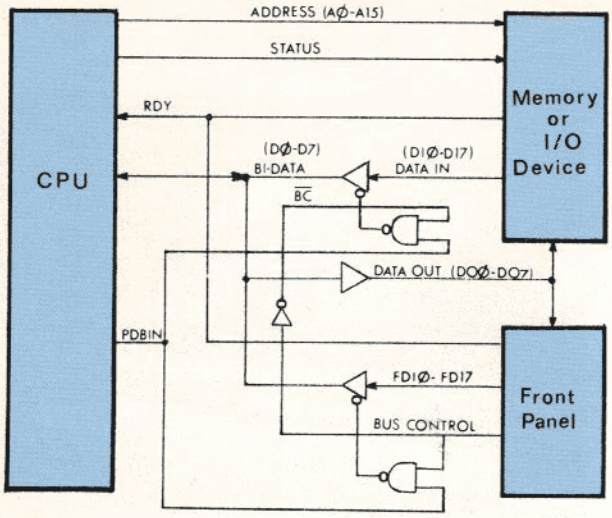
1. CPU. The new CPU circuit board uses the Intel 8224 clock generator integrated circuit (IC). The 8224 IC provides a specified clock frequency to the ALTAIR 8800b using an external crystal and dividing the crystal frequency down to 2MHz. Therefore, both the clock pulse widths and phasing (as well as frequency) are crystal controlled.
2. Front Panel. All front panel data lines are connected to an interface which buffers them from the rest of the ALTAIR 8800b. The front panel circuits also use a programmable read only memory (PROM) which contains programs for the following eight functions:
   EXAMINE
   EXAMINE NEXT
   ACCUMULATOR DISPLAY
   ACCUMULATOR LOAD
   DEPOSIT
   DEPOSIT NEXT
   INPUT ACCUMULATOR
   OUTPUT ACCUMULATOR

   The front panel circuits also have a wiring option which allows the CPU to perform a complete instruction cycle or a single machine cycle during the single step or slow operation.

Mechanical Design Advancements

The mechanical design advancements on the ALTAIR 8800b are incorporated for ease of assembly and maintenance.

1. The wiring harness connection which exists on the front panel of the ALTAIR 8800 is replaced with ribbon cables. These ribbon cables connect the front panel circuits to the interface circuits.
2. The four slot expander cards in the ALTAIR 8800 have been replaced by a single piece 18-slot motherboard. The 18-slot motherboard contains 100 solder lands which comprise the 100 pin bus.
3. A new multi-color and redesigned dress panel is used in the ALTAIR 8800b. The front surface of the dress panel has a protective sheet of mylar to insure that the graphics are not rubbed or scratched off.



8800b BLOCK DIAGRAM

8800b BLOCK DIAGRAM DESCRIPTION

The 8800b computer contains four main circuits: a Central Processing Unit (CPU), a Memory, an Input/Output (I/O), and a Front Panel. The CPU controls the interpretation and execution of software instructions, and the Memory stores the software information to be used by the CPU. The I/O provides a communication link between the CPU and external device. The Front Panel allows the operator to manually perform various operations with the 8800b. The 8800b block diagram description explains: A) the communication between the CPU and the memory or I/O circuits; and B) the communication between the CPU and the front panel.

CPU to Memory or I/O Operation

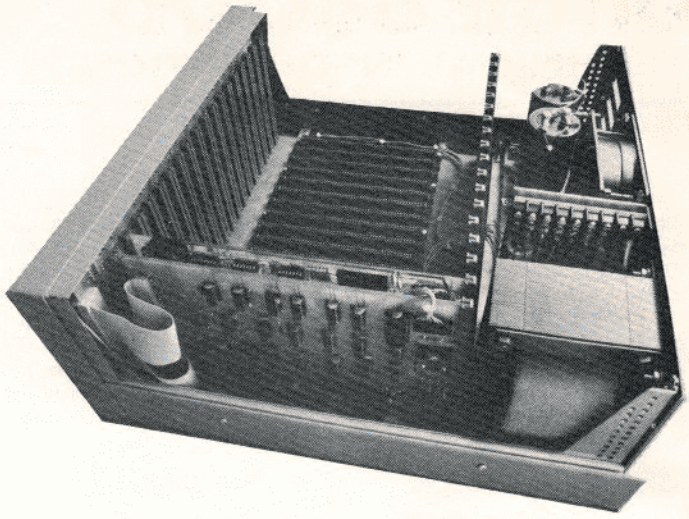
The Memory or I/O operation requires several main signals which allow for transfer of data to and from the CPU. The ADDRESS (AØ-A15) signal consists of sixteen individual lines from the CPU to the Memory or I/O device. This signal represents a particular memory address location or external device number which is needed to establish communications with the Memory or I/O Device. Once the ADDRESS (AØ-A15) data is presented to the Memory or I/O device, the CPU generates various STATUS signals. The STATUS signals either enable decoding of a memory address, or they condition the I/O device card to send or receive data from the CPU.

Data from the Memory or I/O device is presented on the DATA IN (DIØ-DI7) lines and applied to eight non-inverting bus drivers. The drivers are enabled by a PDBIN signal from the CPU and a BC (bus control) signal. The BC signal is LOW when the Front Panel is not in operation. The eight non-inverting bus drivers, when enabled, present the input data to BI-DATA (DØ-D7) lines which apply the data from the Memory or I/O device to the CPU.

Data to the Memory or I/O device is presented on the DATA OUT (DOØ-DO7) lines from the BI-DATA (DØ-D7) lines from the CPU. The RDY (ready) line either forces the CPU to a wait state while data is being transferred or allows the CPU to process data.

Front Panel Operation

The Front Panel Operation is very similar to the Memory or I/O operation. The Front Panel gains control of the CPU by producing a HIGH BC signal. The BC signal disables the DATA IN (DIØ-DI7) lines from a Memory or I/O device and enables the FDIØ-FDI7 lines. The FDIØ-FDI7 lines contain Front Panel data which is transferred to the CPU upon the occurrence of the PDBIN signal. All data from the CPU to the Front Panel is applied to the DATA OUT (DOØ-DO7) lines and displayed on the Front Panel.



COMPATABILITY

Compatibility

All of the current 8800 software is compatible with the 8800b, and all the current plug-in circuit boards are compatible, with the exception of the 8800a CPU Board.

Memory Cards

1. 4K Dynamic RAM Memory Board
2. 4K Static RAM Memory Board
3. 16K Static RAM Memory Board
4. PROM Memory Board

Interface Cards

1. Serial Interface Board
2. Parallel Interface Board
3. Audio-cassette Interface Board
4. Disc Controller Board

ALTAIR 8800b
Specifications

Number of Boards	Up to 18
Microprocessor	
Model	8080A
Technology	NMOS
Data Word Size, Bits	8
Instruction Word Size, Bits	8
Clock Frequency	2M Hz
Add Time, Register to Register, Microsec. Per Data Word	2
Number of Instructions	78
Input/Output Control	
I/O Word Size, Bits	8
Number of I/O Channels	256
Direct Memory Access	Optional
Interrupt Capability	Std.
Vectored Interrupt (8 priority levels)	Optional
Software	
Resident Assembler	Yes
Higher-level Language	BASIC
Monitor or Executive	Sys. Mon.; text edit.
Complete Software Library Separately Priced	Yes

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Altair™ C-700 Printer

Technical Information

The C-700 bidirectional matrix printer produces fast, legible hard-copy for a variety of small business uses such as banking or credit operations, medical laboratories (instrument data logging), reservation systems and inventory. The print head moves right and left seeking the nearest margin of the next line of print. This bidirectional printing method greatly increases efficiency by eliminating the need for time-consuming carriage returns.

Printing Method

The C-700 uses a 64-character subset of USASCII and prints an original and four copies in 132 columns of 5 x 7 dot matrix characters (10 char/inch) at a rate of 60 char/sec (26 lines/min). Character width can be adjusted to provide a total of 66 columns of double-width characters. Printed lines are vertically spaced at 6 lines/inch.

LSI Circuit Design

All of the C-700's electronic circuitry is contained on one printed circuit card. Simple maintenance is provided through the use of custom Large Scale Integration (LSI), which minimizes component parts and improves functional reliability.

Hardware

The interface board occupies one slot on the Altair computer bus and connects to the printer with a 40 conductor plug-in flat cable. The printer measures 7" high x 18" deep x 24.5" wide and requires 50 or 60 Hz, 115 or 230 VAC.

Internal and External Controls

The indicator/switch controls consist of: ON/OFF, SELECT/DESELECT and PAPER OUT INDICATOR.

The internal controls include: Auto Motor Control, Paper Runaway Inhibit and Auto Line Feed on carriage return.

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altair™ Floppy Disk (88-DCDD)

The 88-DCDD consists of the Disk Controller and one Disk Drive with an interconnect cable. The Disk Controller consists of 2 PC boards (over 60 ICs) that fit in the Altair chassis. The Disk Drive unit consists of a PERTEC FD-400, a power supply PC board, and a Buffer/Address/ Line Driver PC board. The Disk Controller converts the serial data to and from 8-bit parallel words (one word every 32 microseconds). The Disk Controller also controls all mechanical functions of the disk as well as presenting disk status to the computer.

Software and System Features

Altair Disk Extended BASIC is an enhanced version of Altair Extended BASIC with added capabilities for saving and loading programs, and for manipulating data files on disk.

Altair Disk Extended Basic uses random and sequential files for storing information on disk.

Utility software is included with Altair Disk Extended BASIC for copying diskettes, initializing blank diskettes, listing directories, etc.

Disk bootstrap loader is available on paper tape, cassette tape, or PROM (used with 88-PMC PROM Memory Card).

Hard sectored format (non IBM compatible) allows storage of over 300,000 data bytes.

Altair Disk Extended BASIC requires a minimum of 20K of RAM memory to operate in.

PROM Disk Bootstrap loader allows loading of Altair Disk Extended BASIC in less than 10 seconds from the time power is turned on.

Hardware

A. Description and Features

The Disk Controller, which acts as the interface between the Altair and the Disk Drives, consists of 2 PC boards that fit in the Altair chassis. They require 2 slots in the Altair, contain over 60 ICs, and connect to the Disk Drives via an 18 pair flat cable. The Controller can address up to 16 drives.

The Disk Drive Unit consists of a Pertec FD-400 drive in an Optima case 5½" high, 17" wide, and 17½" deep (same width and depth as the Altair 8800). Also in the Disk unit is a power supply and a Buffer/Address card for selecting the drive and interconnecting multiple disk systems. A fan is included to maintain low ambient temperature for continuous operation. The Disk Drive units interconnect to each other in daisy chain fashion and to the controller using 18 pair flat cables and DC-37 type 37-pin rectangular connectors.

B. Hardware Specifications

Access Time:
Track to track: 10 ms.
Head load and settle time: 45 ms.
Average time to read or write: 400 ms.
Worst case: 1135 ms.

Rotational speed: 360 RPM (166.7 ms/rev)

Tracks: 77 per disk

Sectoring: Hard sectored, 32 sectors per track, 5.2 ms/sector (non IBM compatible)

Data Transfer Rate: 250,000 bits/sec. (one 8-bit byte every 32 microseconds)

Maximum number of drives per system: 16

Data storage capacity: 310,000 bytes per disk

Data bytes per sector: 128

Data bytes per track: 4,096

Disk Drive head life: over 10,000 hours of diskette to head contact

Disk Drive MTBF: exceeds 4,000 hours

Disk Drive data reliability: not more than 1 in 10^9 soft (recoverable errors, 1 in 10^{12} hard (non-recoverable errors

Power:
Controller: 1.1 amps at + 8V unregulated (from Altair bus)
Disk Drive Unit: 110 watts 50/60 Hz 117/220 VAC

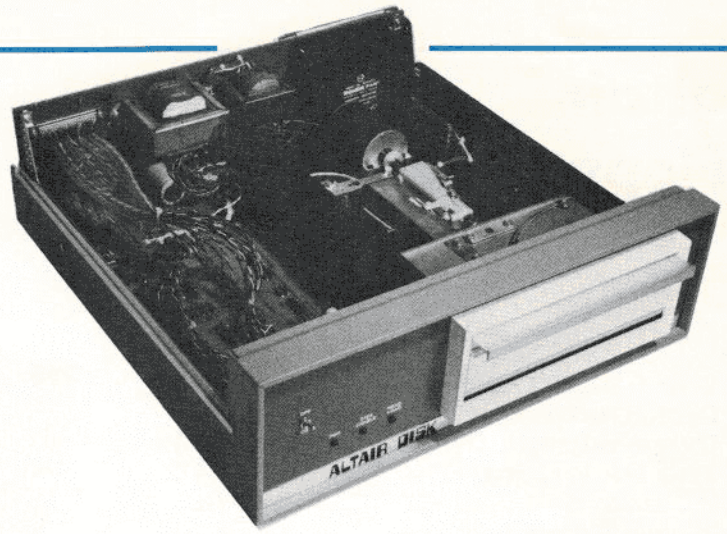
Diskette: Hard sectored, 32 sectors + index hole (Dysan #101, ITC #FD 32-100)

Disk Drive Unit Weight: 40 pounds

C. Operating Principle

The Disk Controller cards provide the interface between the Disk Drive Unit and the Altair bus. Serial read data from the disk is converted into 8-bit parallel form by the controller for transfer to memory via the CPU. Data is written on the disk by converting the 8-bit bytes outputted from the Altair CPU to serial form. All read and write data is transferred one byte at a time through the CPU.

Disk Controller Board #1 controls I/O address selection, sector counting, read data, and disk status. Disk Controller Board #2 controls disk drive addressing, write data, and disk drive functions.



Ordering information:

1. 88-DCDD

Includes:
Set of controller cards
1 Disk Drive Unit
1 interconnect cable—6 ft. long
1 Assembly and Operators Manual
1 Disk Extended BASIC Manual
1 Blank Diskette

2. 88-DISC

Includes:
1 Disk Drive Unit (117 VAC unless otherwise requested)
1 Interconnect cable—6 ft. long
1 Blank Diskette

3. Altair Disk Extended BASIC
Requires a minimum 20K of memory for operation.

Includes:
Altair Disk Extended BASIC on diskette
Altair Disk Extended BASIC Manual
Paper tape or cassette magnetic tape bootstrap loader (specify when ordering)

4. Disk Bootstrap Loader on PROM:
Order 88-PMC (PROM Memory Card) and DBL PROM (PROM programmed with disk bootstrap loader routine)

5. Manuals only:
Disk Hardware Manual
Altair Disk Extended BASIC Manual

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Altair Q-70 Printer

Specifications

Power: + 5VDC±3% at 3.5 amps DC
+ 15VDC±10% at 4.5 amps average
− 15VDC±10% at 4.5 amps average

Print Speed: 45 characters/second

Font: 96 character positions on "daisy" printwheel; wide variety of standard font styles in 10 and 12 pitch and proportional spacing.

Format: Horizontal—132 columns at 10 characters/inch; 158 columns at 12 characters/inch, and proportional spacing in increments of 1/120 inch, left or right. Electronic tabbing and carriage return up to 13.1 inches (33.3 cm) at 320 ms maximum. Vertical—Spacing increments of 1/48 inch, up or down; slew rate at 5 inches (12.7 cm) per second.

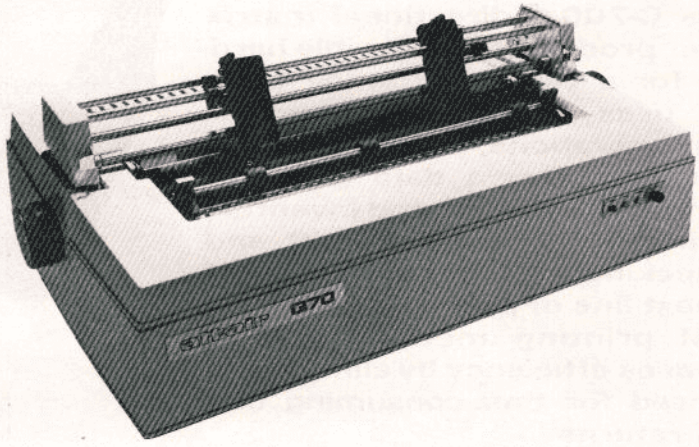
Plotting: Resolution of 5760 points per square inch.

Forms: Single sheets and continuous forms, with or without sprocket holes.

Form width: 15 inches (38.1 cm)

Interface: MITS Call Control Card is included.

Applications: High quality business and professional printing.



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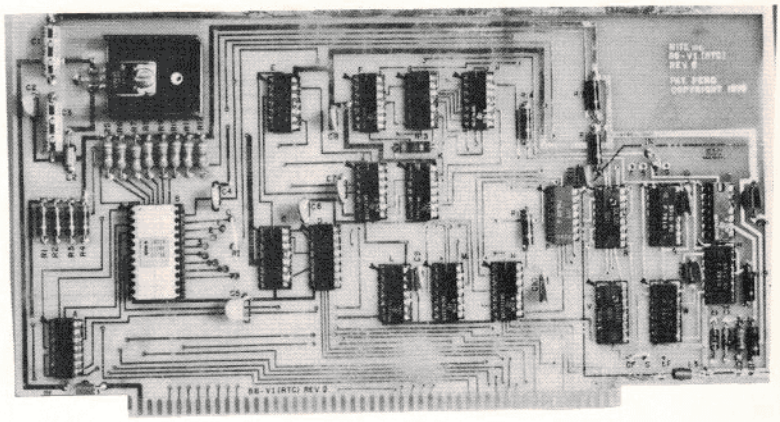
Vector Interrupt / Real Time Clock (88-VI/RTC)



The 88-VI gives the computer the capability to interrupt activity via the Restart (RST) instruction and to allow only the highest active priority of the 8 priority levels to interrupt the CPU.

The Real Time Clock provides the computer user with the capability to interrupt the processor at one of four selectable rates. The RTC generates an interrupt after a precise interval of time, which enables software to time certain routines and even to generate the correct time, day, and year, upon request.

The RTC source may be selected from either a derivative of the 2 megahertz clock or the line frequency. The 2 megahertz clock should be used if a fast RTC is needed; it is selectable for time intervals down to every 100 microseconds. The line frequency (60 Hertz) should be used in systems that require accuracy over a long period of time.

Hardware

Altair Slots: One.

Power: 5 volts at 300 ma.

Operation

ENABLE INTERRUPT instruction of the computer permits interruption. ENABLE INTERRUPT must also be activated after each interrupt is completed in order to reactivate the CPU's internal interrupt.

RST is an instruction which translates in octal code to 3N7; where "N" is a 3 bit code which represents one of the 8 priority locations, 0, 10, 20, 30, 40, 50, 60, or 70 (octal). Restart instructions are RST0= 307, RST10= 317, RST20= 327, etc. (octal). The vector interrupt places the RST instruction on the data bus at the correct time.

The 88-VI directs the interrupt to one of its 8 bus lines (VI0-VI7). VI0 is the highest priority, VI7 is the lowest.

The RST address will direct the computer to the highest active VI bus line. When an interrupt occurs that is higher priority than the active interrupt, the 88-VI interrupts the CPU and puts the RST instruction and the 3-bit address associated with that priority level on the data bus.

The Interrupt Service Handler is the software device which supervises all individual device service routines. Interrupt Service Handler enables the interruption of a lower interrupt routine by a higher one and also insures that each lower routine will be returned to and fully executed.

Address: Address 376 (octal). Bits 0, 1, 2, and 3 are used to update current level status. Bit 6 is used to enable/ disable the Vector Interrupt feature.

The Real Time Clock offers 2 clock sources: the system clock (operates at 2 megahertz), or the line frequency (operates at 60 hertz). The system clock interrupts once every 100 microseconds, 1 millisecond, 10 milliseconds, or 100 milliseconds. Line frequency interrupts once every 16.67 milliseconds, 166.7 milliseconds, 1.667 seconds, or 16.07 seconds. Any of the selected time intervals may be used to interrupt at any one of the 8 priority levels.

Clock Source Intervals:
System Clock (2MHz): 100 ns, 1 ms, 10 ms, or 100 ms.

Line Frequency (60Hz) Intervals: 16.67 ms, 166.7 ms, 1.667 sec., or 16.67 sec.

Accuracy: 2MHz, .01%.

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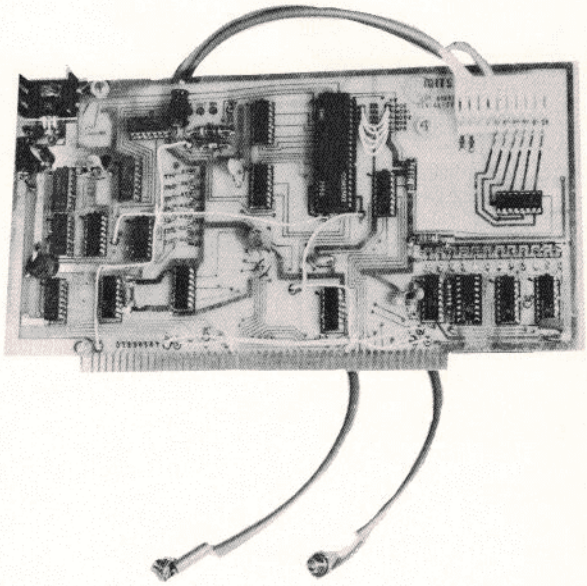
AUDIO CASSETTE RECORD INTERFACE (88-ACR)

The 88-ACR allows reading and writing of data on audio cassettes, using frequency modulation. The 88-ACR may be used with any medium (or better) quality cassette tape. (Music quality recorders generally give better performance than smaller portable recorders.)



Features

The 88-ACR may be used with machine language Read/Write programs or with ALTAIR BASIC commands (8K and Extended versions).

ALTAIR BASIC commands, CSAVE and CLOAD, are used to save and load programs or data arrays through the 88-ACR.

ALTAIR software is available on audio cassette tapes for loading into the ALTAIR through the 88-ACR.

Uses any tape recorder with less than 2% wow and flutter. The better the speed stability, the better the data integrity.

Hardware

General Description:

Consists of 88-SIOB (Serial I/O Board) mated to a MODEM (Modulator/Demodulator) board.

Requires one slot in the ALTAIR bus.

Connects to a tape recorder via miniature phone jacks (user supplies the interconnect cord).

MODEM Circuit Operation

Operates by frequency modulating audio frequencies in the record (write) mode, and demodulating these tones in the play (read) mode.

To record data, digital information from the ALTAIR is changed to audio frequencies by dividing the 2MHz system clock at different rates. A logic 1 gives a 2400 Hz tone, a logic 0 gives an 1850 Hz tone.

To read data, audio tones are filtered and then demodulated by a phase locked loop.

88-SIOB Operation

Digital information is in Universal Asynchronous Receiver/Transmitter (UART) format (start bit, 8 data bits, stop bit) at 300 baud.

The UART converts ALTAIR write data from parallel to serial form for the modulator.

The UART converts serial read data from the demodulator to parallel form for the ALTAIR.

Specifications

Modulation Frequencies: Logic 1-2400 Hz, Logic 0-1850 Hz.

Data Rate: 300 baud, 30 bytes/second.

Bit Format: UART type (1 start bit, 8 data bits, 1 stop bit).

Output Level: 100 MV p-p sawtooth, suitable for "MIC" input of recorders.

Output Impedance: 1.5K ohms.

Input Level: 200 MV p-p to 10 V p-p.

Input Impedance: 100K ohms.

Speed Tolerance: 2% without adjustment of PLL, 5% with adjustment of PLL.

Connector Type: 3.5 mm (⅛ in.) miniature phone jack.

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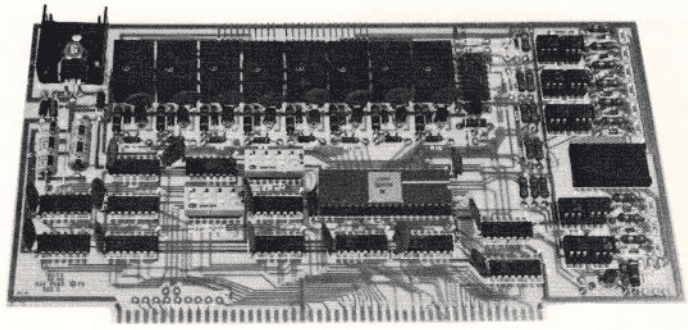
Technical Information

Altair™ 88-Process Control Interface (88-PCI)

Introduce your Altair 8800b to the diverse world of electrical, mechanical and sensory devices with the addition of the 88-Process Control Interface. By relaying various types of sensory information to the computer, the 88-PCI permits a wide range of control applications.



Applications

Whether your applications revolve around industrial, scientific, business, communication or household uses, the potential of the 88-PCI is virtually unlimited.

Some possible industrial applications include a product sorting and grading system. The 88-PCI can be interfaced with various kinds of sensors for measuring size, weight, optical density and other properties while controlling a sorting mechanism.

In the field of scientific research, an 88-PCI may be used to control environmental test conditions. Test responses can be gathered either by an 88-AD/DA converter or by the 88-PCI.

Suggested household uses include: control of thermostat settings, manual switches, lighting, lawn sprinkling and other home operations.

Features

The board consists of an eight relay output section, with each relay capable of switching 120v AC at 1 amp. Eight opto-isolators which can be configured by the user to accept a wide range of voltages make up the input section. Four more opto-isolated signal lines are arranged as two pairs of handshake lines, with the input section and output section each having one handshake pair. These lines are for control of and communication with external devices. All of the lines are completely isolated and balanced for use in environments with high levels of electrical noise.

Operation

When the board is set-up and initialized, relay control is accomplished by outputing an eight bit word to the relay control channel. Logic "1" lines will energize their respective relays, and those set to "0" will de-energize. An input from the opto-isolator input channel reads the data from the opto-isolated input lines. The interrupt structure and use of the handshake lines are under software control.

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Technical Information

88-Analog to Digital/ Digital to Analog Converter (88-AD/DA)

Another new option has been added to the growing line of Altair 8800 series peripherals. The 88-AD/DA is an eight channel analog I/O subsystem, allowing the acquisition and digitizing of analog data ranging from 0 to 10 VDC. Digital to analog conversion produces a 0 - 10 VDC output available in 256 steps of 39 millivolts. With the 88-AD/DA, the Altair 8800 microcomputer can measure analog voltages and generate them to eight bit accuracy.

Applications

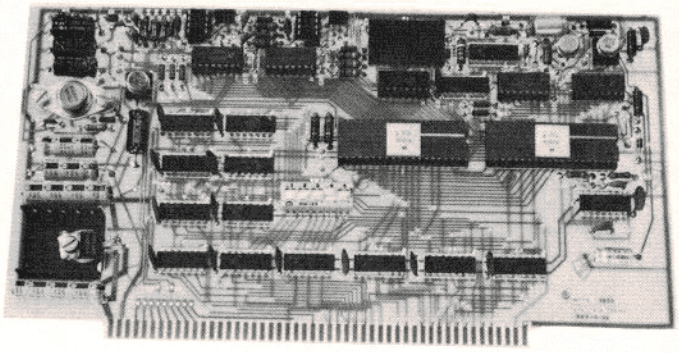
The versatility of the 88-AD/DA allows user implementation for many applications where analog to digital and digital to analog conversion is necessary. 88-AD/DA operation may be implemented for computer control, graphics production, games, scientific/electronic experimentation and monitoring.

Some suggested inputs and sources from which data can be obtained include joysticks (games, remote control, graphics), transducers (light, pressure, temperature), magnetic tape and instrumentation amplifiers (biomedical, chemical, circuit and acoustical analysis).

Oscilloscopes, magnetic recorders, meters and music synthesizers (voltage controlled oscillator, voltage controlled filter) are just some of the output devices to which data transfer is possible.

Operation

The 88-AD/DA Converter is an analog subsystem that functions as an Input/ Output (I/O) device. Analog data is input to an eight channel Multiplexer and converted to a digital equivalent value by a successive approximation type Analog-to-Digital Converter. Sample and Hold is provided to insure accurate conversions even for rapidly changing signals, and on-board timing is available to control sequencing of the Sample and Hold and Successive Approximation Register. From the time the Multiplexer has a valid address, 10 to 12 μs must elapse before the conversion data is available to the system. The conversion time for the Analog-to-Digital Converter itself, without settling time allowed for the Sample and Hold, is less than 5 μs.



The 88-AD/DA Converter board contains two Digital-to-Analog Converters that may be used to provide low cost analog output. The conversion time for each converter is limited only by the slew rate. The slew rate of the Digital-to-Analog Converters is adjustable with an on-board feedback capacitor to a maximum rate of approximately 50v per μs. The 88-AD/DA Converter board features 8 bit resolution for both A to D or D to A sections.

Specifications

AD Section

Input Mux Channels: 8

Resolution: 8 bits

Monotonicity: 8 bits

Sample and Hold Settle Time: 5 μsec.

Conversion Time: 5 μsec:

Time from Start Conversion to conversion complete: 11 μsec.

Nominal Input Range: 0-10 VDC (39mV per step)

DA Section

DA Converters: 2

Resoultion: 8 bits

Monotonicity: 8 bits

Settle Time: 85ns (50v/μsec)

Nominal Output Range: 0-10 VDC (39 mV per step)

Power Requirements

+ 18V unregulated at 45mA

– 18V unregulated at 47mA

+ 8V unregulated at 450mA

An AD-DA Converter is also available for the Altair 680b Computer. Specify 680b AD-DA Converter when ordering.

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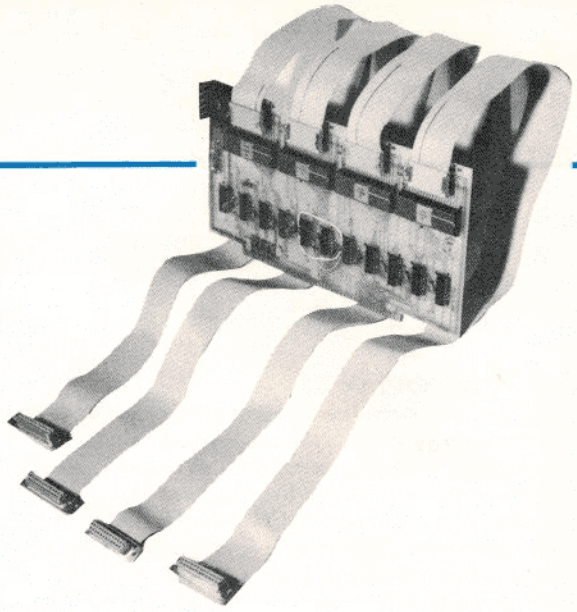
4-Port Parallel I/O Board (88-4PIO)



The 88-4PIO board design is based upon a peripheral interface integrated circuit. The chip contains all control and data registers, thus most 88-4PIO options are software selectable. These options include data direction (each data line can act as input or output) and interrupt/control structure modification. The 88-4PIO board can be expanded to four "PORTS" (four 6820 ICs), making it one of the most powerful and versatile interface boards available.

Hardware

The 4PIO board connects to the back panel of the computer with a removable flat cable. The cable has a 24-pin removable plug on the board, and a 25-pin connector on the back panel.

Altair slots: One.

Power: +5 volts at 500 milliamps with 4 ports.

Capabilities

The 4PIO board is capable of handling up to 4 ports on one plug-in card. Each port contains 16 data lines. Each line can be initialized as input or output to interface a terminal (8 lines in, 8 lines out).

The 4PIO board can handle 2 inputs (such as a paper tape reader and keyboard) or two output devices (such as a paper tape punch and printer) or any combination of custom applications.

All data lines are fully TTL compatible. Eight of the 16 lines are capable of directly driving the base of a transistor switch (1.5V at 1 ma).

A 4PIO with 4 ports has 64 data lines (each group of 8 is individually selectable) and consumes 500 ma at 5V—typical.

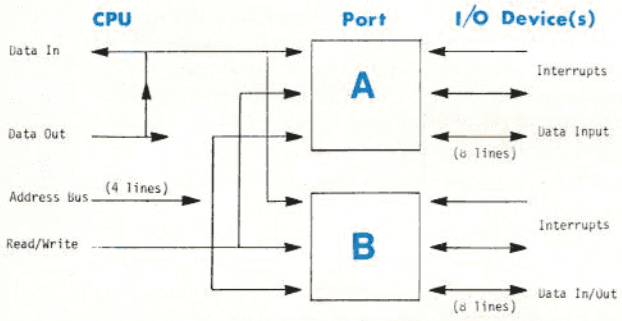
Interface—Parallel; 16 data lines, 4 control/interrupt lines; TTL compatible input and output, plus 8 of the 16 data lines can drive 1.5 volts at 1 milliamp for transistor compatibility.

Bit Configuration : Each data line can be software selected to act as an input or output.

Operation

Each port provides 4 controllable handshake lines. These lines are enabled/disabled under software control. Two interrupt lines are capable of acting as outputs for ready/busy handshake. There are 2 control/status registers which contain a status bit for each of the 2 interrupt lines to the CPU.

The following simplified block diagram demonstrates the address-register operation of one port on the 88-4PIO:



Assuming that the board is addressed at location 0, register selection for port 0 is:

Address	Register
0	Section A—Control
1	Section A—Data
2	Section B—Control
3	Section B—Data

Port 1 includes addresses 4, 5, 6, and 7;
Port 2 includes addresses 8, 9, 10, and 11;
Port 3 includes addresses 12, 13, 14, and 15.

Control/Status—Each 8-bit section:
a. Input : sets flag and/or interrupt line
b. Input: acts as above
Output: acts as "busy" signal back to the device.

Interrupt Structure—Each 8-bit section:
a. Interrupt request signal to CPU or 88-VI.
b. 2 interrupt status bits, 1 for each of above control lines.

Address Select—Each port requires 4 addresses.

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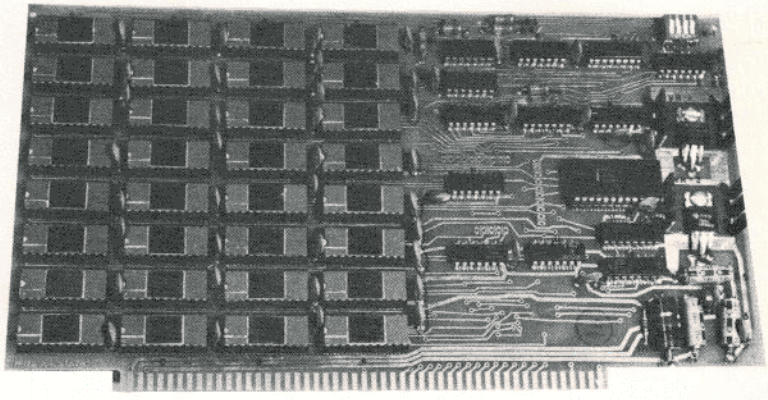
16K Static Memory Board (88-16MCS)



The 88-16MCS design is based upon a 4,096 x 1 bit static random access integrated circuit. These RAMs offer the advantage of low power consumption and extremely fast access time, and also eliminate the need for additional refresh logic common to dynamic memories.

Hardware

Dimensions: 10" x 5"

Altair Slots: One

Power: +5V (400 mA, Max.), +12V (200 mA, max.), −5V (100 mA).

Epoxy solder masks cover areas not to be soldered.

Sockets are provided for all RAM ICs.

A DIP Switch is used for board address selection.

Capabilities

Provides 16,384 8-bit words of Random Access Memory on one card.

Access Time: 215 ns.

Cycle Time: 390 ns.

Operation

There are no wait states (due to fast access time).

Since only four 88-16MCS boards are required for the maximum amount of memory directly addressable by the computer, only the upper two address bits are required to select a particular board. The upper four address bits select a single 4K block on a particular 16K card. The remaining twelve address bits are buffered and inverted to select one location within a block.

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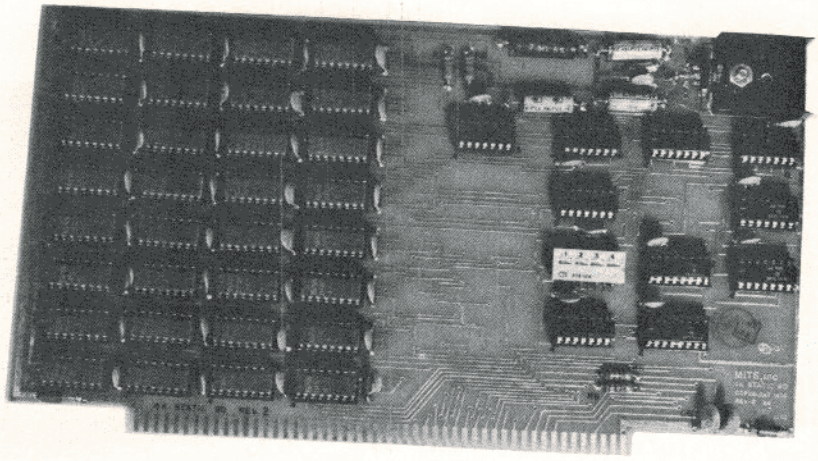
4K Static RAM Board (88-4MCS)



Technical Information

The 88-4MCS consists of four 1024 by 8 bit memory arrays, an Address Select Circuit, a Read Circuit, a Write Circuit, a Memory Protect Circuit, and a voltage regulator. The board operates by retaining data in its memory cells, each cell having a unique location, or address.

Hardware

A solder mask on the soldered side of the PC board helps prevent solder bridges during assembly.

A DIP Switch for address selection (no address jumpers).

Sockets for all logic and memory ICs.

Power: +8V unregulated at 1.2A, Max.

Access Time: 450 ns., worst case; 300 ns., typically.

Operation

To place information (in 8-bit binary form) in a memory cell, the CPU (Intel 8080 in the Altair 8800) performs a write function, usually caused by a Store Data instruction or a Move Data to Memory instruction. Data may also be stored in memory by using the Deposit Switch on the Altair Front Panel.

To read data from memory, the CPU must perform a Read Data operation. This is a normal function since the CPU must "fetch" data stored in memory in order to perform the necessary operations. The data in memory may be instructions for the CPU or data for the CPU to manipulate.

Data is stored in the Altair 8800 memory in groups of 8 bits, called words or bytes. The Altair can directly address up to 65,536 bytes of memory (sixteen 4K boards).

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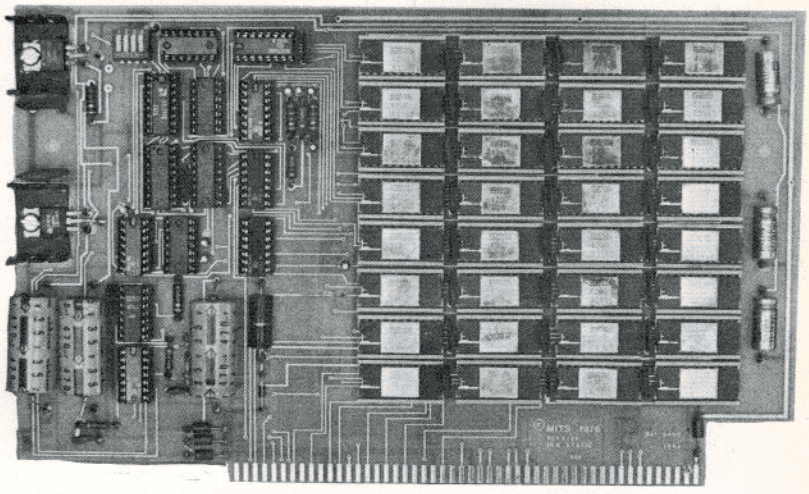
16K Static Memory Card (680b-BSM)



The 680b-BSM 16K memory card consists of four 4096 x 8 bit static memory arrays, an Address Select circuit, a Read/ Write circuit, and three voltage regulators.

Hardware

A DIP switch is used for address selection (no address jumpers).

Test points have been installed at important signal outputs for ease of checkout and troubleshooting.

Ferrite beads are used on all common supply lines for noise isolation.

Epoxy solder masks cover areas not to be soldered.

Sockets are provided for all ICs.

Power: + 16V (130 milliamps, maximum)
− 16V (110 milliamps, maximum)
+ 9V (150 milliamps, maximum)

Capabilities

Power consumption of 5 watts or 38 microwatts per bit. This allows operation of two 16K cards without adding a second power transformer.

RAM Access Time: 215 ns., max.

RAM Cycle Time : 400 ns., min.
Up to three 680b-BSM 16K memory cards may be used with the Altair 680b.

Operation

The 680b-BSM memory card operates by retaining data in its memory cells, each cell having a unique location, or address. To place information in a memory cell, the CPU (Motorola 6800) performs a write function, usually caused by a store instruction. Data may also be written into memory by halting the CPU (Halt switch), selecting the memory address (switches A0-A15), selecting the data to be deposited (switches D0-D7), and toggling the deposit switch.

To read data from memory, the CPU must perform a read data operation. This may be done several ways. First, during normal execution of a program, the CPU must fetch (read) instructions and data from memory. Also, the CPU may be instructed to transfer data from memory to some other location, thus requiring a read operation.

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Technical Information

Serial Interface Board (88-2SIO)

The 88-2SIO Board design is based upon an Asynchronous Communications Interface Adaptor (ACIA). The ACIA contains both the control register and the status register, so that most options are software selectable.

Hardware

Level Selection: Wire jumpers.

Baud Rate Generator: Crystal-controlled CMOS divider/low power multiplexer.

Device Connection: 12 conductor cable:
10-pin removable connector on board
25-pin connector on back panel

Altair slots: One

Power:
+5V at 520 milliamps
+15V at 70 milliamps
−15V at 70 milliamps

Capabilities

The 88-2SIO board has two serial input/output ports. Each port provides 5 control lines, allowing maximum utilization of sophisticated terminals.
The five control lines are:
Transmit Data
Receive Data
Data Carrier Detect
Clear to Send
Request to Send

All lines are user selectable for ± 12V levels (RS-232), TTL levels (0-5V), or 20 milliamp current loop (Teletype).

Each port is programmable for 9 or 10 bit transmission as follows:
7 data bits + parity bit (odd, even, or none) + 1 or 2 stop bits;
8 data bits + 1 or 2 stop bits;
8 data bits + 1 stop bit + parity bit (odd or even).

Full 8-bit Status Register provides:
Received Data Available
Transmitter Buffer Empty
Carrier Detect
Clear to Send
Framing Error
Received Data Overflow
Parity Error
Interrupt Request

The 8-bit status register allows for greater control and handshaking ability.

2SIO transmit and receive interrupts enable/disable is via software control.

Provides an on-board, crystal-controlled clock for any of 8 baud rates (with a single jumper):
110
150
300
1200
1800
2400
4800
9600

A programmable counter can provide other baud rates:
37.5
75
600

2SIO, with 2 ports, can interface 2 serial I/O devices, each running at a different baud rate and each using a different electrical interconnect. Thus, 2 ports can be operating entirely independently of each other (such as an RS-232 CRT terminal running at 9600 baud and a 20 milliamp Teletype running at 110 baud). 5 volt power consumption is typically 520 milliamps.

Interface levels: TTL, RS-232, TTY.

Bit Configuration: Software selectable for 7 or 8 bits, 1 or 2 stop bits, odd or even parity.

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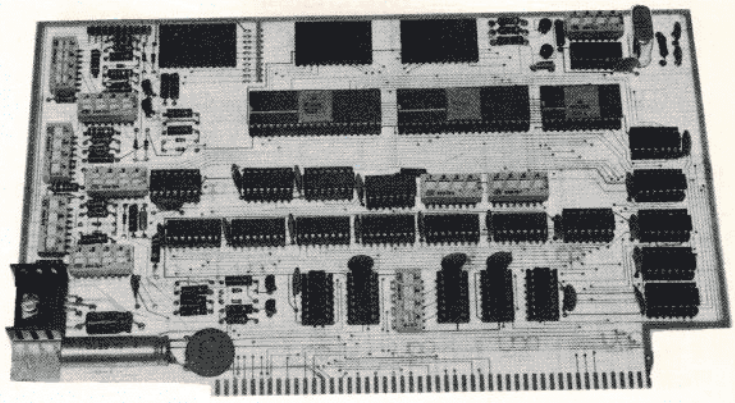
Altair 680b™ Universal I/O Card

Technical Information



Expand Your Altair 680b System!

The 680b Universal I/O card greatly enhances the input/output capabilities of the 680b computer by providing (optionally) one serial port and two parallel ports for communication with various terminal devices. Whether you use just one port, two ports or all three at once, each is configured individually and drives an I/O device independently of the other ports. Interface lines are switch selectable for RS-232, TTL and TTY operation.

Parallel Ports

Use the Universal I/O's parallel ports to interface the Altair 680b computer to such devices as a high speed reader and a high speed printer.

Serial Port

Use the Universal I/O's serial port to transmit and receive RS-232 and TTY data through such devices as a CRT, Teletype or Modem. An on-board, crystal-controlled 2.4576 MHz clock allows switch selection of any of the following baud rates: 50, 75, 110, 134.5, 150, 200, 300, 600, 1200, 1800, 2400, 9400 or 9600.

Port Design

The parallel port's design is based upon a Peripheral Interface Adaptor (PIA) which contains all of the Control and Data Registers, thus making most options, such as data direction and interrupt/control structure, software selectable.

The design of the serial port is based upon an Asynchronous Communications Interface Adapter (ACIA) which contains both Control and Status Registers.

Hardware

The serial port plugs into an on-board 10-pin connector with a 12 conductor round cable. Each parallel port plugs into an on-board 24-pin connector with a flat cable. The UI/O occupies one slot on the 680b Expander Card. Power requirements are as follows:

For TTY: + 16v and − 16v max., approx. 63 mA
min., approx. 45 mA

For RS-232: + 16v approx. 36 mA
− 16v 0 mA

Fully expanded: + 5v at approx. 350 mA

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Capabilities

Each PIA contains two sections. Sections A and B each contain two channels: a Control/Status Channel and a Data/Data Direction Channel. Address lines AØ and A1 enable the selection of each Section (A or B) and the Control/Status Channel or the Data Channel of that Section.

The Universal I/O with only one PIA parallel port can handle two inputs (such as a paper tape reader and keyboard) or two output devices (such as a paper tape punch and printer) or any combination of custom applications. A Universal I/O with two PIA parallel ports has 32 data lines (each group of eight is individually selectable). All data lines are fully TTL compatible. Eight of the 16 lines (per PIA parallel port) are capable of directly driving the base of a transistor switch (1.5v at 1 ma).

The ACIA contains both Control and Status Registers. The five control lines allow maximum utilization of sophisticated terminals. These control lines are: transmit data, receive data, data carrier detect, clear to send and request to send. The 8-bit Status Register allows for greater control and handshaking ability by indicating received data available, transmitter buffer empty, carrier detect, clear to send, framing error, received data overflow, parity error, and interrupt request.

All of the input/output lines to or from the ACIA are switch-selectable for RS-232, TTL levels or 20 milliamp current loop (TTY). An on-board, crystal-controlled clock allows user selection for any of 13 baud rates by positioning a dip switch. The Selectable Baud rates are:

50	200	1800
75	300	2400
110	600	4800
134.5	1200	9600
150		

The serial port is software programmable for nine or ten bit transmission as follows:

a. 7 data bits + parity bit (odd, even, or none) + 1 or 2 stop bits;
b. 8 data bits + 1 or 2 stop bits;
c. 8 data bits + 1 stop bit + parity bit (odd or even).

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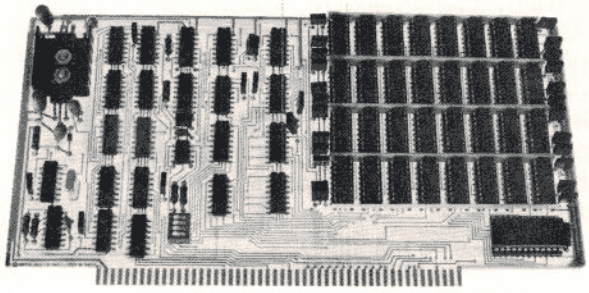
16K Dynamic Board (88-16MCD)

Designed using 32 dynamic random access memory ICs (4K x 1 bits each), the 16K Dynamic board provides 16,384 bytes of random access memory for the Altair™ 8800 series computers. The memory ICs have a maximum access time of 350 nanoseconds, yet require only 3 watts of power.



Special Features

The 88-16MCD provides continuous operation at maximum speed by eliminating the need for time-consuming wait states.

All logic timing is crystal-controlled for greater accuracy.

System Design

Occupying one slot in the motherboard, the 88-16MCD plugs directly into the computer. Address selection is done by an 8-pin dip switch. One jumper selects either 8800a, 8800b or 8800b Turnkey operation.

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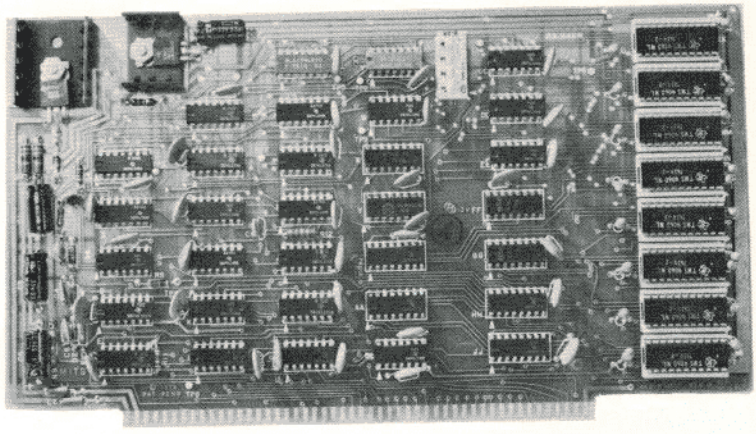
Synchronous 4K Memory Board (88-S4K)



The 88-S4K Board is totally synchronous—this means that the board relies solely on the CPU for timing signals (no single shots). The S4K provides 4,096 bytes of Random Access Memory. Each board contains memory protect circuitry, and address selection circuitry for any one of 16 starting address locations in increments of 4K.

Hardware

Dimensions: 10" x 5"

Altair Slots: One

Power (worst case):
+5V at 450 milliamps
+12V at 290 milliamps
+12V at 10 milliamps (unselected)

Operation

Runs at maximum speed (no wait states).

No hardwire jumpers.

A DIP switch is used for board select.

The entire 4,096 bytes of memory can be protected by switching to PROTECT.

Access Time: 200-300 ns.

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Technical Information

Altair™ 8800b Turnkey Model

The Altair 8800b Turnkey Model is designed for those who want the convenience, security and simplicity of operation provided by the front panel's key-locked power switch. The Turnkey Model (like the full front panel Altair 8800b) is a general-purpose byte-oriented computer containing 78 basic machine language instructions. The Turnkey will support up to 64K of directly addressable memory and the 100-pin bus structure allows expansion of up to 256 separate input/output devices.

System Design

The 8800b Turnkey Model is comprised of a special Turnkey Module board, a Central Processing Unit (CPU) board and a Power Supply board.

A serial input/output (SIO) interface, 1K of RAM, a sense switch input and provisions for 1K of PROM are included on the **Turnkey Module board.** The SIO allows RS-232, TTL or TTY interfacing. The Auto Start Circuit automatically branches to a predetermined address when power is applied or when the Reset switch is activated.

By means of the 8080A microprocessor circuit, the master timing circuit and 8 input and output data lines, the **CPU board** controls and processes all instruction data within the computer. Clock pulse widths, phasing and frequency are all crystal-controlled by the Intel 8224 clock generator IC which uses an external crystal.

The **Power Supply board** provides pre-regulated positive and negative 18 volt supplies to the computer bus. The 8-volt, 18 amp tapped secondary supply permits the addition of as many as 16 printed circuit boards, and the multiple tapped primary transformer allows 110v/50Hz or 220v/60Hz operation.

Options

8800b Turnkey options include:

1) the Disk Boot Loader which loads Disk BASIC;
2) the Multiboot Loader which loads programs from cassette or paper tape;
3) the Turnkey PROM Monitor, a 256-byte PROM chip, that offers these functions:
   a. M—memory contents examine and modify
   b. D—memory dump
   c. J—jump to an address

Specifications

Number of Boards	Up to 18
NMOS 8080A Microprocessor	
Data Word Size	8 bits
Instruction Word Size	Variable, 8-24 bits
Clock Frequency	2MHz
Add Time, Register to Register	2 μs. per data word
Number of Instructions	78
Input/Output Control	
I/O Word Size	8 bits
Number of I/O Channels	256
Direct Memory Access	Optional
Interrupt Capability	Standard
Vectored Interrupt (8 priority levels)	Optional
Software (sold separately)	
BASIC	High-level language
Package II	Assembly Language Development System
Disk Operating System	

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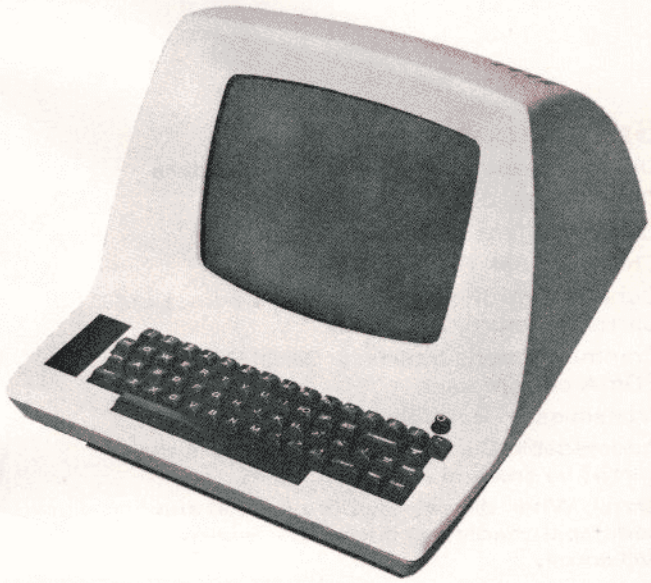
LSI ADM-3 CRT Terminal



Specifications

DISPLAY
12" (diagonally measured) rectangular CRT screen with P4 phosphor and bonded etched non-glare surface.

DISPLAY FORMAT
Standard 1920 characters, displayed in 24 lines of 80 characters per line.

CHARACTER SET
Standard: 64 ASCII characters, displayed as upper case, plus punctuation and control.

CHARACTER GENERATION
5 x 7 dot matrix.

CURSOR
Underline, homes to lower left of screen.

DATA ENTRY
New data enters on bottom line of screen; line feed causes upward scrolling of entire display with top-of-page overflow. Automatic new line switch selectable; end-of-line audible tone.

REFRESH RATE
60 Hz standard.

NUMBER OF KEYS
59 (plus TTY control keys).

COMPUTER INTERFACES
EIA standard RS232C and 20mA current-loop (switch selectable).

AUXILIARY INTERFACES
Extension RS232C port for interfacing serial asynchronous ASCII hard copy printer, magnetic tape recorder, or additional data terminals.

COMMUNICATION RATES
75, 110, 150, 300, 600, 1200, 1800, 2400, 4800, 9600, 19,200 baud (switch selectable).

TRANSMIT/RECEIVE MODES
Full and half-duplex (switch selectable).

WORD STRUCTURE
Total word length: 9, 10, or 11 bits. Data: 7 bits. Start: 1 bit. Stop: 1 or 2 bits. Parity: 1 bit (odd, even, high, low or none; switch selectable).

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Altair B-100 CRT Terminal

Specifications

Display Format: 24 lines x 80 characters

Display Size: 6.5" high x 8.4" wide

Character Type: 5 x 7 dot matrix

Character Set: 64 ASCII displayable

Cursor Control: Left, Right, Up, Down, Home, Carriage Return, Line Feed

Communications Interface: Serial RS232C, 20mA current loop

Transmission Rate: Switch Selectable

Addressable Cursor: Directly positions the cursor by line and column

Scroll: When display memory is filled and additional characters added, the display will scroll

Keyboard: 82 key, auto repeat, 2-key rollover, alpha lock and 11-key numeric pap

Input Voltage: 100 VAC±10% 50/60 Hz
115 VAC±10% 50/60 Hz
230 VAC±10% 50/60 Hz

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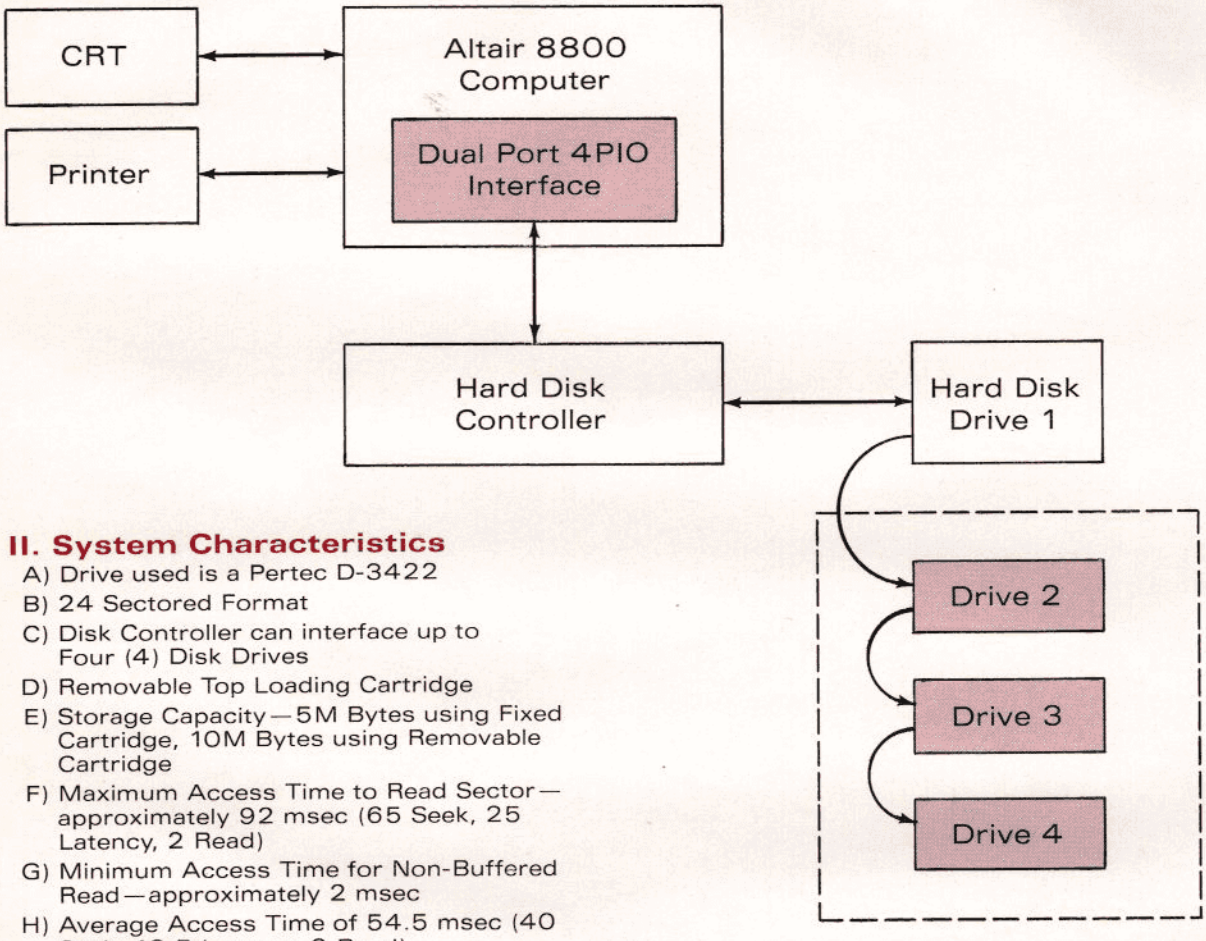
Altair™ Hard Disk System

I. Block Diagram



II. System Characteristics

A) Drive used is a Pertec D-3422
B) 24 Sectored Format
C) Disk Controller can interface up to Four (4) Disk Drives
D) Removable Top Loading Cartridge
E) Storage Capacity—5M Bytes using Fixed Cartridge, 10M Bytes using Removable Cartridge
F) Maximum Access Time to Read Sector—approximately 92 msec (65 Seek, 25 Latency, 2 Read)
G) Minimum Access Time for Non-Buffered Read—approximately 2 msec
H) Average Access Time of 54.5 msec (40 Seek, 12.5 Latency, 2 Read)
I) Maximum Single Track Sector Time of 10 msec
J) Seeks may be overlapped with Buffer Transfers and Seeks of other drives
K) Data Rate from Controller to Altair 8800A or B is asynchronous with Handshaking and may vary from 0 to 2.5M bytes/sec
L) 1K of Buffer Storage is provided in the Controller

III. System Options

A) 4K of Buffer Storage which will allow DMA and Data Transfers
B) Multiple Processor Card for more than one Altair 8800 Computer per Disk Drive
C) Nine Track Tape Interface Board for standard IBM Tapedrives
D) Simulated ROM for Program Development

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Altair™ Minidisk System (88-MDS, 680b-MDS)

The Altair Minidisk System, used for mass storage of data with Altair microcomputers, provides 71,680 formatted bytes of storage capacity per minidiskette. The Minidisk System has a data transfer rate of 125,000 bits per second with an access time of less than three seconds. Included in the Minidisk System are two controller boards for the 88-MDS (one for the 680b-MDS), an Interconnect Cable, one Minidisk Drive and Altair Minidisk Basic software. Additional Minidisk Drives may be purchased separately.

System Design

The Minidisk System's Disk Drive consists of the Drive itself, Interconnect cable and one blank minidiskette. Inside the Minidisk Drive cabinet are the Disk Drive, power supply, line buffers and addressing circuitry. The Drive Address is switch selectable and the selected address is displayed on the front panel for easy identification. The Disk Drive also offers WRITE PROTECT as a standard feature.

The Minidisk Controller, consisting of an Interconnect Cable and two Controller Boards that plug into the Altair computer bus, provides interaction between the computer and the Minidisk Drive. All control, status and data input/output for the Minidisk System are handled through three I/O ports dedicated to the Minidisk Controller. To insure maximum life of the Drive motor, a timer in the Controller turns the system off if the Minidisk remains unaccessed for five seconds.

Minidisk BASIC

The software most commonly used with the Minidisk System is Altair Minidisk BASIC, which resides in the lower 20K of memory and provides the disk utilization routines. Altair Minidisk BASIC includes the standard features of BASIC, plus many extra functions that significantly increase programming power. The Software Driver for the Minidisk READ/WRITE function simplifies Controller design by implementing the hard-sectoring technique.

Options and Accessories

1. Software— Altair Minidisk BASIC, available on a WRITE Protected Minidiskette, is virtually identical in operation and features to Altair Disk BASIC. The documentation includes Bootstrap Listings and READ/WRITE Driver Codes. Specify cassette tape or paper tape for the Bootstrap Loader, if required.
2. MDBL PROM— Minidisk Bootstrap Loader on a Programmable Read Only Memory IC is designed for use with the 88-PMC PROM Memory Card or 680b PROM socket at the highest 256 byte block address.
3. DRWT PROM— Designed for use with the 88-PMC at the third highest 256 byte block address, the Minidisk READ/WRITE Test PROM contains fundamental diagnostic tests for checking hardware operation.

4. Miscellaneous
   a) Minidiskette—blank, hard sectored (MITS Part Number 102501)
   b) Drive Service Manual (MITS Part Number 101597)
   c) Alignment Minidiskette to be used with Service Manual (MITS Part Number 102502)
   d) Altair Minidisk System Operators/Theory Manual (MITS Part Number 101571). This manual is included with the purchase of the Altair Minidisk System, or it may be purchased separately.

Altair Minidisk System Specifications

1. Minidisk Controller
   Number of slots required in 8800 bus . . . . . 2 680b bus 1
   Number of ICs:
      a) TTL Logic . . 57
      b) CMOS Logic 1
      c) Voltage Regulators . . . 2
   Interconnect Wiring . . . . . Insulation displacement cables and connectors
   I/O Addresses (Octal) 010, 011, 012
   Data Transfer Rate . . . . . 1 byte every 64 μs.
   Data Format . . . . Hard Sectored (16 Sectors)
   Interrupt System . . . . . Interrupt at beginning of sector (Optional—not used for Minidisk BASIC)
   Power Requirements . . 1.5A @ 8v
2. Minidisk Drive
   A. Performance:
      1) Data Capacity—Hard Sectored Format
         a. Per Minidiskette . . . . . 71,680 Data Bytes
         b. Per Track . . . . . 2,048 Data Bytes
         c. Per Sector . . . . 128 Data Bytes
      2) Data Transfer Rate . . . . . 125,000 Bits per second
      3) Access Time
         a. Disk Enable to READ or WRITE (Function of motor start-up time) . . . . . 1 sec. (min)
         b. Track to Track . 50 ms.
         c. Average Access Time (including motor start-up time) . . . . 1.85 sec.
         d. Worst Case Access Time . . . . 2.9 sec.
         e. Worst Case Latency . . . . . 200 ms.
   B. Functional Specifications:
      1) Rotational Speed . . . . . 300 rpm (200 ms/Rev.)
      2) Track Density . . . . . 48 Tracks per inch
      3) Number of Tracks 35
      4) Number of Sectors 16
      5) Time Per Sector . . . . . 12.5 ms.
   C. Reliability Specifications:
      1) Error Rates
         a. Soft (recoverable) . . . . . 1 per 10^8 bits READ
         b. Hard (unrecoverable) 1 per 10^{11} bits READ
      2) MTBF 8000 Hrs. (25% motor run time)
      3) Service Life . . . . 5 years
      4) Media Life . . . . . 3.0 x 10^6 passes/track
   D. Power Requirements:
      Minidisk Drive Cabinet
      1) Standby: 25 watts, typical . . . . 110v or 220v, 50Hz or 60Hz
      2) Operating: 35 watts, typical
   E. Physical Specifications:
      1) Dimensions . . . 5" high x 11" wide x 11" deep
      2) Weight . . . . . 10 lbs.

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Industrial and Scientific Systems

for Altair™ Microcomputers

Equipped with the powerful dual features of a Process Control Interface Board and AD/DA Converter Board, MITS Altair 8800b and 680b microcomputers provide a new aspect of efficient, precision process control for scientific, industrial and agricultural purposes.

Process Control Interface As Illustrated by MITS Altair 8800b

Unique to the Altair 8800b and 680b microcomputers is a powerful and flexible, Process Control Interface Board which allows the microcomputer to communicate with the real world of electromechanical devices, such as:

- —electrical valves
- —air pumps
- —heaters
- —fans
- —titrators
- —thermostats
- —motors
- —contactors
- —alarms
- —solenoids, etc.

The output section of the board consists of eight relays, each capable of switching 120 volts AC at 1 amp. The input section consists of eight opto-isolators which the user can configure to accept a wide range of voltages. More power can be controlled by the use of additional relays or contactors external to the chassis. In addition 88-PCI contains four more opto-isolated signal lines configured as two pairs of handshake lines. All of the lines are completely isolated and balanced for use in environments with high levels of electrical noise.

The versatile flexibility of the PCI suggests numerous uses. This Scientific Exhibit displays one such hypothetical use. Via the PCI Board computer control can be exerted over a number of output devices such as valves, titrators, heaters simultaneously. As shown here, fluid is moved thru a network of tubes and valves, with various computer controlled manipulations taking place in the process. As the computer receives and transmits signals thru the PCI Board, the liquid is heated, cooled or titrated as it is pumped thru the tubes. Applied to practical problems such as computerized process control, this type of monitoring is highly desirable in situations that demand accurate and sensitive manipulation of chemicals or reagents.

While this exhibit suggests many possible scientific and industrial uses, the versatility of the PCI Board and Altair microcomputers may also be utilized in other ways as suggested in the table below.

Input from:	Output Control over:
Household	
thermostats	heater/cooler
alarm sensors	alarms, intruder alert devices, coffee maker, lights, etc.
timers	
Ham Radio	
signal strength comparator	antenna rotation
end of tape sensor	recording equipment power switch for transmitters
Agriculture	
humidistat	irrigation equipment
flow meters	pumps
pressure sensor	solenoid valves
automatic material weighing	hopper control
Chemical Process Control	
ph meters	agitator motors
viscosity testers	solenoid valves
Industrial Process Control	
strain gauges	tool position motor
limit switches	solenoid valves
pressure transducer	solenoid-operated
position sensor	stampers

AD/DA Conversion As Illustrated by Altair 680b

In addition to the flexible capabilities afforded by the PCI Board, both the Altair 8800b and the Altair 680b computers may be equipped with their own AD/DA converter boards too.

The 680b-AD/DA and 88-AD/DA are highly versatile plug-in boards that can measure analog voltages and generate them to eight bit accuracy.*

Adaptable to measure most analog quantities, the Altair AD/DA converters can, for example, be interfaced with temperature and level transducers to measure temperatures and fluid levels.

*Also available for the Altair 8800b: an A/D converter (88-ADC) for 12-bit A to D and multiplexer (88-MUX) for added input channels in multiples of 24.

While there are many potential uses for the AD/DA converter, the following table defines a number of possible ways in which the AD/DA converter can be effectively utilized.

Input

pressure transducers
temperature transducers
linear position transducers
light sensors
modems

Output

meters
magnetic recorders
oscilloscopes
plotters

In this demonstration the 680-AD/DA Converter is utilized for DC parameter testing.

Several parameters are manipulated under computer control, with variations measured against other parameters. Possible parameters under computer control are supplied voltage and bias voltage. Each is controlled via a programmable power supply. The bias voltage can also be directly controlled. As these parameters are changed, the resulting variations in other parameters are acquired and measured by the Multiplexer and Analog-to-Digital Converter. The computer stores these measurements in memory for later printout or graph plotting.

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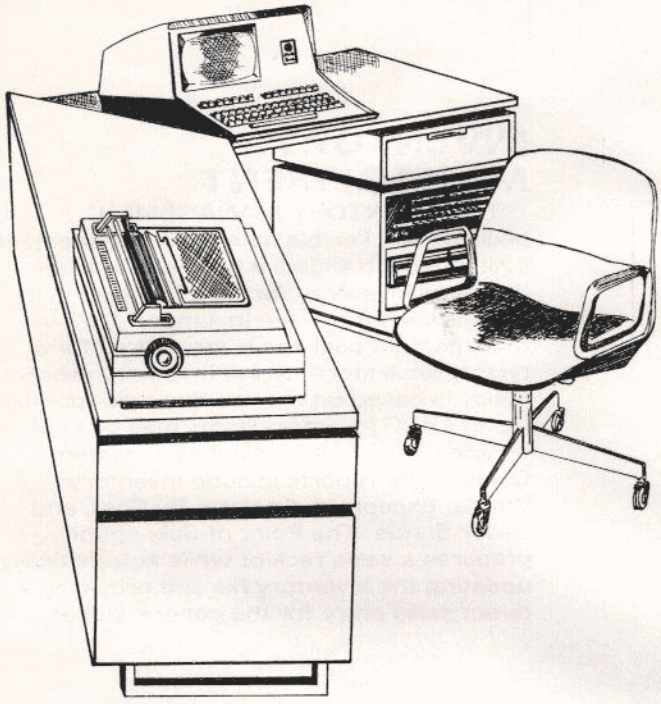
ALTAIR™ BUSINESS SYSTEM



The Altair Business System is a complete set of modular software packages for Accounting, Word Processing and Inventory Management. Office managers, professional firms and independent retailers can easily incorporate a microcomputer system into their office operations using the Altair Business System. All packages are well documented and contain a complete set of prompts and other helping messages that allow even an inexperienced operator to make full use of the system with minimum instructions.

The packages will operate individually or as an integrated system to accommodate the software needs of almost any office situation. Customization to conform with exact end-user requirements is available, if needed.

ACCOUNTING SYSTEM

The ACCOUNTING SYSTEM is comprised of four modules—general ledger, receivables, payables and payroll. The GENERAL LEDGER package is the heart of a financial reporting system for a small business. It allows a firm to keep a detailed monthly general ledger of all its transactions and generate a monthly balance sheet and income statement to provide timely information on the financial status of the company. The PAYROLL package allows a company to prepare its periodic payroll for hourly, salaried, and commissioned employees while accumulating the necessary information for tax reporting. It generates the monthly, quarterly, and annual returns to be filed with local, state and federal governments. It also prepares employee W-2's and maintains an up-to-date information reference for each employee. The payroll package includes tables for federal withholding and FICA as well as withholding for all 50 states and up to 20 cities from precomputed or user generated tables. The package will automatically produce payroll checks at the user's option. The RECEIVABLES package is a complete invoicing and monthly statement generating system that keeps track of the current and aged accounts receivable. The receivables package maintains a customer file with addresses and credit information as well as account status. The package allows the current status of any active customer account to be displayed. The PAYABLES package keeps track of current and aged accounts payable and incorporates a check writing feature. The payables package maintains a complete vendor file with information on purchase orders and discount terms as well as active account status. Each of the three subsidiary systems—receivables, payables and payroll—provides input directly to the general ledger package.

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WORD PROCESSING

The WORD PROCESSING package is a flexible text editor system that allows large volume text material, such as contracts or other lengthy documents, to be stored, easily edited and printed. In addition, documents can call for inserts from other files or from the terminal, thereby making repetitive letters and complicated documents easy to produce. The text material is stored in a file without regard to pages or margins. In this way additional text material may be inserted conveniently while page headings, numbering, margins, spacing and other formats may be specified at the time of printing. A single document may contain up to 120,000 characters (about 45 single spaced pages) and documents may be linked for longer text. The text editor allows simple in-line corrections and extremely powerful global editing to be easily accomplished. The document files allow the user to "see" the embedded editing commands and line numbers thereby making corrections simpler. Documents are printed through a text formatter which arranges the text as specified by the user. The flexibility of the word processing package allows it to be used as a large document editor, a repetitive letter producer, a mailing list system, or a variety of other functions.

INVENTORY MANAGEMENT

The INVENTORY MANAGEMENT package is a flexible data base management system which allows a business to keep complete inventory records "on line." In its off-the-shelf form, the Inventory Management package is structured for a typical retail store whose inventory reorder policy is based on minimum reorder points. Up to 1800 inventory items may be kept on line with a floppy disk based system. Some major reports include Inventory Status, Exception, Analysis By Cost, and Order Status. The Point of Sale option prepares a sales receipt while automatically updating the inventory file and providing a direct sales entry for the general ledger.

The component packages of the Altair Business System are available under a onetime fee licensing arrangement. The license fee includes up to three years of software maintenance.

The system hardware may be individually configured for each installation and typically includes a CRT terminal, a typewriter-quality precision printer and two flexible disk units.

For more information on price and delivery or a personal demonstration, visit your local Altair Computer Center. Or contact the Altair Software Distribution Company directly.

Altair Software Distribution Company
21111 Erwin Street
Woodland Hills, CA 91367

Timesharing Anyone?

Altair™ Timesharing BASIC for microcomputers is a unique and dynamic package with powerful capabilities that challenge a field dominated by larger, more costly computers.

Altair Timesharing BASIC and Altair Timesharing Disk BASIC are magnified versions of the powerful and efficient Altair Extended BASIC. Each version includes increased capabilities to accommodate as many as eight different programs running simultaneously and independently within the system.

Instantaneous Keyboard Response

Input and output are interrupt driven and fully buffered to provide virtually instantaneous keyboard response even when the system supports the maximum number of users. The output buffers empty more quickly than they are filled, thus it will appear the CPU is dedicated to each individual terminal.

High Speed Systematic Job Rotation

Operating within a highly efficient round-robin system, the CPU suspends operation of a job currently being executed, stores the address of the next instruction and moves to the next job. Each job is served a hundred millisecond slice of its program.

Partitioned Memory Locations

Established as a Fixed Partition System, each job is confined to a unique area of memory. Users may then access only their individual jobs, not the system or other jobs. This protects jobs from alteration or destruction. The size of the memory area must be established with a minimum of 1024 bytes during initialization. Memory areas may be of different sizes, depending on need. Each program area contains:

- —BASIC program text
- —Variable and string space
- —Work space
- —Approximately 300 bytes of the timesharing system

I/O Device Support

A variety of input devices can be linked to Altair Timesharing BASIC and Altair Timesharing Disk BASIC. This flexibility permits the use of CRT's for high speed data manipulations and Teletypes™ and hard copy terminals when hard copy output is required.

Altair Timesharing Disk BASIC facilitates the listing of programs on a line printer. Programs await listing in a queue to prevent mixing different jobs. Users receive a message if the line printer is unavailable.

Versatile Program Storage and Loading Capabilities

Altair Timesharing Disk BASIC provides rapid loading and program retrieval since all programs reside on a floppy disk. Read and modify passwords may be specified for program fixes to limit access by other users.

Altair Timesharing BASIC can be loaded from paper tape or audio cassette. Programs may be stored for later use on paper tape.

Other Features

—Control of a specific job may be transferred from one terminal to another with a single command.

—Various control characters allow suspension and resumption of each job without loss of data.

—Extensive diagnostics for program debugging.

—Automatic line numbering.

—Both versions of Altair Timesharing BASIC furnish line-oriented text editor with line and character manipulation capabilities.

Educational Applications

A single Altair 8800b loaded with either version of Timesharing BASIC can be utilized by several students performing independent operations. One student practices program development, another makes use of Timesharing BASIC's extensive diagnostics to debug a program while several other students calculate complicated equations. All program activity occurs simultaneously with no discernable response delay.

Computer oriented education need not be limited to programming classes. An Altair Timesharing System may be a valuable visual tool to assist in the instruction of science, math and engineering classes and as an introduction to the various aspects of computer technology to solve real world problems.

An Altair Timesharing System stimulates interest and provides a vehicle for discussion for the younger student. Children find it particularly fascinating to use a computer to solve arithmetic problems.

Scientific and Engineering Uses

Engineering firms and scientific labs currently using programmable calculators will benefit from the multi-purpose capabilities of a microcomputer for complex math routines and statistical manipulation. An Altair 8800b operating with Timesharing BASIC provides a number of individuals with access to graphic or tabular output in addition to the following mathematical functions; SIN, COS, TAN, LOG, SQR, SGN, ABS, INT and RND.

Required Hardware

The following hardware is needed to support both versions of Altair Timesharing BASIC.

—Altair 8800 series mainframe and CPU

—A minimum of 32K RAM

—Vector interrupt/Real time clock board

—Up to 4 2SIO boards to interface terminals (no other types of I/O boards can be supported.)

—Line printer (optional for Altair Timesharing Disk BASIC.)

The following products are optional for Altair Timesharing BASIC loading and required for Altair Timesharing Disk BASIC.

—An Altair floppy disk drive and controller.

—88 PROM board.

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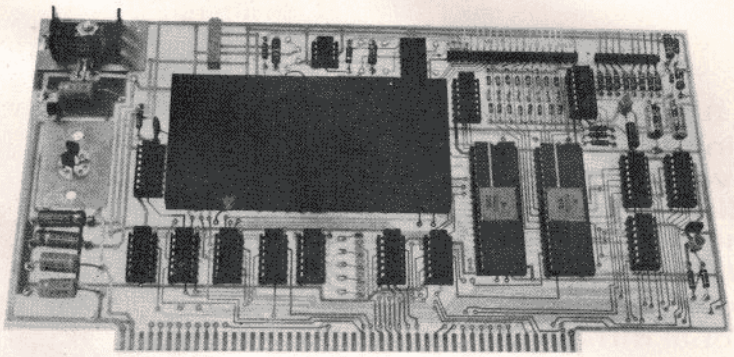
88-Analog-to-Digital Converter



The 88-Analog-to-Digital Converter is a high accuracy conversion card that translates real-world analog signals into 12-bit binary signals and inputs them into the Altair computer. The 88-ADC can be used for many scientific and industrial applications such as monitoring pressure, temperature or linear position transducers, light or frequency sensors and instrumentation amplifiers. It can also be used for personal applications such as remote control devices, video games and computer graphics.

Circuitry Design

The heart of the 88-ADC is the analog-to-digital converter module which contains virtually all of the circuitry needed to represent analog voltage as a 12-bit binary value. In addition, the 88-ADC includes:

1. A buffer amplifier which can be set for a gain of up to 1,000 (with a true differential input instrumentation amplifier option, AD521, to track signal increments smaller than 50 mv)*
2. An 8-channel multiplexer (used to select one of eight input signals)**

The remaining circuitry is used for addressing and timing.

Special Features

The 88-ADC is capable of either unipolar or bipolar operation at a voltage range of:

Unipolar: 0 to + 5v
0 to + 10v } 8-channel multiplexer or 88-MUX system†

Bipolar: − 5 to + 5v
− 10 to + 10v (Direct input to buffer amplifier only; no MUX)

The 88-ADC also provides vector interrupt capability so that the 88-ADC board can be read at fixed "real" time intervals asynchronous to program execution.

Capabilities

The 88-ADC operates with a maximum conversion time of 65 microseconds†† at an accuracy rate of:

Quantizing Error: ± 1/2 LSB
Nonlinearity: ± 1/2 LSB
Offset: Externally adjustable to zero

The 88-ADC has an input impedance of 1 megohm (100 megohms with 88-ADC Option #1) and operates with the following stability coefficients:

Offset vs. Temp: 20 ppm/°C (max)
Gain vs. Temp: 80 ppm/°C (max)
Nonlinearity vs. Temp: 20 ppm/°C (max)
Gain vs. Supply Voltage: ± 30 ppm/%Vs (max)

Power Supply Requirements and Temperature Ranges

The 88-ADC requires voltages of:

+ 5v at 500 mA
+ 15v at 25 mA
− 15v at 30 mA

The operating temperatures for the board range from 0 to 70°C and storage temperatures range from − 40 to 100°C.

*Specify 88-ADC option #1 (AD521) when ordering.

**An optional 24-channel multiplexer (88-MUX, see other side) can be used to replace the on-board 8-channel multiplexer.

†By adding two resistors per channel on an 88-MUX card, larger voltages can be scaled down according to the user's application.

††Module time only; processing time is not included. The sample program provided with the card can read and store data at a maximum rate of 65 microseconds/12-bit sample (approximately 50 microseconds/8-bit sample).

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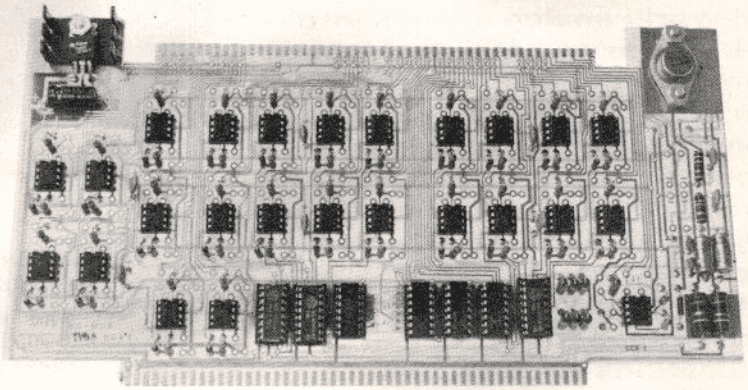
88-Multiplexer

The 88-MUX can greatly expand the input capacity of the 88-A/D Converter board for those applications requiring a large number of analog inputs. The 88-MUX provides 24 single-ended analog input channels with optional differential inputs for use in low noise/small signal applications.* With these optional inputs or by simple component modifications, the 88-MUX can be set up to handle a differential input on each channel.

The 88-MUX is utilized in conjunction with the Analog-to-Digital Converter board. Both boards occupy one slot on the Altair 8800 motherboard and are connected by a 12-pair shielded cable to a 25-pin DB connector on the computer's back panel.



Capabilities

Settling time of the output to .01% of the final value occurs within 15 microseconds.

Input impedance is approximately 1 megohm, while offset is 5 mv (max).

Power Requirements

+ 5v at 40 mA
+ 15v at 180 mA
− 15v at 180 mA

Special Features

By selecting the proper feedback resistors, gain can be set from 1 to 1,000.

A maximum of four 88-MUX cards may be added to a system, providing a total of 96 channels.**

As an added bonus, each channel's filtering and scale factoring can be set independently. This feature allows a variety of I/O devices to operate simultaneously, thus providing great flexibility of system design.†

Options

*Specify 88-MUX Option #1 when ordering —Useful for tracking signal increments less than 50 mv. Consists of differential inputs and a special cable.

**Specify 88-MUX Option #2 when ordering —Required for all systems using more than one 88-MUX card. Consists of a special cable harness.

†Not available with 88-MUX Option #1.

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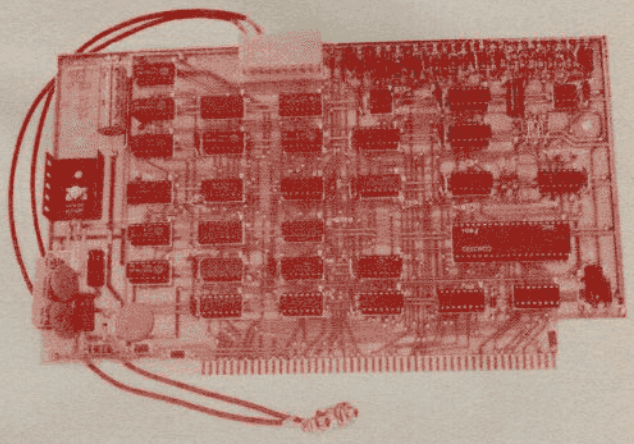
Technical Information

altair™ 680b-KCACR

Mass data storage is now available for the Altair 680b. By utilizing the 680b-KCACR, the 680b bus can be interfaced with an audio cassette recorder allowing inexpensive saving and loading of programs. The KCACR design is based on the Kansas City Standard, making data transfer highly reliable under widely varying conditions without circuitry adjustments.



Features

In addition to eliminating circuitry alignment for precise operation, the 680b-KCACR offers a host of other design features. These include: motor control circuitry for starting and stopping tape motion, low power consuming CMOS logic and a digital demodulator for logic level discrimination. Sockets are provided for all ICs. Test points are provided at key circuit areas.

Kansas City Standard

The Kansas City Standard is a method of audio cassette data interfacing which employs frequency shift modulation. Data transfer is at a rate of 300 baud with a + 20, – 20% playback speed tolerance. The self clocking action of the audio frequencies used for modulation allows for variations in tape speed and head alignment. Because of these flexible parameters, hardware cost and complexity is minimized. The recorded character is comprised of a space as a start bit, eight data bits and two or more marks as stop bits. A space (logical zero) bit consists of four cycles at a frequency of 1200 Hz. Mark (logical one) bits consist of eight cycles at a frequency of 2400 Hz.

Specifications

Demodulator Playback Speed Tolerance: + 20, – 20% from recorded speed

Demodulator Input Levels (Playback): 300MV peak to peak minimum (100MV RMS)
10V peak to peak maximum (3.5V RMS)

Demodulator Input Impedance: 10K ohms

Modulator Output Level: 30 MV P-P (suitable for microphone input)

Modulator Output Impedance: 1K ohms.

Error Rate: Relative to quality of recorder and tape, typically less than 1 error in 10^6 bits READ with low noise audio tape.

Power Requirements: + 8 Volts unregulated —220 MA typical
– 16 Volts unregulated — 50MA typical
(less than 3 watts total power)

Requires 1 slot in 680 bus.

Audio Cable Connectors: Mini phone jacks, 3.5MM dia mounted on back panel.

680b Bus Address: FØ1Ø — Status, control
FØ11 — Read data, write data

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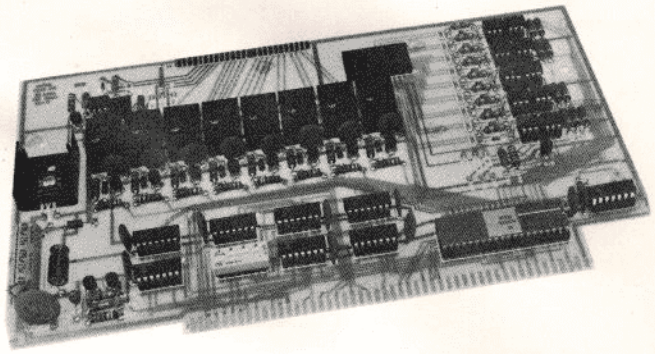
Altair™ 680b-Process Control Interface (680b-PCI)

Introduce your Altair 680b to the diverse world of electrical, mechanical and sensory devices with the addition of the 680b-Process Control Interface. By relaying various types of sensory information to the computer, the 680b-PCI permits a wide range of control applications.



Applications

Whether your applications revolve around industrial, scientific, business, communication or household uses, the potential of the 680b-PCI is virtually unlimited.

Some possible industrial applications include a product sorting and grading system. The 680b-PCI can be interfaced with various kinds of sensors for measuring size, weight, optical density and other properties while controlling a sorting mechanism.

In the field of scientific research, a 680b-PCI may be used to control environmental test conditions and gather test responses.

Suggested household uses include: control of thermostat settings, manual switches, lighting, lawn sprinkling and other home operations.

Features

The board consists of an eight relay output section, with each relay capable of switching 120VAC at 1 amp. Eight opto-isolators which can be configured by the user to accept a wide range of voltages make up the input section. Four more opto-isolated signal lines are arranged as two pairs of handshake lines, with the input section and output section each having one handshake pair. These lines are for control of and communication with external devices. All of the lines are completely isolated and balanced for use in environments with high levels of electrical noise.

Operation

When the board is set up and initialized, relay control is accomplished by outputting an eight bit word to the relay control channel. Logic "1" lines will energize their respective relays, and those set to "0" will de-energize. An input from the opto-isolator input channel reads the data from the opto-isolated input lines. The interrupt structure and use of the handshake lines are under software control.

Specifications

+ 9V unreg. @ 100ma when all relays off
+ 9V unreg. @ 400ma when all relays energized

*Opto-Isolators
Isolation: Resistance input to output: 200G ohms
Voltage: 1500V min.

Input active current: 10-100ma

Propagation delay: Varies with diode current from input to data (D) line

Diode and Transistor: Turn on: 60 μsec., typical
Turn off: 10 μsec., typical

*Relay Outputs
Isolation: Contact to contact—750VAC at 250M ohms
Contact to coil frame: 2000 VAC

Propagation delay: Pull in: 3.5 msec.
Release: 4 msec.
Bounce: 1.2 msec.

*Handshake Lines
Input: Same as Opto-Isolators
Output: Off leakage current @ 25°C: 10^{9} amps
On current: approximately 30ma

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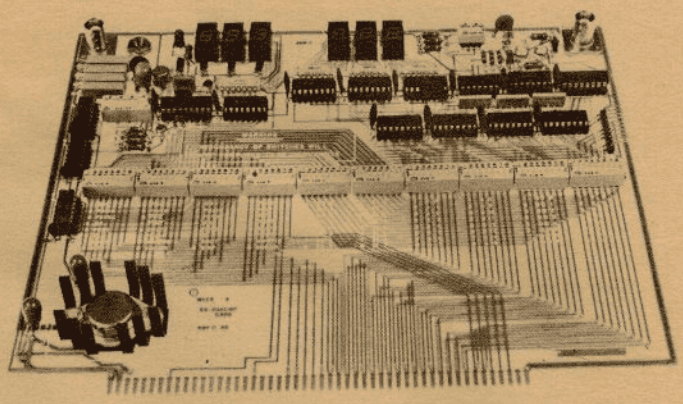
Expand Your Troubleshooting Capabilities!

Technical Information

The Altair™ 88-DC Diagnostic Card and 88-SE Switchable Extender Card provide a precise, effective method of trouble-shooting the Altair 8800 computer. The 88-SE is a stand-alone device, but for a more powerful system, it may be utilized with the 88-DC. Both cards are sold separately.



Altair 88-DC Diagnostic Card

The Altair 88-DC Diagnostic Card provides an efficient, comprehensive means of trouble-shooting that has not been available on the computer market until now. Used in conjunction with an oscilloscope, the 88-DC allows suspected problem signals to be viewed in relation to other waveforms for correct timing relationships.

Special Features

An **Eight-Bit-to-Octal Decoder/Display** allows the user to examine the program on either the input or output data lines.

A **Digital Voltmeter,** switch-selectable between bus (+ 8v, + 18v, − 18v) and external (± 9.99v full scale range) voltages is supplied to monitor bus and card regulator voltages.

An **Output Synchronization Jack** is provided for oscilloscope display referencing of data and control signals. Sync is selectable from the Data Out and Data In lines and 16 control lines to provide a stable oscilloscope display.

System Design

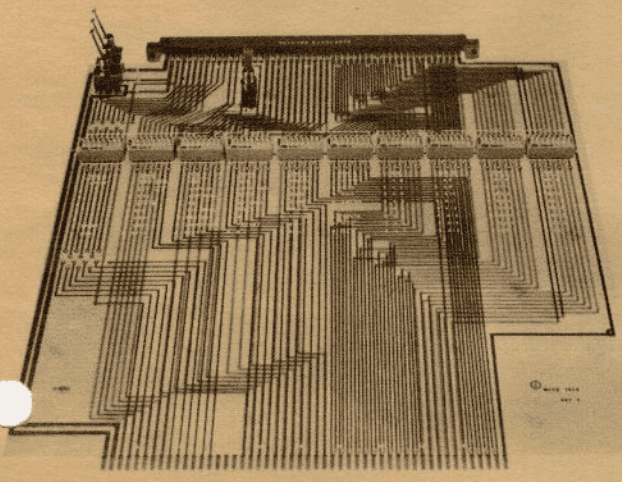
Any combination of data, address and control lines can be selected (except where redundancy of dip switches causes the computer to become inoperative) to display up to eight signals on a single channel of an oscilloscope.

Troubleshooting of individual boards with critical timing relationships is possible with a 10-pin right angle connector acting as an external input. Assembly of a special cable (user-supplied) is required to meet individual needs.

Approximately 3 inches taller than most printed circuit cards, the 88-DC plugs directly into the computer's edge connectors and allows easy access to the dip switches.

BNC connectors are provided on the card for oscilloscope hook-up.

Power consumption is 8 watts (worst case), and the card draws less than 1 amp of current.



Altair 88-SE Switchable Extender Card

The Altair 88-SE Switchable Extender Card simplifies the problem of locating and testing trouble areas by isolating the suspected problem lines and switching them out of the circuit. Ten 8-position dip switches make the board easy to use, and the 80 different switch positions allow maximum isolation capability.

System Design

Slightly taller than most printed circuit cards, the 88-SE plugs directly into the computer's edge connectors and allows easy access to the switches.

Six switch sections are uncommitted and available for the operator to use as desired. The card contains vector interrupt capabilities that are activated by the installation of jumpers to the uncommitted switches.

The +8 and ±18 bus voltages can be switched off to allow removal or insertion of a card without stopping the computer.

Memory contents may be checked by switching the PRDY line LOW which forces the CPU into a wait state.

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Technical Information

Altair T.M. 8800b Turnkey Model

The Altair 8800b Turnkey Model is designed for those who want the convenience, security and simplicity of operation provided by the front panel's key-locked power switch. The Turnkey Model (like the full front panel Altair 8800b) is a general-purpose byte-oriented computer containing 78 basic machine language instructions. The Turnkey will support up to 64K of directly addressable memory and the 100-pin bus structure allows expansion of up to 256 separate input/output devices.

System Design

The 8800b Turnkey Model is comprised of a special Turnkey Module board, a Central Processing Unit (CPU) board and a Power Supply board.

A serial input/output (SIO) interface, 1K of RAM, a sense switch input and provisions for 1K of PROM are included on the **Turnkey Module board.** The SIO allows RS-232, TTL or TTY interfacing. The Auto Start Circuit automatically branches to a predetermined address when power is applied or when the Reset switch is activated.

By means of the 8080A microprocessor circuit, the master timing circuit and 8 input and output data lines, the **CPU board** controls and processes all instruction data within the computer. Clock pulse widths, phasing and frequency are all crystal-controlled by the Intel 8224 clock generator IC which uses an external crystal.

The **Power Supply board** provides pre-regulated positive and negative 18 volt supplies to the computer bus. The 8-volt, 18 amp tapped secondary supply permits the addition of as many as 16 printed circuit boards, and the multiple tapped primary transformer allows 110v/50Hz or 220v/60Hz operation.

Options

8800b Turnkey options include:

1) the Disk Boot Loader which loads Disk BASIC;
2) the Multiboot Loader which loads programs from cassette or paper tape;
3) the Turnkey PROM Monitor, a 256-byte PROM chip, that offers these functions:
   a. M—memory contents examine and modify
   b. D—memory dump
   c. J—jump to an address

Specifications

Number of Boards	Up to 18
NMOS 8080A Microprocessor	
Data Word Size	8 bits
Instruction Word Size	Variable, 8-24 bits
Clock Frequency	2MHz
Add Time, Register to Register	2 μs. per data word
Number of Instructions	78
Input/Output Control	
I/O Word Size	8 bits
Number of I/O Channels	256
Direct Memory Access	Optional
Interrupt Capability	Standard
Vectored Interrupt (8 priority levels)	Optional
Software (sold separately)	
BASIC	High-level language
Package II	Assembly Language Development System
Disk Operating System	

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altair™ 8800b
TECHNICAL INFORMATION

The ALTAIR 8800b computer is a general purpose byte-oriented machine (8-bit word). It uses a common 100-pin bus structure that allows for expansion of either standard or custom plug-in modules. It supports up to 64K of directly addressable memory and can address 256 separate input and output devices. The ALTAIR 8800b computer has 78 basic machine language instructions and is comprised of a power supply board, an interface board, a central processing unit (CPU) board, and a display/control board.

Power Supply Board

The Power Supply Board provides two output voltages to the ALTAIR 8800b computer bus, a positive and negative 18 volts. It includes a bridge rectifier circuit and associated filter circuit, a 10-pin terminal block connector, and the regulating transistors for the positive and negative 18 volt supplies.

Interface Board

The Interface Board buffers all signals between the display/control board and the ALTAIR 8800b bus. It also contains eight parallel data lines which transfer data to the CPU from the Display/Control board.

CPU Board

The CPU board controls and processes all instruction data within the ALTAIR 8800b computer. It contains the model 8080A microprocessor circuit, the master timing circuit, eight input and eight output data lines to the ALTAIR bus, and control circuits.

Display/Control Board

The Display/Control Board conditions all ALTAIR 8800b front panel switches and receives information to be displayed on the front panel. It contains a programmable read only memory (PROM), switch and display control circuits, and control circuits to condition the CPU.

NEW DESIGN FEATURES

Several new design features have been incorporated into the electronic and mechanical areas of the ALTAIR 8800b computer. Some of the new design features include additional front panel capabilities, redesigned power supply, and various electronic and mechanical design advancements.

New Front Panel Switches

Five new front panel switch positions have been added to the ALTAIR 8800b computer to expand the front panel capability.

1. SLOW position: Permits execution of a program at a rate of approximately 2 machine cycles per second or slower. The normal machine speed is approximately 500,000 machine cycles per second. The ALTAIR 8800b operates in the slow mode as long as the SLOW switch is depressed on the front panel.
2. DISPLAY ACCUMULATOR position: Displays the contents of the CPU accumulator register on the ALTAIR 8800b front panel.
3. LOAD ACCUMULATOR position: Loads the information present on the lower eight front panel address switches into the CPU accumulator register.
4. INPUT ACCUMULATOR position: Inputs the information present at an Input/Output device into the CPU accumulator register. The Input/Output device is selected on the upper eight front panel address switches.
5. OUTPUT ACCUMULATOR position: Outputs the contents of the CPU accumulator register to a selected input/output device. The input/output device is selected on the upper eight front panel address switches.

New Power Supply

The new power supply in the ALTAIR 8800b contains an 8 volt, 18 ampere tapped secondary supply which permits the addition of up to 16 printed circuit cards, and pre-regulated positive and negative 18 volt, 2 ampere supplies. A multiple tapped primary transformer provides for 110/220 volt operation and a 50/60 Hz operation.

Electronic Design Advancements

The electronic design advancements on the ALTAIR 8800b are in the CPU and front panel circuit boards.

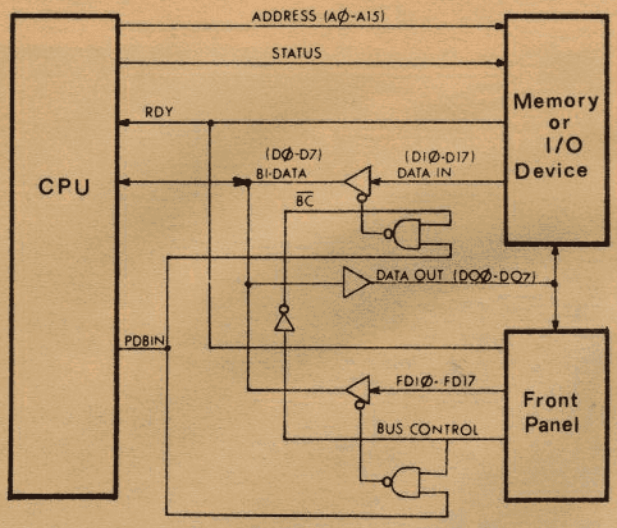
1. CPU. The new CPU circuit board uses the Intel 8224 clock generator integrated circuit (IC). The 8224 IC provides a specified clock frequency to the ALTAIR 8800b using an external crystal and dividing the crystal frequency down to 2MHz. Therefore, both the clock pulse widths and phasing (as well as frequency) are crystal controlled.
2. Front Panel. All front panel data lines are connected to an interface which buffers them from the rest of the ALTAIR 8800b. The front panel circuits also use a programmable read only memory (PROM) which contains programs for the following eight functions:
   EXAMINE
   EXAMINE NEXT
   ACCUMULATOR DISPLAY
   ACCUMULATOR LOAD
   DEPOSIT
   DEPOSIT NEXT
   INPUT ACCUMULATOR
   OUTPUT ACCUMULATOR

   The front panel circuits also have a wiring option which allows the CPU to perform a complete instruction cycle or a single machine cycle during the single step or slow operation.

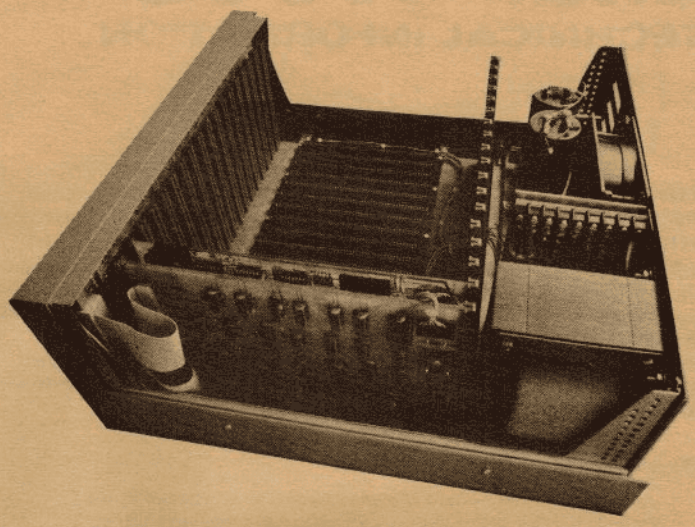
Mechanical Design Advancements

The mechanical design advancements on the ALTAIR 8800b are incorporated for ease of assembly and maintenance.

1. The wiring harness connection which exists on the front panel of the ALTAIR 8800 is replaced with ribbon cables. These ribbon cables connect the front panel circuits to the interface circuits.
2. The four slot expander cards in the ALTAIR 8800 have been replaced by a single piece 18-slot motherboard. The 18-slot motherboard contains 100 solder lands which comprise the 100 pin bus.
3. A new multi-color and redesigned dress panel is used in the ALTAIR 8800b. The front surface of the dress panel has a protective sheet of mylar to insure that the graphics are not rubbed or scratched off.



8800b BLOCK DIAGRAM



COMPATABILITY

8800b BLOCK DIAGRAM DESCRIPTION

The 8800b computer contains four main circuits: a Central Processing Unit (CPU), a Memory, an Input/Output (I/O), and a Front Panel. The CPU controls the interpretation and execution of software instructions, and the Memory stores the software information to be used by the CPU. The I/O provides a communication link between the CPU and external device. The Front Panel allows the operator to manually perform various operations with the 8800b. The 8800b block diagram description explains: A) the communication between the CPU and the memory or I/O circuits; and B) the communication between the CPU and the front panel.

CPU to Memory or I/O Operation

The Memory or I/O operation requires several main signals which allow for transfer of data to and from the CPU. The ADDRESS (AØ-A15) signal consists of sixteen individual lines from the CPU to the Memory or I/O device. This signal represents a particular memory address location or external device number which is needed to establish communications with the Memory or I/O Device. Once the ADDRESS (AØ-A15) data is presented to the Memory or I/O device, the CPU generates various STATUS signals. The STATUS signals either enable decoding of a memory address, or they condition the I/O device card to send or receive data from the CPU.

Data from the Memory or I/O device is presented on the DATA IN (DIØ-DI7) lines and applied to eight non-inverting bus drivers. The drivers are enabled by a PDBIN signal from the CPU and a BC (bus control) signal. The BC signal is LOW when the Front Panel is not in operation. The eight non-inverting bus drivers, when enabled, present the input data to BI-DATA (DØ-D7) lines which apply the data from the Memory or I/O device to the CPU.

Data to the Memory or I/O device is presented on the DATA OUT (DOØ-DO7) lines from the BI-DATA (DØ-D7) lines from the CPU. The RDY (ready) line either forces the CPU to a wait state while data is being transferred or allows the CPU to process data.

Front Panel Operation

The Front Panel Operation is very similar to the Memory or I/O operation. The Front Panel gains control of the CPU by producing a HIGH BC signal. The BC signal disables the DATA IN (DIØ-DI7) lines from a Memory or I/O device and enables the FDIØ-FDI7 lines. The FDIØ-FDI7 lines contain Front Panel data which is transferred to the CPU upon the occurrence of the PDBIN signal. All data from the CPU to the Front Panel is applied to the DATA OUT (DOØ-DO7) lines and displayed on the Front Panel.

Compatibility

All of the current 8800 software is compatible with the 8800b, and all the current plug-in circuit boards are compatible, with the exception of the 8800a CPU Board.

Memory Cards

1. 4K Dynamic RAM Memory Board
2. 4K Static RAM Memory Board
3. 16K Static RAM Memory Board
4. PROM Memory Board

Interface Cards

1. Serial Interface Board
2. Parallel Interface Board
3. Audio-cassette Interface Board
4. Disc Controller Board

ALTAIR 8800b
Specifications

Number of Boards	Up to 18
Microprocessor	
Model	8080A
Technology	NMOS
Data Word Size, Bits	8
Instruction Word Size, Bits	8
Clock Frequency	2M Hz
Add Time, Register to Register, Microsec. Per Data Word	2
Number of Instructions	78
Input/Output Control	
I/O Word Size, Bits	8
Number of I/O Channels	256
Direct Memory Access	Optional
Interrupt Capability	Std.
Vectored Interrupt (8 priority levels)	Optional
Software	
Resident Assembler	Yes
Higher-level Language	BASIC
Monitor or Executive	Sys. Mon.; text edit.
Complete Software Library Separately Priced	Yes

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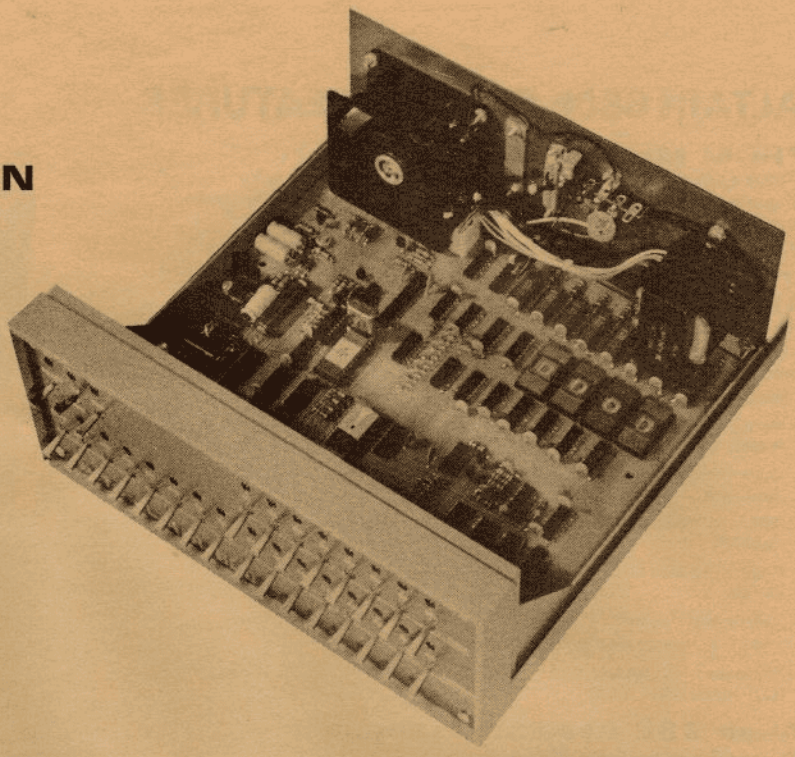
altair T.M. 680b

TECHNICAL INFORMATION



The ALTAIR 680b microcomputer is an excellent compromise between computer power and low cost structure, without sacrificing design reliability. The system is based on the 6800 microprocessing unit, which adapts nicely to a minimum design configuration. The ALTAIR 680b measures 11-1/16" wide x 11-1/16" deep x 4-11/16" high. The ALTAIR 680b is available with a full front panel or a turnkey front panel.

Almost all of the 680b circuitry is contained on a single large printed circuit board, including memory and a built-in I/O port. The full front panel model contains all of the controls necessary to program and operate the computer and includes an additional printed circuit board, which provides all of the logic circuitry necessary to reset, halt or start the processor. Also located on this board are switches and associated LED indicator lights for each of the sixteen address lines and eight data lines. The front panel circuit board mounts directly to the main printed circuit board via a 100-contact edge connector. The power switch is located on the back panel of the unit for safety purposes. A "turn-key" front panel model, which eliminates all control except restarting the processor, is also available.

The basic ALTAIR 680b computer can be subdivided into five functional sections. These are the MPU and clock, the memory, an I/O port, control and indication, and the power supply. The first three of these sections, along with the power supply regulation components, are located on the main printed circuit board.

At the heart of the 680b system is the 6800 Microprocessing Unit, which is largely responsible for the overall simplicity of the 680b design. The 6800 MPU contains three 16-bit registers and three 8-bit registers. The program counter is a two byte register which keeps track of the current address of the program. The stack pointer is also a two byte register which keeps track of the current address of the program and contains the next address in an external, variable length push-down/pop-up stack. The index register is a two byte register used to store data or a memory address for indexed addressing operations. There are two single byte accumulators used for holding operands and results from the arithmetic logic unit (ALU). The 8-bit condition code register indicates the results of an ALU operation. In this register there are two unused bits, kept at a logic one. The remaining six bits are used to indicate the status of the following: carry; half carry; overflow; zero; negative; interrupt.

The 6800 has seven different addressing modes, with the particular mode being a function of both the type of instruction and the actual coding within the instruction. The seven modes include the following: Accumulator Addressing—one byte instructions, specifying either of the two accumulators; Immediate Addressing—two or three byte instructions, with the MPU addressing the location given in the 2nd or 2nd and 3rd bytes when the immediate instruction is fetched; Direct Addressing—two byte instructions which allow the user to directly address the lowest 256 bytes of memory in the machine; Extended Addressing—three byte instructions, the second two bytes referring to an absolute address in memory for the operation; Indexed Addressing—two byte instructions, the second byte being added to the 16-bit index register to give the address of the operand; Implied Addressing—one byte instructions and the instruction itself gives the address; Relative Addressing—two byte instructions where the second byte is added to the lower 8 bits, allowing the user to address memory + 129 to -125 bytes from the location of the present instruction.

There are several timing and control signals required to operate the MPU. Two clock inputs are required, phase 1 and phase 2. These must be nonoverlapping and run at the Vcc voltage level. In the 680b the clock is a 2-MHz crystal controlled oscillator with logic to provide a 500-KHz two phase clock.

Sixteen active high address outputs are used to specify the sections of memory or I/O to be used. These can drive up to one standard TTL load and 130 pf. There are also eight bi-directional data lines with the same drive capability as the address lines.

ALTAIR 680b SPECIAL FEATURES

PROM Monitor

A 256-byte PROM monitor that allows immediate loading/running of programs (no boot loaders necessary) and examining and modifying of memory locations.

The Main board comes with 1K bytes of RAM and an on-board I/O port that may be configured for RS-232 or TTY transmission.

Altair 680 BASIC*

There is a version of Altair BASIC that is available for the Altair 680b. It is a high-level language that offers a number of powerful features including:

- —Boolean operators for bit manipulation
- —Variable length strings of up to 255 characters with LEFT$, RIGHT$ and MID$ functions
- —Concatenation operator for conversion between strings and numbers
- —Ability to read or write a byte from any I/O port or memory location
- —Program interrupt features that allow examination of variable values
- —String and numeric arrays of as many as 30 dimensions
- —Loop nesting limited only by available memory
- —Intrinsic functions of SIN, COS, TAN, LOG, EXP, SQU, SGN, ABS, INT, RRE, RND, POS

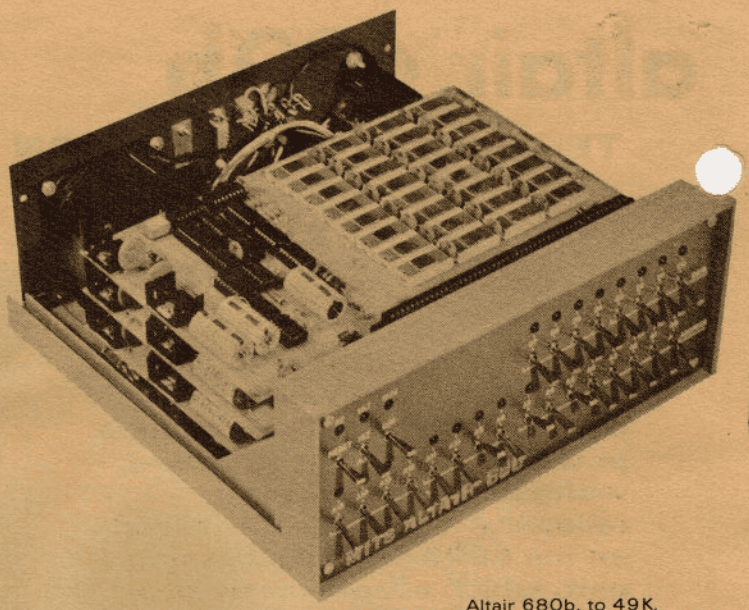
Altair 680 Assembly Language Development System*

A two-pass resident assembler and text editor are available for assembly language programming. This software is compatible with Motorola's format for assembly language programs, text and object files. 8K bytes of memory are required to run this package. The assembler produces a full assembly listing on the second pass, including the hex codes for the location counter and the instruction mnemonics. A symbol table listing is also produced. The text editor has full capabilities for text editing, including the insertion, printing, deletion and modification; as well as commands for changing one string of characters to another and for searching the text buffer for a particular character string.

EXCITING PLUG-IN OPTIONS

- —MITS offers a growing family of peripherals for the Altair 680b, including the 16K Static Memory Board (680b-BSM), 680b-KCACR, Universal Input/Output Board (680b-UI/O), Process Control Interface (680b-PCI) and Altair Minidisk System (680-MDS).

*680 BASIC and 680 Assembly Language Development System purchased separately, or a copy included free with an Altair 680b 16K memory board.



Altair 680b, to 49K.

Altair 680b Specifications

No. of Boards	Up to 3 additional
Microprocessor	
Model	6800
Technology	NMOS
Data Word Size, Bits	8
Instruction Word Size, Bits	8
Clock Frequency,	500KHz
Add Time, Register to Register, Microsec. Per Data Word	2
Number of Instructions	72
Input/Output Control	
I/O Word Size, Bits	8
Number of I/O channels	256 Memory Address Locations Designated
Interrupt Capability	Std.
Type of Interrupt System	Maskable (Interrupt Request) and Non-maskable Interrupt
Software	
Resident Assembler and Editor	Yes
Higher-level language	BASIC
Monitor	Resident System Monitor on PROM
Complete Software Library Separately Priced	Yes

In addition to the full front panel model, the Altair 680b is available in this Turnkey Model. It has a power indicator light and controls for RESET and RUN/HALT on the front panel. The system PROM monitor, when used in conjunction with a terminal, eliminates the necessity for toggling front panel switches to load bootstraps or to examine and change memory contents.

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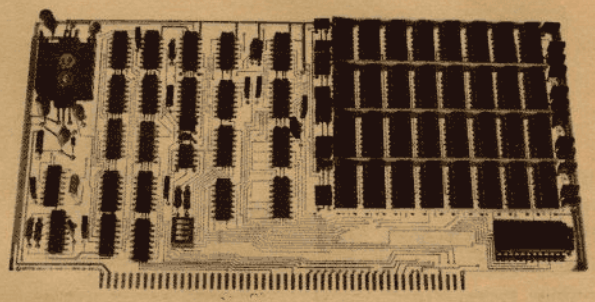
16K Dynamic Board (88-16MCD)

Designed using 32 dynamic random access memory ICs (4K x 1 bits each), the 16K Dynamic board provides 16,384 bytes of random access memory for the Altair™ 8800 series computers. The memory ICs have a maximum access time of 350 nanoseconds, yet require only 3 watts of power.



Special Features

The 88-16MCD provides continuous operation at maximum speed by eliminating the need for time-consuming wait states.

All logic timing is crystal-controlled for greater accuracy.

System Design

Occupying one slot in the motherboard, the 88-16MCD plugs directly into the computer. Address selection is done by an 8-pin dip switch. One jumper selects either 8800a, 8800b or 8800b Turnkey operation.

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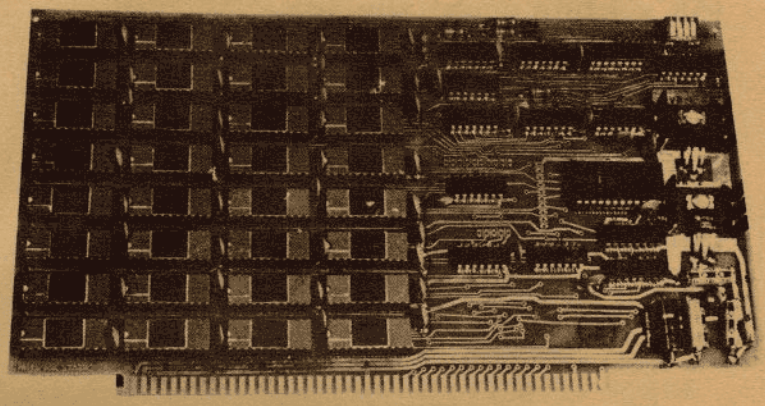
16K Static Memory Board (88-16MCS)



The 88-16MCS design is based upon a 4,096 x 1 bit static random access integrated circuit. These RAMs offer the advantage of low power consumption and extremely fast access time, and also eliminate the need for additional refresh logic common to dynamic memories.

Hardware

Dimensions: 10" x 5"

Altair Slots: One

Power: +5V (400 mA, Max.), +12V (200 mA, max.), −5V (100 mA).

Epoxy solder masks cover areas not to be soldered.

Sockets are provided for all RAM ICs.

A DIP Switch is used for board address selection.

Capabilities

Provides 16,384 8-bit words of Random Access Memory on one card.

Access Time: 215 ns.

Cycle Time: 390 ns.

Operation

There are no wait states (due to fast access time).

Since only four 88-16MCS boards are required for the maximum amount of memory directly addressable by the computer, only the upper two address bits are required to select a particular board. The upper four address bits select a single 4K block on a particular 16K card. The remaining twelve address bits are buffered and inverted to select one location within a block.

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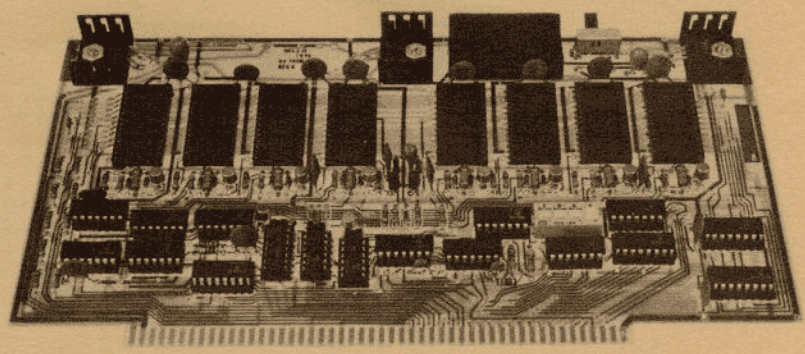
Altair™ 88-PMC8 8K PROM Memory Board

Technical Information

The Altair 88-PMC8 is an Erasable Programmable Read Only Memory (EPROM) board that provides a convenient method of data storage and allows programming (and reprogramming) of EPROM ICs (2708s) at user command. Unlike conventional "volatile" memory boards, programmed data is retained during power-down conditions, thus eliminating the need for repeat reloading. Provisions for up to 8K of EPROM memory are contained on the board.*



Special Features

For specific applications where the full 8K of memory is not needed, the 88-PMC8 can be modified to act as a 4K memory board. The 4K byte configuration saves space by allowing data to be loaded into memory in 4K increments.

Requiring no extra hardware for system integration, the 88-PMC8 board contains its own power supply module and plugs directly into the computer's motherboard.

The 88-PMC8 board may be optionally configured to utilize electrically erasable EPROMs (PD458s).

Power consumption is automatically reduced when the board is not being addressed.

System Design

EPROM ICs are electrically programmed by inserting the EPROM into the board, then accessing and running a Write program. The user may devise his own Write program or he may purchase the WRPROM IC** which contains a totally relocatable Write and Transfer program. The Write portion of the program serves as a general purpose service routine that selects the size of the memory block to be programmed and performs all necessary control functions. The Transfer portion of the program moves stored memory data (from 1 to 31K bytes in length) from PROM to RAM or from RAM to RAM. To insure the accuracy of the data or Write program transfer, a Program Verify routine is also contained in the WRPROM.

EPROM ICs can be erased by exposure to ultraviolet light at a wavelength of 2,537 angstroms.†

Specifications

Power Requirements:
+8v @ 700mA
+15v @ 180mA
−15v @ 100mA

Access Time:
Less than 450 ns (no wait states required)

Operating Temperatures:
0° C to 70° C

*EPROM ICs are not supplied with the board, but may be optionally purchased through the MITS Marketing Department or your local Altair Computer Center.

**The WRPROM IC is optional and may be purchased through the MITS Marketing Department or your local Altair Computer Center.

†Ultraviolet lamps are not available from MITS.

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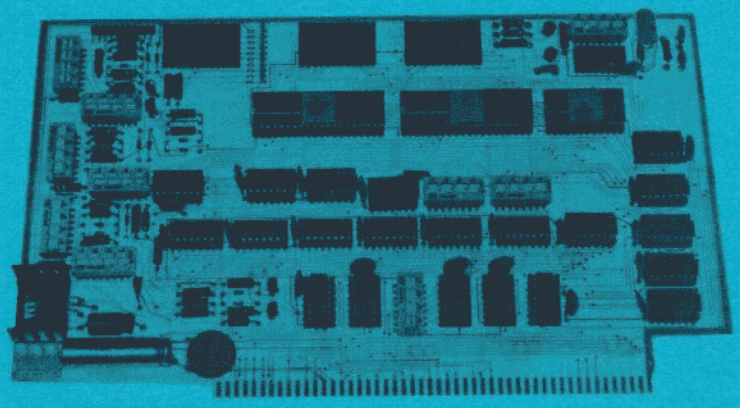
Altair 680b Universal I/O Card

Technical Information

Expand Your Altair 680b System!

The 680b Universal I/O card greatly enhances the input/output capabilities of the 680b computer by providing (optionally) one serial port and two parallel ports for communication with various terminal devices. Whether you use just one port, two ports or all three at once, each is configured individually and drives an I/O device independently of the other ports. Interface lines are switch selectable for RS-232, TTL and TTY operation.



Parallel Ports

Use the Universal I/O's parallel ports to interface the Altair 680b computer to such devices as a high speed reader and a high speed printer.

Serial Port

Use the Universal I/O's serial port to transmit and receive RS-232 and TTY data through such devices as a CRT, Teletype or Modem. An on-board, crystal-controlled 2.4576 MHz clock allows switch selection of any of the following baud rates: 50, 75, 110, 134.5, 150, 200, 300, 600, 1200, 1800, 2400, 9400 or 9600.

Port Design

The parallel port's design is based upon a Peripheral Interface Adaptor (PIA) which contains all of the Control and Data Registers, thus making most options, such as data direction and interrupt/control structure, software selectable.

The design of the serial port is based upon an Asynchronous Communications Interface Adapter (ACIA) which contains both Control and Status Registers.

Hardware

The serial port plugs into an on-board 10-pin connector with a 12 conductor round cable. Each parallel port plugs into an on-board 24-pin connector with a flat cable. The UI/O occupies one slot on the 680b Expander Card. Power requirements are as follows:

For TTY: + 16v and − 16v max., approx. 63 mA
min., approx. 45 mA

For RS-232: + 16v approx. 36 mA
− 16v 0 mA

Fully expanded: + 5v at approx. 350 mA

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Capabilities

Each PIA contains two sections. Sections A and B each contain two channels: a Control/Status Channel and a Data/Data Direction Channel. Address lines A0 and A1 enable the selection of each Section (A or B) and the Control/Status Channel or the Data Channel of that Section.

The Universal I/O with only one PIA parallel port can handle two inputs (such as a paper tape reader and keyboard) or two output devices (such as a paper tape punch and printer) or any combination of custom applications. A Universal I/O with two PIA parallel ports has 32 data lines (each group of eight is individually selectable). All data lines are fully TTL compatible. Eight of the 16 lines (per PIA parallel port) are capable of directly driving the base of a transistor switch (1.5v at 1 ma).

The ACIA contains both Control and Status Registers. The five control lines allow maximum utilization of sophisticated terminals. These control lines are: transmit data, receive data, data carrier detect, clear to send and request to send. The 8-bit Status Register allows for greater control and handshaking ability by indicating received data available, transmitter buffer empty, carrier detect, clear to send, framing error, received data overflow, parity error, and interrupt request.

All of the input/output lines to or from the ACIA are switch-selectable for RS-232, TTL levels or 20 milliamp current loop (TTY). An on-board, crystal-controlled clock allows user selection for any of 13 baud rates by positioning a dip switch. The Selectable Baud rates are:

50	200	1800
75	300	2400
110	600	4800
134.5	1200	9600
150		

The serial port is software programmable for nine or ten bit transmission as follows:

a. 7 data bits + parity bit (odd, even, or none) + 1 or 2 stop bits;
b. 8 data bits + 1 or 2 stop bits;
c. 8 data bits + 1 stop bit + parity bit (odd or even).

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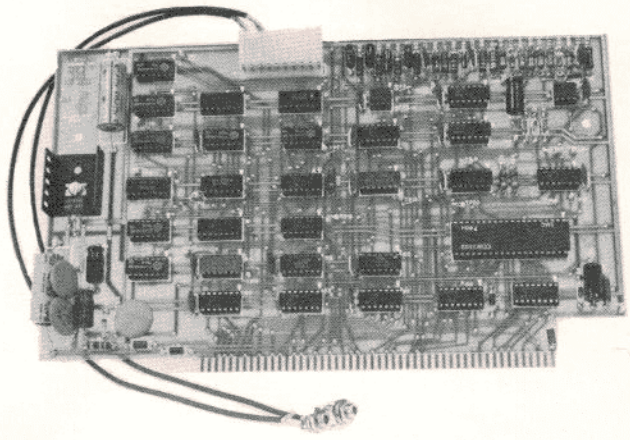
Technical Information

altair™ 680b-KCACR

Mass data storage is now available for the Altair 680b. By utilizing the 680b-KCACR, the 680b bus can be interfaced with an audio cassette recorder allowing inexpensive saving and loading of programs. The KCACR design is based on the Kansas City Standard, making data transfer highly reliable under widely varying conditions without circuitry adjustments.



Features

In addition to eliminating circuitry alignment for precise operation, the 680b-KCACR offers a host of other design features. These include: motor control circuitry for starting and stopping tape motion, low power consuming CMOS logic and a digital demodulator for logic level discrimination. Sockets are provided for all ICs. Test points are provided at key circuit areas.

Kansas City Standard

The Kansas City Standard is a method of audio cassette data interfacing which employs frequency shift modulation. Data transfer is at a rate of 300 baud with a + 20, − 20% playback speed tolerance. The self clocking action of the audio frequencies used for modulation allows for variations in tape speed and head alignment. Because of these flexible parameters, hardware cost and complexity is minimized. The recorded character is comprised of a space as a start bit, eight data bits and two or more marks as stop bits. A space (logical zero) bit consists of four cycles at a frequency of 1200 Hz. Mark (logical one) bits consist of eight cycles at a frequency of 2400 Hz.

Specifications

Demodulator Playback Speed Tolerance: + 20, − 20% from recorded speed

Demodulator Input Levels (Playback):
30 MV peak to peak minimum (100MV RMS)
10V peak to peak maximum (3.5V RMS)

Demodulator Input Impedance: 10K ohms

Modulator Output Level: 300MV P-P (suitable for microphone input)

Modulator Output Impedance: 1K ohms.

Error Rate: Relative to quality of recorder and tape, typically less than 1 error in 10^6 bits READ with low noise audio tape.

Power Requirements: + 8 Volts unregulated —220 MA typical
− 16 Volts unregulated—50MA typical
(less than 3 watts total power)

Requires 1 slot in 680 bus.

Audio Cable Connectors: Mini phone jacks, 3.5MM dia mounted on back panel.

680b Bus Address: FØ1Ø—Status, control
FØ11—Read data, write data

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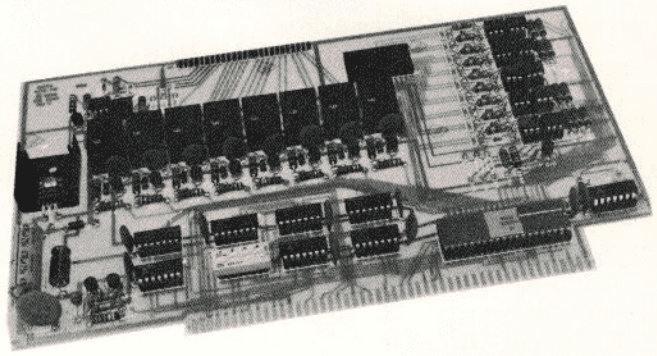
Altair™ 680b-Process Control Interface (680b-PCI)

Introduce your Altair 680b to the diverse world of electrical, mechanical and sensory devices with the addition of the 680b-Process Control Interface. By relaying various types of sensory information to the computer, the 680b-PCI permits a wide range of control applications.



Applications

Whether your applications revolve around industrial, scientific, business, communication or household uses, the potential of the 680b-PCI is virtually unlimited.

Some possible industrial applications include a product sorting and grading system. The 680b-PCI can be interfaced with various kinds of sensors for measuring size, weight, optical density and other properties while controlling a sorting mechanism.

In the field of scientific research, a 680b-PCI may be used to control environmental test conditions and gather test responses.

Suggested household uses include: control of thermostat settings, manual switches, lighting, lawn sprinkling and other home operations.

Features

The board consists of an eight relay output section, with each relay capable of switching 120VAC at 1 amp. Eight opto-isolators which can be configured by the user to accept a wide range of voltages make up the input section. Four more opto-isolated signal lines are arranged as two pairs of handshake lines, with the input section and output section each having one handshake pair. These lines are for control of and communication with external devices. All of the lines are completely isolated and balanced for use in environments with high levels of electrical noise.

Operation

When the board is set up and initialized, relay control is accomplished by outputting an eight bit word to the relay control channel. Logic "1" lines will energize their respective relays, and those set to "0" will de-energize. An input from the opto-isolator input channel reads the data from the opto-isolated input lines. The interrupt structure and use of the handshake lines are under software control.

Specifications

+ 9V unreg. @ 100ma when all relays off
+ 9V unreg. @ 400ma when all relays energized

*Opto-Isolators
- Isolation: Resistance input to output: 200G ohms
  Voltage: 1500V min.
- Input active current: 10-100ma
- Propagation delay: Varies with diode current from input to data (D) line
- Diode and Transistor: Turn on: 60 μsec., typical
  Turn off: 10 μsec., typical

*Relay Outputs
- Isolation: Contact to contact—750VAC at 250M ohms
  Contact to coil frame: 2000 VAC
- Propagation delay: Pull in: 3.5 msec.
  Release: 4 msec.
  Bounce: 1.2 msec.

*Handshake Lines
- Input: Same as Opto-Isolators
- Output: Off leakage current @ 25°C: 10^{9} amps
  On current: approximately 30ma

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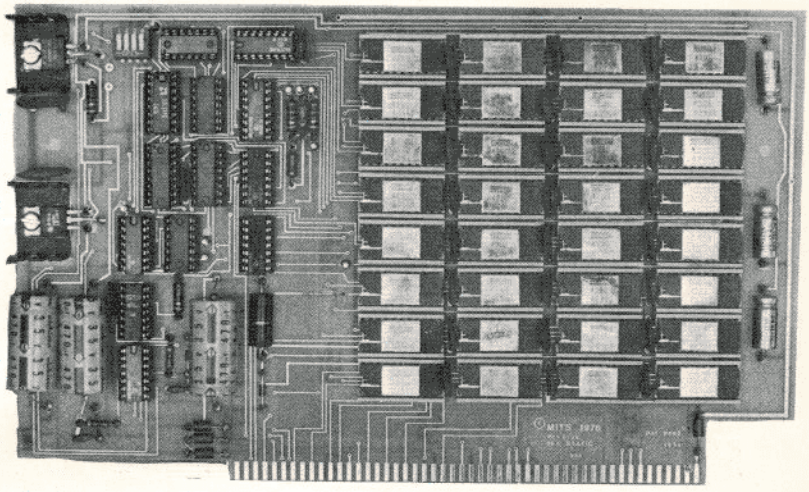
16K Static Memory Card (680b-BSM)



The 680b-BSM 16K memory card consists of four 4096 x 8 bit static memory arrays, an Address Select circuit, a Read/ Write circuit, and three voltage regulators.

Hardware

A DIP switch is used for address selection (no address jumpers).

Test points have been installed at important signal outputs for ease of checkout and troubleshooting.

Ferrite beads are used on all common supply lines for noise isolation.

Epoxy solder masks cover areas not to be soldered.

Sockets are provided for all ICs.

Power: + 16V (130 milliamps, maximum)
− 16V (110 milliamps, maximum)
+ 9V (150 milliamps, maximum)

Capabilities

Power consumption of 5 watts or 38 microwatts per bit. This allows operation of two 16K cards without adding a second power transformer.

RAM Access Time: 215 ns., max.

RAM Cycle Time : 400 ns., min.
Up to three 680b-BSM 16K memory cards may be used with the Altair 680b.

Operation

The 680b-BSM memory card operates by retaining data in its memory cells, each cell having a unique location, or address. To place information in a memory cell, the CPU (Motorola 6800) performs a write function, usually caused by a store instruction. Data may also be written into memory by halting the CPU (Halt switch), selecting the memory address (switches A0-A15), selecting the data to be deposited (switches D0-D7), and toggling the deposit switch.

To read data from memory, the CPU must perform a read data operation. This may be done several ways. First, during normal execution of a program, the CPU must fetch (read) instructions and data from memory. Also, the CPU may be instructed to transfer data from memory to some other location, thus requiring a read operation.

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