



January 15, 1976

Altair 680 UPDATE INFORMATION

Due to delays in shipment of the first generation Altair 680, it has been decided to upgrade all Altair 680's to the second generation design. This means that the Altair 680 will include the following items at no additional cost:

- 1) PROM monitor. 1702A PROM chip programmed so that you can immediately load paper tape. Also contains interrupt vectors for software, reset, maskable, and non-maskable interrupts.
- 2) Asynchronous Communication Interface Adapter (ACIA). Allows machine to transmit and receive a character at a time rather than one bit. Minimizes software needed for I/O routines. Contains crystal clock for baud rate synchronization. User-selectable for RS232, TTL, 60 mA, or 20 mA current loop. Baud rates of 110, 150, 300, 1200, and 2400.
- 3) Compatible with all Motorola 6800 software. This software will be available from MITS, Inc.

While these changes will greatly enhance the Altair 680, this change will cause a 30-60 day delay in delivery schedule.

2450 ALAMO SE, ALBUQUERQUE, NEW MEXICO 87106



MITC ALTAIR 8800

Price List

January 1, 1976

| Part Number  | Description                           | Kit             | Assem     | Days<br>Delivery |
|--------------|---------------------------------------|-----------------|-----------|------------------|
| 8800         | Altair 8800 Computer                  | \$ 439.00       | \$ 621.00 | 60               |
| COMTER II    | Terminal w/Audio Cassette I/O         | 780.00          | 920.00    | 60               |
| CT-256       | Comter 256 Terminal                   | 745.00          | 885.00    | 45-60            |
| CT257,8 or 9 | Pages 2, 3, or 4 for CT-256           | 95.00           | 105.00    | 45-60            |
| CT-8096      | CRT Terminal                          | TBD             | TBD       | TBD              |
| 88-VLCT      | Low Cost Terminal                     | 129.00          | 169.00    | 45-60            |
| 88-80LP      | Line Printer & Controller             | 1,750.00        | 1,975.00  | 60               |
| 88-TTY       | Teletype ASR-33                       | 1,500.00        | 1,500.00  | 60               |
| 88-MM        | Adds 256 words to 88-MCS              | 14.00           | 26.00     | 30               |
| 88-1MCS      | 1K Static Memory                      | 97.00           | 139.00    | 30               |
| 88-4MCD      | 4K Dynamic Memory                     | 195.00          | 275.00    | 60               |
| 88-DCDD      | Disc Controller & 1 Drive             | 1,480.00        | 1,980.00  | 60               |
| 88-DISC      | Disc Drive in Cabinet                 | 1,180.00        | 1,600.00  | 60               |
| 88-DMAC      | Direct Memory Access Cont.            | 98.00           | 149.00    | TBD              |
| 88-DMAE      | Direct Memory I/O Channel             | 126.00          | 186.00    | TBD              |
| 88-DMAI      | Direct Memory I/O Channel             | 123.00          | 183.00    | TBD              |
| 88-4PIO      | 4 Port Parallel I/O                   | 86.00           | 112.00    | 30               |
| 88-PP        | Extra Port on 4PIO                    | 30.00           | 39.00     | 30               |
| 88-2SIO      | 2 Port Serial Board (State I/O)       | 115.00          | 144.00    | 30               |
| 88-SP        | Extra Port for 2SIO Board             | 24.00           | 35.00     | 30               |
| 88-EC        | Expander Mother Board only            | 16.00           | 31.00     | 30               |
| 88-MB        | 88-EC inc. connectors and card guides | 65.00           | 138.00    | 30               |
| 88-EBC       | Expander Cabinet                      | 394.00          | 485.00    | 60               |
| 88-EXC       | Extender Card                         | 57.00           | 83.00     | 30               |
| 88-ACR       | Audio Cassette Record Interface       | 128.00          | 174.00    | 30               |
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| 88-RTC       | Real Time Clock                       | 53.00           | 84.00     | 90               |
| 88-PPCB      | Prototype PC Board                    | 57.00           | 84.00     | 30               |
| 88-FAN       | Cooling Fan                           | 16.00           | 20.00     | 30               |
| 88-FMC       | PROM Memory Card (no PROM's)          | 65.00           | 128.00    | 60               |
| 88-PROM      | PROM's (256 x 8 Bytes)                | 25.00           | 37.00     | 60               |
| 88-PPC       | PROM Programmer Card                  | CONTACT FACTORY |           | 90               |
| 25DB         | I/O Socket for Cabinet Case           | 11.00           | 25.00     | 30               |
| MS-416       | MITScope--4 channel scope             | 127.00          | 189.00    | 30               |
| 680F         | 680 MPU Unit (Assem state I/O)        | 345.00          | 420.00    | 60               |
| 680T         | 680 Less Front Panel                  | 280.00          |           | 60               |
| 680 CPU Bd   | CPU Board w/microprocessor chip       | 195.00          | 275.00    | 60               |
| 680 PROM     | 256 x 8-Bit PROM                      | 25.00           | 37.00     | 60               |
| 680FAN       | Peewee Fan Option                     | 16.00           | 20.00     | 60               |
| 680Socket    | 680 IC Socket Option                  | 29.00           | 42.00     | 60               |

NOTE Prices, specifications, development and delivery all subject to change without notice.

| <u>Suggested 8800 System Prices</u> |                               | Kit      | Assm     | Days Delivery |
|-------------------------------------|-------------------------------|----------|----------|---------------|
| System I                            | ALTAIR Basic I                | 1,712.00 | 2,265.00 | 60            |
| System II                           | ALTAIR Extended Basic II      | 1,893.00 | 2,566.00 | 60            |
| System III                          | ALTAIR DOS/Basic III          | 4,714.00 | 6,397.00 | 90            |
| System IV                           | ALTAIR Extended Engr/Acctg IV | 7,938.00 | 9,985.00 | 120           |

(To substitute teletype for COMTER II add \$720.00 to kit or \$580.00 to assembled price.)

Postage and Handling for systems will be subject to quotation.

Software for 8800 Systems

|            |          | Prices for Purchasers of 8800 plus: |           |    |
|------------|----------|-------------------------------------|-----------|----|
| 4K Basic   | \$150.00 | 4K memory, I/O                      | \$ 60.00  | 30 |
| 8K Basic   | \$200.00 | w/ 8K memory, I/O                   | \$ 75.00  | 30 |
| EXT Basic  | \$350.00 | w/12K memory, I/O                   | \$ 150.00 | 30 |
| Package #1 | \$175.00 | w/ 8K memory, I/O                   | \$ 30.00  | 30 |
| DOS        | \$500.00 | w/12K memory, I/O                   | \$ 150.00 | 60 |
| DEBUG      | \$100.00 | 4K memory, I/O                      | \$ 25.00  | 60 |

\$15.00 copying charge for update copy or second copy of above software. Copying charge in addition to update charge will be imposed for those updating their software.

PLEASE SPECIFY PAPER TAPE OR AUDIO TAPE WHEN ORDERING SOFTWARE except for DOS which is available only on DISC.

Manuals

|        |                     |       |   |       |
|--------|---------------------|-------|---|-------|
| CT-256 | Operator's          | 6.50  | } BASIC Language Documentation                          | 10.00 |
|        | Assembly            | 10.00 |   |       |
|        | Theory of Operation | 10.00 |   |       |
| 8800   | Operator's          | 7.50  | } Special Offer--All Three Manuals in a Binder--\$15.00 |       |
|        | Assembly            | 9.00  |   |       |
|        | Theory of Operation | 9.00  |   |       |
| 680    | Operator's          | 7.50  | } Special Offer--All Three Manuals in a Binder--\$14.50 |       |
|        | Assembly            | 7.50  |   |       |
|        | Theory of Operation | 10.00 |   |       |

Postage & Terms

Terms: Cash with order, Mastercharge or BankAmericard  
Postage & Handling:

1. Add \$8.00 for each terminal, computer, line printer and disc
2. Add for Modular Boards
  - a. -0- if ordered with computer
  - b. \$3.00 if ordered separately
3. Postage included in price of manuals
4. Teletype orders will be sent truck freight charges collect.
5. Canada, Hawaii & Alaska postage charges subject to quotation.

Above applies to domestic shipments in U.S.A. only. Overseas shipment, unless otherwise specified are usually made by airfreight via our shipping agents, Emery Airfreight, on airfreight collect basis.

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MIT S ALTAIR 8000

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Author: Gerhald Hansel  
Length: 46 lines of Basic  
Title: Addition problems  
Produces a group of math addition problems and answers. Written to use PRINT USING, a feature of Extended Basic, to format its output.

#1020752 -- \$2.00

Author: Lee Eastburn  
Length: 290 locations  
Title: Print program  
Dumps a program with page headings, an address field and the octal contents of the address. Columns are provided to fill in labels, instruction mnemonics and comments.

#1021751 -- \$2.00

Author: Jack Coats Jr.  
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Title: A Dual-Tasker  
An interrupt level routine to switch between two tasks. Context is saved on the stack and the stack pointer is saved in memory.

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Author: Jack Coats Jr.  
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Using the real-time-clock interrupts this program keeps track of the hours, minutes, seconds and hundredths of seconds that elapse. The data is stored in binary coded decimal.

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Author: Roger J. Walker  
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Title: TVTDR-I/O handler for TVT-II  
TVTDR is designed to overcome a deficiency in the TVT-II that prevents it from blanking to the end of the line when a carriage return is output. The appropriate number of spaces are output instead of a carriage return. Instructions for interfacing to Altair Basic are given.

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Title: BCD multiplication subroutine  
Currently set up to multiply two 8-digit numbers in memory and give a 16-digit number in memory for a result. Can be changed for different size numbers without much difficulty.

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Author: Lee Eastburn  
Length: LOAD section-71 bytes  
DUMP section-96 bytes  
Title: ASCII Octal Loader and Dumper  
The DUMP section outputs the contents of the block of memory in ASCII octal (3 characters ["0" - "7"]) for each byte). Twenty bytes are printed on each line of output. The LOAD section loads a tape of the same format, ignoring all characters except "0" through "7." The start and end locations are specified by changing LXIs in the programs themselves.

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Author: John Trautschold  
Length: 16 bytes  
Title: VLCT load program  
Allows entry of a load address and program data in octal from a VLCT keyboard. The entered data is displayed for verification. Documented with high 8-bits of start address as "XXX" so the program can easily be located at the start of any memory page (a block of 256 consecutive memory locations, the first location of which has an address divisible by 256 [decimal]).

#117751 -- \$5.00

Author: S. Armstrong  
Length: 124 instruction bytes (not including embedded NOPs)  
342 data bytes  
Title: Punch tape label  
Punches paper tape labels by using 5 tape frames to make a block letter. Can "print" any alphabetic, numeric, or common delimiter. Additional characters can easily be added. "Prints" an entire line at once with separating blanks.

#117752 -- no charge

Author: Jerry Ford  
Length: 318 bytes  
Title: JAMON - a teletype monitor  
This monitor allows examining (dumping) of memory blocks, depositing into memory blocks and jumping to a specified address. All inputs and outputs are in octal. Subroutines for character input, character output, octal input and octal output are included.

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Author: George Rompot

Length: 41 bytes

Title: GET - a "Lifeline" subroutine

A well-documented subroutine to perform the functions of the TGET and LGET subroutines specified in the lifeline article in Byte magazine. (October 1975, pp. 34-41) Includes test routine.

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Title: CHECK

A well-documented subroutine to calculate a 16-bit sum of an area of core specified in the calling parameters. Optionally checks the computed checksum with a checksum provided in the calling sequence. A testing program is included.

#1121751 -- \$2.00

Author: Gary Tack

Length: 152 bytes

Title: Random Magic Squares

Generates 3 numbers which are used to make a magic square (a 3x3 grid in which the sums of the numbers in each row, column and diagonal are equal). All "magic squares" can be generated since 3 numbers characterize a magic square. Each group of 3 numbers generates a distinct magic square. Stores magic square information in memory. Doesn't do any input/output.

#1123751 -- \$15.00

Author: Jim Gerow

Length: 33 pages

Title: A FORTRAN simulator for the B080

A FORTRAN program to take as input the code generated by Mr. Gerow's Cross Assembler (#521751) and simulate the Altair's execution of the code. Extremely useful for debugging. A manual is included with the source listing. A list of changes to be made to cross assemblers received before December 1, 1975 to allow them to work with the simulator is given.



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**EXCLUSIVE**

**Popular Electronics**  
NOVEMBER 1975

# THE MICROCOMPUTER FOR THE HOBBYIST



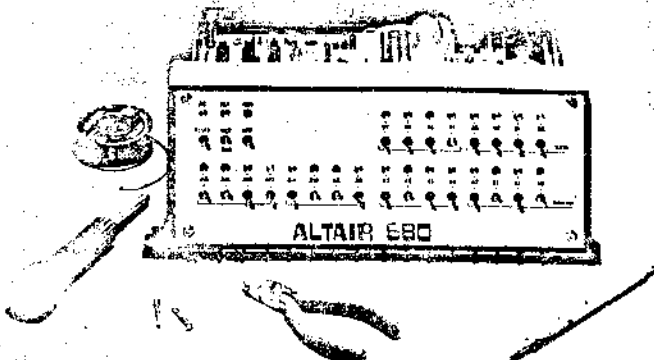
*Features compact size, simplified installation,  
built-in I/O interface and low cost.*

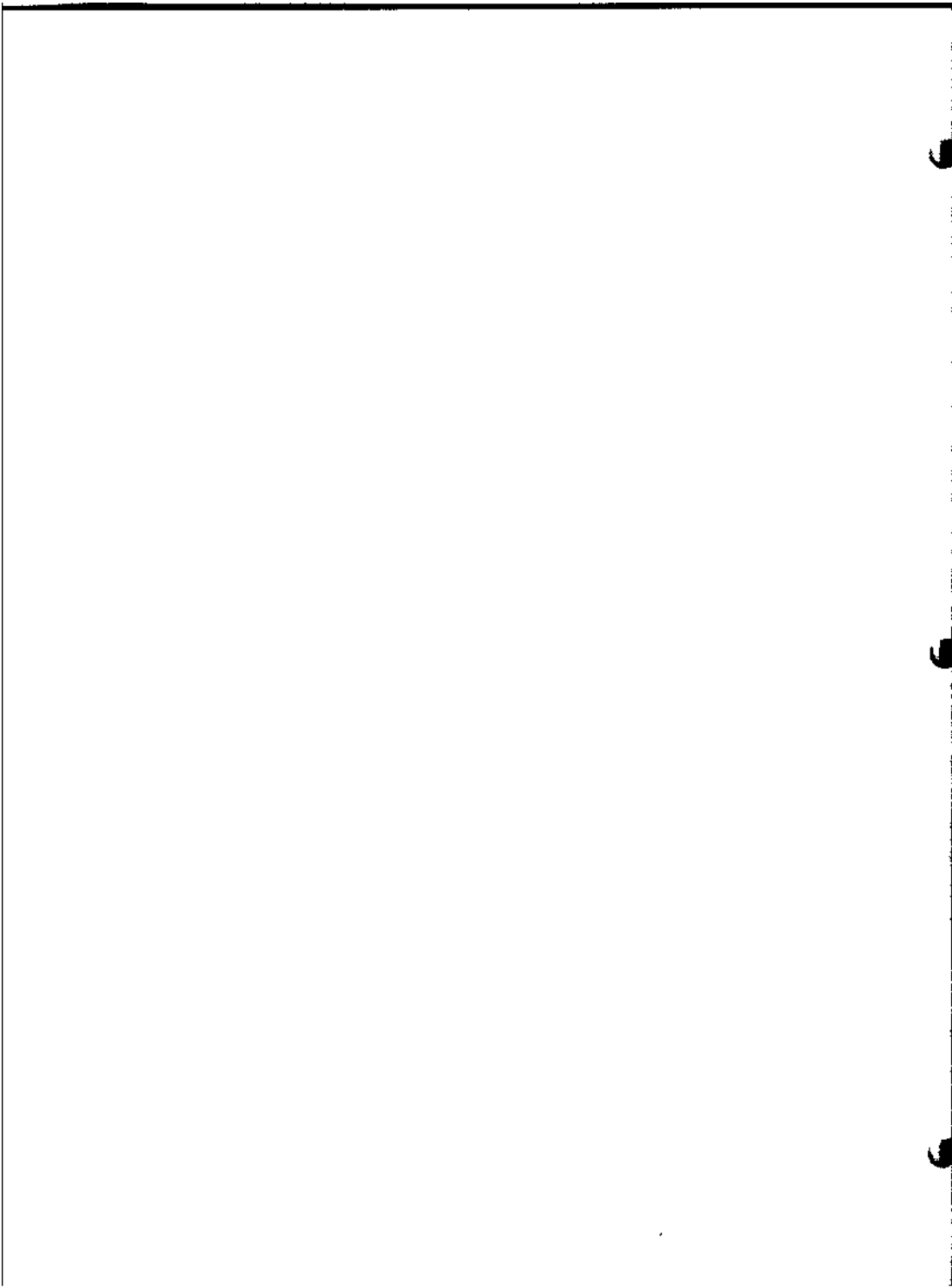
**L**ARGELY self-contained, the Altair 8800 provides many useful features to the hobbyist. One of the most significant features is the integrated MOS (Metal Oxide Semiconductor) microprocessor (MOS 6800), which has made it possible to build microcomputers that are still less than a year old. In fact, the Altair 8800 is the most popular microcomputer in the world, and its price is still reasonable. Cost and wide availability are important features.

However, many knowledgeable hobbyists have been looking for a microcomputer that would be of a number of other microprocessors available. Some people would like a microprocessor that is capable of replacing the existing Motorola M6800 microprocessor. Some people would like a microprocessor that is capable of replacing the existing Motorola M6800 microprocessor. Some people would like a microprocessor that is capable of replacing the existing Motorola M6800 microprocessor. Some people would like a microprocessor that is capable of replacing the existing Motorola M6800 microprocessor.

**T**he Altair 8800 is available in a variety of packages. The most popular is the Altair 8800 kit, which is the size of a Altair 8800. Although both kits have the same memory capacity, the 8800 kit is smaller and more rugged. The Altair 8800 kit is available in a variety of packages. The most popular is the Altair 8800 kit, which is the size of a Altair 8800. Although both kits have the same memory capacity, the 8800 kit is smaller and more rugged.

Other altair kits include a complete assembly kit, a large PCB board, and a kit with a built-in keyboard. The Altair 8800 is faster than earlier small computers. The Altair 8800 is a full product line. The Altair 8800 is based on the 6800. Another feature is the construction of the 6800. The 6800 is a high speed design. The 6800 is available from Motorola Semiconductor Products Group. The 6800 is a microprocessor. The 6800 is a microprocessor. The 6800 is a microprocessor. The 6800 is a microprocessor.





### ALTAIR COMPUTER COMPARISON CHART

| Features   | Altair 680  | Altair 6800             |
|--|---|-------------------------|
| Maximum word size                                      | 24 bits (byte oriented)   | 24 bits (byte oriented) |
| Arithmetic unit  | 8-bit parallel  | 8-bit parallel          |
| Minimum cycle time                                     | 4 $\mu$ s   | 2 $\mu$ s               |
| Program instructions                                   | 72  | 78                      |
| Maximum memory size                                    | 65k bytes   | 65k bytes               |
| Internal expandability                                 | 5 interface cards   | 250 interface cards     |
| Interrupt  | 3 levels  | 8 levels                |
| MPU  | 6800 (Motorola, AMI)  | 8080 (Intel, TI)        |
| Approximate system cost<br>(1k memory, I/O, case, P/S) | \$300   | \$600                   |
| Miscellaneous  | Fewer parts<br>2 printed circuit boards<br>Smaller size<br>Built-in TTY interface | Minimum of 4 pc boards  |

#### MAIN BOARD PARTS LIST

BD1—Bridge rectifier (V1048)  
 C1—3300- $\mu$ F, 50-V electrolytic capacitor  
 C2, C3—100- $\mu$ F, 50-V electrolytic capacitor  
 C4 to C9—0.33- $\mu$ F, 50-V disc ceramic capacitor  
 C10, C13—0.1- $\mu$ F, 16-V disc capacitor  
 C11, C12—0.33- $\mu$ F, 16-V disc capacitor  
 C14—0.01- $\mu$ F, 16-V disc capacitor  
 C15—1- $\mu$ F, 50-V electrolytic capacitor  
 D1, D2, D7 to D13—1N4004 diode  
 D3 to D6—1N4739A, 9.1-V zener diode  
 F1—1-A, 250-V ac, 3-AG fuse  
 ICA—7404  
 ICB—7473  
 ICC, ICUU—7408  
 ICD, ICE, ICS—4449  
 ICF, ICG—74LS01  
 ICH, ICJ, ICK, ICL, ICM, ICN, ICP,  
 ICR—2102  
 ICT, ICU, ICGG, ICHH, ICPP,  
 ICRR—74LS30

ICV—74L00  
 ICW—74L74  
 ICX, ICY, ICTT—4050  
 ICZ, ICAA, ICBB, ICC—1702  
 ICDD, ICFF—74L04  
 ICBE, ICM—74L10  
 ICJJ—6800  
 ICKK, ICLL, ICSS—74LS05  
 ICNN—74LS27  
 O1, O3, O4—T1S98  
 O2—EN3907  
 Except where noted, following resistors  
 are 1/2-watt, 5%:  
 R1, R2—33 ohms, 2-watt, 5%  
 R3, R4, R5, R7—100 ohms  
 R6—130 ohms, 1-watt, 5%  
 R8, R11—800 ohms  
 R9—220 ohms, 1-watt, 5%  
 R10, R28 to R31—7500 ohms  
 R12, R15, R16, R17—1000 ohms  
 R13—470 ohms  
 R14, R20, R21—390 ohms  
 R18, R19—330 ohms  
 R22—33,000 ohms  
 R23, R24, R25, R60—10,000 ohms

R26, R27, R36, R57, R58, R59—not used  
 R52 to R55—3000 ohms  
 SP1—Spdt toggle switch  
 T1—5-volt, 1.2-A transformer  
 VR1—7805 regulator  
 XTAL—2-MHz crystal  
 Misc.—Fuse holder (Buss HKP-CC, line  
 cord, fan (1MC 334"), I/O socket  
 (DB-255), sockets (14-pin, 22-pin, 20-  
 24-pin, 40-pin, 1), case optional).  
 Note—The following are available from  
 MITS, 6328 Linn, N.E., Albuquerque,  
 NM 87108: complete kit (all parts)  
 #680P at \$293; complete kit except for  
 front panel board #680F at \$240; kit  
 #680MPU, including pc board, 6800  
 MPU, 1k memory, and all main board  
 components except power supply at  
 \$180; front panel and MPU pc boards  
 #680PC at \$48; I/O socket kit at \$29; fan  
 kit at \$16; 256 x 8-bit PROM kit at \$42;  
 construction information package is  
 free, with self-addressed stamped 9" x  
 12" envelope.

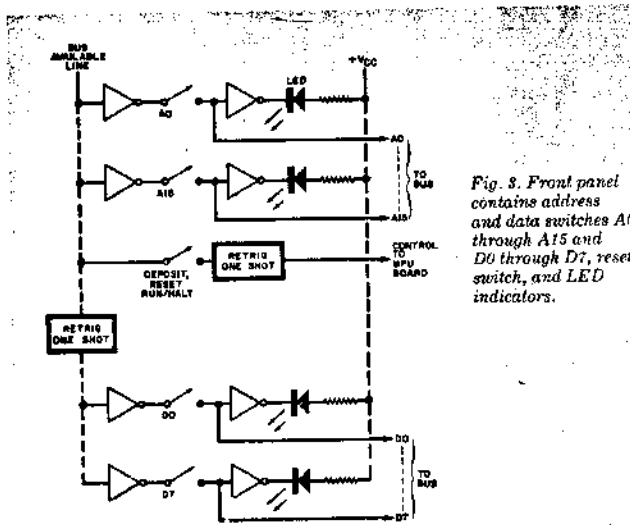


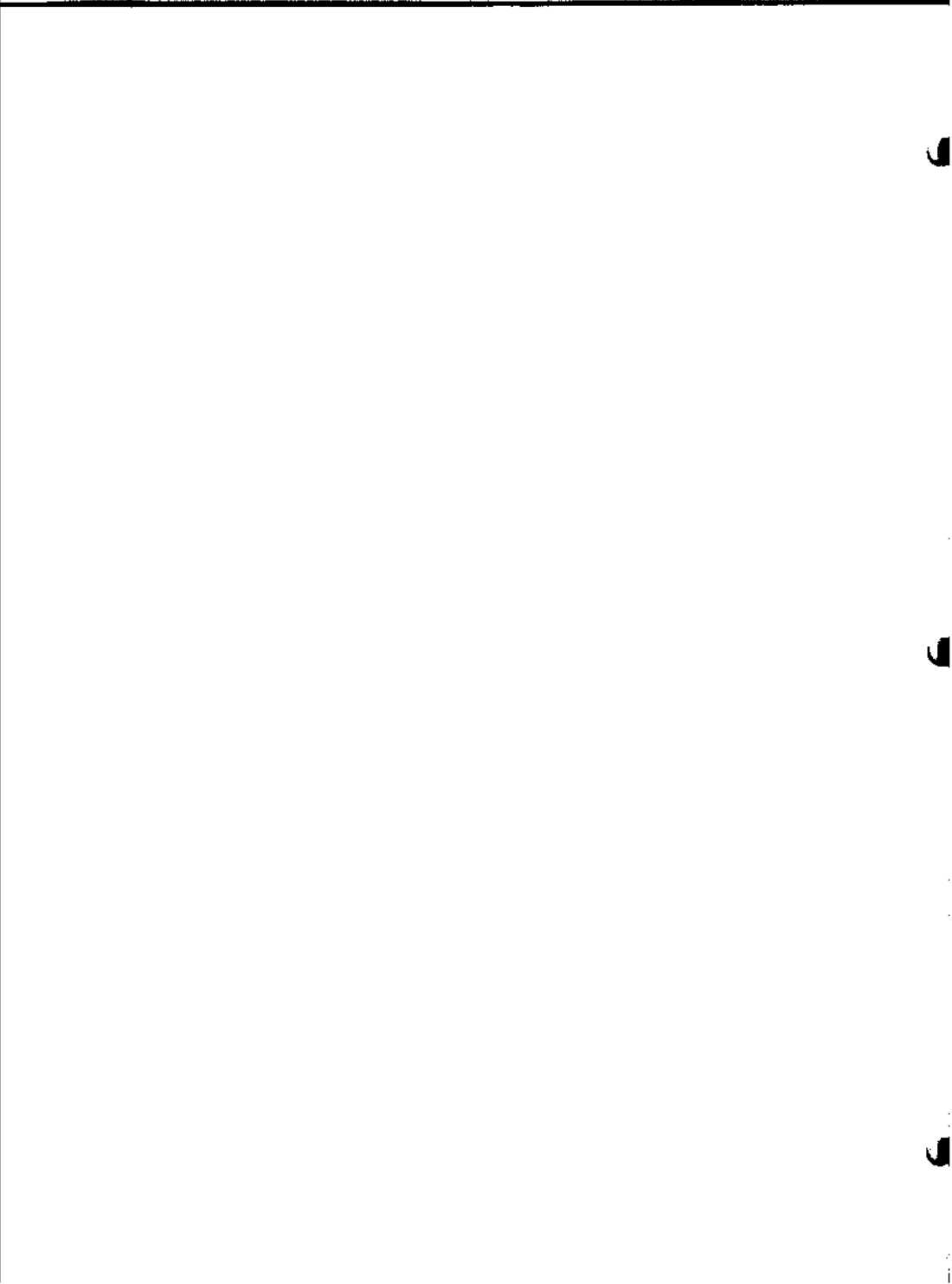
Fig. 8. Front panel contains address and data switches A0 through A16 and D0 through D7, reset switch, and LED indicators.

memory address location will then appear as lighted and unlighted LED's in the DATA display.

To change data in a location, the desired data is written via the DATA switches and entered by operating the DEPOSIT switch. This triggers a one-shot multivibrator, enabling the data information to the data bus and causing the R/W signal to go low. Since the address bus is already connected to the switches by being in the halt state, the write pulse causes the data to be written into the selected RAM address.

When the RESET switch is operated, the CPU resets. This, in turn, initiates a restart sequence. That is, the address bus is pulled to the high state and causes the hard-wired data in the board jumpers to be used as the restart address.

Access to the I/O port is gained by addressing location 17577 (in octal). A sequence of events then occurs that



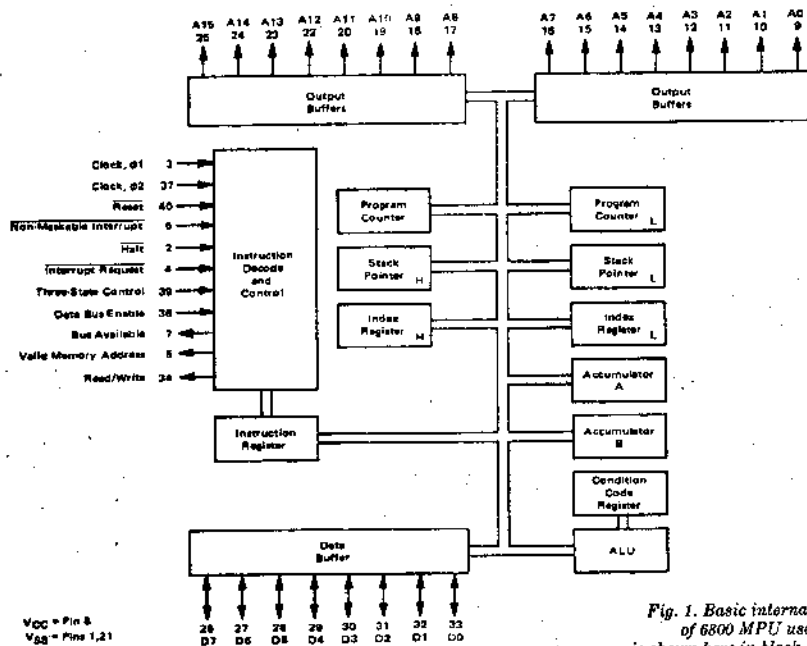


Fig. 1. Basic internal arrangement of 6800 MPU used in computer is shown here in block-diagram form.

**Basic System Philosophy.** The basic MPU, memory, I/O (input/output), and power-supply circuits in the Altair 680 are located on a single printed circuit board. The addition of a compact power transformer makes this assembly a complete computer system. (Front-panel switch programming can be used, but in the absence of this assembly, PROM's or ROM's must be installed for programming.)

The front-panel assembly contains all the logic needed to reset, halt, or start the processor. Also, any memory cell can be read or written into from the front panel via 16 ADDRESS and eight DATA switches. Mounted on the front-panel circuit board is a 100-contact edge connector that permits the main MPU board to plug directly into the front panel, thus eliminating the need for a wiring harness. (In systems that do not use the front-panel assembly, the MPU board automatically starts running at an address specified by either a PROM or a hard-wired patch.) The front panel contains 27 LED's that indicate the state of each switch. As a safety measure, the POWER switch is located on

the back of the cabinet to obviate the possibility of its being accidentally operated during programming.

The basic computer contains 1024 bytes of memory and has provisions for an additional 1024 bytes of PROM or ROM memory. An I/O channel and interface are also included in the basic system. The I/O channel can be configured to interface RS-232 or a 20-mA or 60-mA TTY loop. This means that anyone who can obtain an old five-level Baudot-type Teletype—such as the MOD-15, MOD-19, etc.—can use it as a computer terminal. (Many such Teletypes are available for less than \$100 and frequently for as little as \$25 nationwide.)

The Altair 680 can be built with either a full-programmability or a "turn-key" front panel. The latter eliminates all controls except restarting the processor. There are a number of applications where this is desirable to eliminate the possibility of having an operator affect the contents of the memory or the computing cycle. An example might be in a sophisticated intruder-detection system where the only control provided for the operator is essentially on/off.

**Software.** The software associated with the 6800 MPU includes an editor, PROM monitor, and assembler, as contrasted to the editor, assembler, monitor and basic for the Altair 8800 computer.

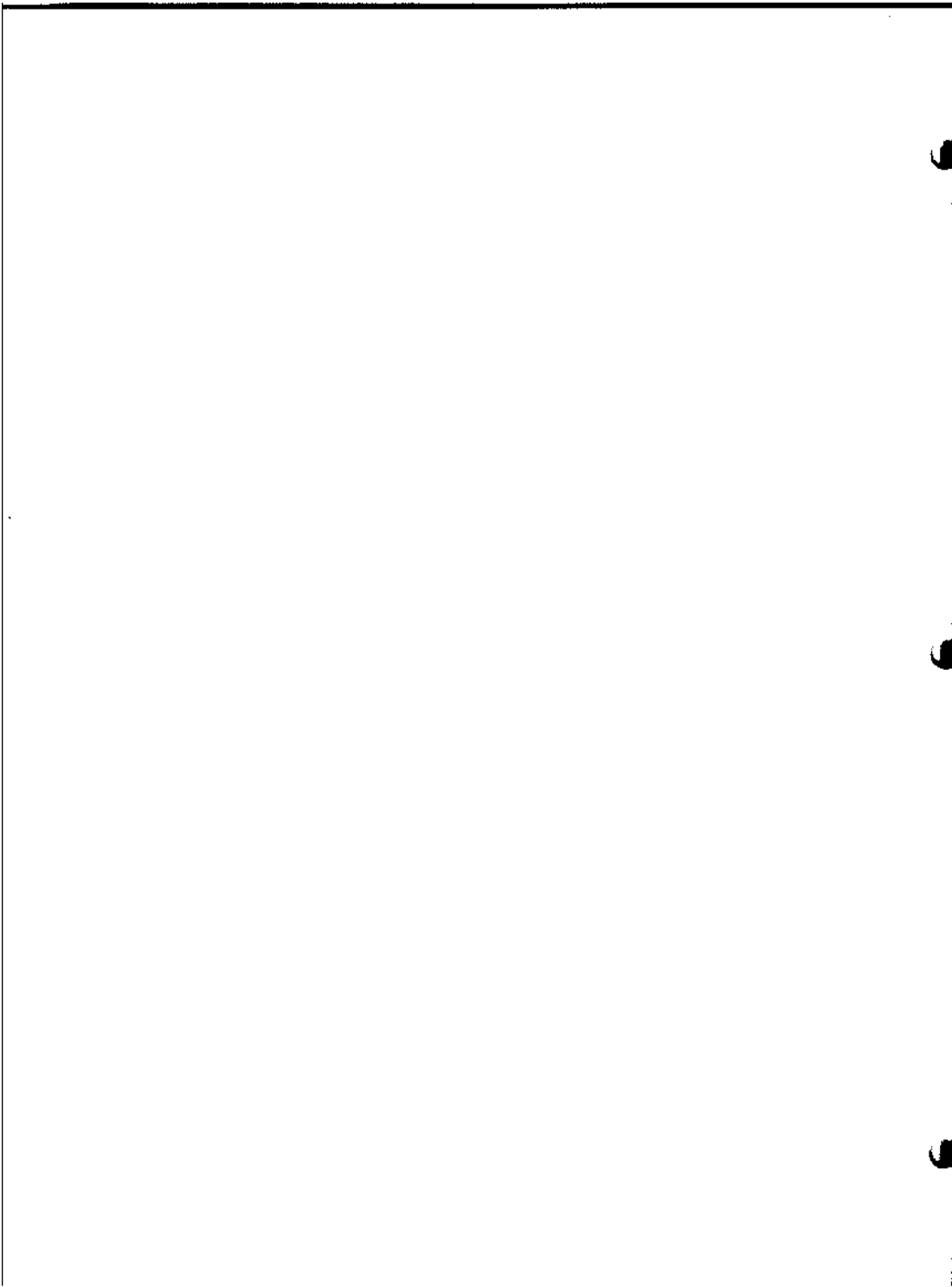
**System Details.** The Altair 680 computer is composed of five sections: MPU and clock, memory, control and indication, I/O port, and power supply.

**MPU and Clock.** As mentioned earlier, the MPU and clock are the new 6800 LSI chip. Its basic internal arrangement is shown in Fig. 1. The main elements are instruction decode and control, instruction register, data and address registers and buffers, 16-bit index register, 16-bit program counter, 16-bit stack pointer, two 8-bit accumulators, condition code register, and ALU (arithmetic logic unit).

The timing and control inputs and outputs for the 6800 chip are:

Phase 1 and phase 2 clock ( $\phi 1, \phi 2$ )—a nonoverlapping 500-kHz clock at  $V_{cc}$ .

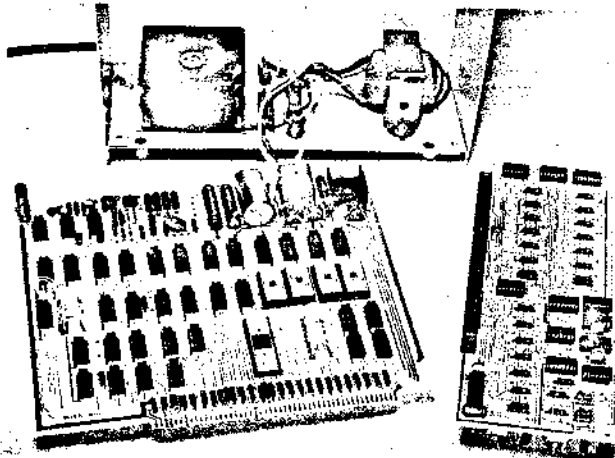
Address bus A0 through A15—16 high active outputs that determine address or I/O sections to use.





## DISPLAY PARTS LIST

C1,C4—0.33- $\mu$ F, 12-V disc ceramic capacitor  
 C2,C3—0.47- $\mu$ F, 12-V disc ceramic capacitor  
 DA00 to DA15, DD00 to DD07, and DS1 to DS3—RL21 light-emitting diode  
 ICA, ICB, ICC, ICD, ICE—74LS05  
 ICE, ICF, ICG, ICH—4449  
 ICJ—74100  
 ICK, ICL—26L123  
 Following resistors are 1/2-watt, 5%:  
 R1 to R16, R20 to R27—1500 ohms  
 R17 to R19—20,000 ohms  
 R28 to R30, R33 to R37—4700 ohms  
 R31 to R38—1000 ohms  
 R39, R40—10,000 ohms  
 SC1 to SC12—0.1- $\mu$ F, 12-V disc ceramic capacitor  
 SA00 to SA15, SD00 to SD07, S24—Spdt toggle switch  
 S26, S27—Spdt momentary toggle switch  
 Misc.—100-contact edge connector



Almost entire computer is assembled on a single large pc board (left). Board at right is for front panel. Boards plug together.

Data bus D0 through D7—eight high active bidirectional lines for transfer to and from memory and peripherals.

Halt signal (HLT)—low active input that ceases activity in the computer.

Read/write signal (R/W)—in the high state, signals the memory and peripherals that the MPU is in the read condition; in the low state, signals that the MPU is in the write condition.

Valid memory address (VMA)—signals external devices (memory and I/O) that the MPU has a valid address on the memory bus.

Data bus enable (DBE)—enables the bus drivers.

Bus available (BA)—indicates machine has stopped and address bus is available.

Reset (RES)—resets and starts the MPU from a power-off condition. A positive-going edge on this input tells the MPU to begin the restart sequence.

Interrupt request (IRQ)—when low, tells the MPU to start an interrupt sequence (save the registers on the stack, set interrupt mask bit high so no other interrupts can occur, and vector to the interrupt address). This type of interrupt can only occur if the interrupt mask bit in the condition code register is low.

Nonmaskable interrupt (NMI)—

essentially the same as the IRQ, except it is not dependent on the condition code register.

The clock is a 2-MHz crystal-controlled oscillator that uses a pair of inverters that drive flip-flops to form a 500-kHz, two-phase clock that is distributed to the MPU, memory, and I/O sections in the computer via inverters and buffers.

**Memory.** The memory system consists of 1024 words of 8-bit-wide RAM, using 2102-type 1024  $\times$  1-bit devices, and up to 1024 words of PROM, using ultraviolet-erasable 1702 devices. The basic arrangement is shown in Fig. 2. The low-order address bits are fed to both the RAM's and PROM's.

**Front Panel.** The front panel assembly contains the RUN/HALT switch, with a LED for each switch position; a reset switch with no LED indicator; and the ac power ON LED indicator (Fig. 3). The 16 ADDRESS switches each have their own LED indicator.

The DEPOSIT, RESET, DATA, and ADDRESS switches are enabled only when the RUN/HALT switch is in the HALT position, at which time, a retriggerable one-shot multivibrator drives the halt input of the MPU low. This, in turn, drives the bus-available (BA) signal high and also conditions the other switches. To view the data in any memory location, the RUN/HALT switch must be placed in the HALT position and the ADDRESS switches set to the required address. The data at that

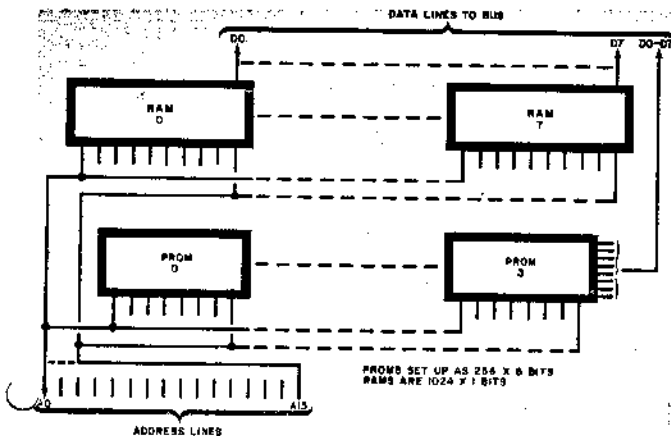


Fig. 2. There are eight RAM's (RAM 0 through RAM 7) and four PROM's (PROM 0 through PROM 3) in the computer's memory system.



causes an output to the built-in TTY output jack and at the Teletype itself.

**Power Supply.** The main 5-volt line is generated within the computer by a conventional bridge rectifier, filter capacitor, and IC regulator circuit. A 32-volt winding on the transformer is used to generate the unregulated  $\pm 16$  volts required for the TTY interface system, while a -16-volt line is fed to

four zener-diode-regulated outputs to provide four 9-volt lines for the PROM's.

**Construction.** The actual-size etching and drilling guides for the computer boards are larger than our page size. Rather than reducing or cutting them up to fit our pages, a free construction package is available. If you

wish to obtain a construction information package, simply send a self-addressed stamped 9" x 12" envelope to the address given at the end of the Parts List.

The construction package contains full-size schematics, full-size etching and drilling guides, component-placement diagrams, and front-panel layout. ♦

### CRAMER ELECTRONICS ENTERS OEM COMPUTER KIT MARKET

**T**HE major reason for the tremendous success of the various computer kits on the market is that they save considerable time. One doesn't have to hunt down the MPU's, memories, etc., that must be accumulated before embarking on a home computer project. It appears that OEM engineers are also spending considerable time in hunting down computer parts. Cramer Electronics, one of the leading U.S. electronic parts distributors, has decided to enter the computer kit business, with emphasis on the OEM market.

Cramer is starting with three kits, separately based on the Intel 8080, Motorola 6800, and Texas Instruments TMS8080 MPU's. Each of the kits

shares a common \$495 price tag.

You get a lot for \$495: complete color-coded schematic diagram; RAM with 1024 (8-bit) bytes, expandable to 65 k bytes; erasable PROM with 1024 (8-bit) bytes; support circuitry, including clock, complete buffering, control and synchronization logic, interrupts, DMA controls; etc. The PROM gives you a program to run at the outset. There are at least four 8-bit-wide input and output ports, with expandability to 512 ports, decoding for 16 of which is included.

The PROM contains a system monitor to permit the computer to be used as soon as it is assembled. Programs can be entered, modified, examined, and executed under switch

control or by typed-in commands. A cassette program, included with the kit, can be used to debug the computer. Finally, a complete user manual gives hints on programming and how to expand the computer.

All together, there are about 190 parts in each kit, adding up to a total catalog value of some \$700. Software is included in the kits to help in programming via front-panel switches and LED's, cassette tape, Teletypewriter, or any RS-232-compatible terminal. Not supplied are printed circuit boards, power supply, and cabinet.

For more information about the new computer kits, write to: Cramer Electronics, Inc., 65 Wells Ave., Newton, MA 02159. ♦

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Most of you know the evaluation of automotive electrical systems . . . an evaluation characterized only occasionally by efficiency and performance. I know that, and that's why I use the Delta Mark Ten B CDI on all my cars, new and old. And believe me, you don't have to have a new car to appreciate the best electronic ignition available today. Study these features and you'll know what I mean.

1. Mark Ten and Mark Ten B Capacitive Discharge Ignition Systems are manufactured by Delta Products, Inc., a company with a conscience, and with a proven record of reliability both in product and in customer relations.
2. The Mark Ten CDI's really do save money by eliminating the need for 2 out of 3 tune-ups. Figure it out for yourself. The first tune-up or two saved pays for the unit, the rest is money in your pocket. No bunk!
3. Because the Mark Ten CDI's keep your car in better tune, you actually can save on expensive gasoline.
4. With a Mark Ten, spark plugs stay clean and last longer . . . fouling is virtually eliminated.



No matter what kind of car you drive, it too can use a Delta quality lift.

I want to know more about Mark Ten B CDI's. Send me complete no-nonsense information on how they can improve the performance of my car.

Name

Address

City  State  Zip

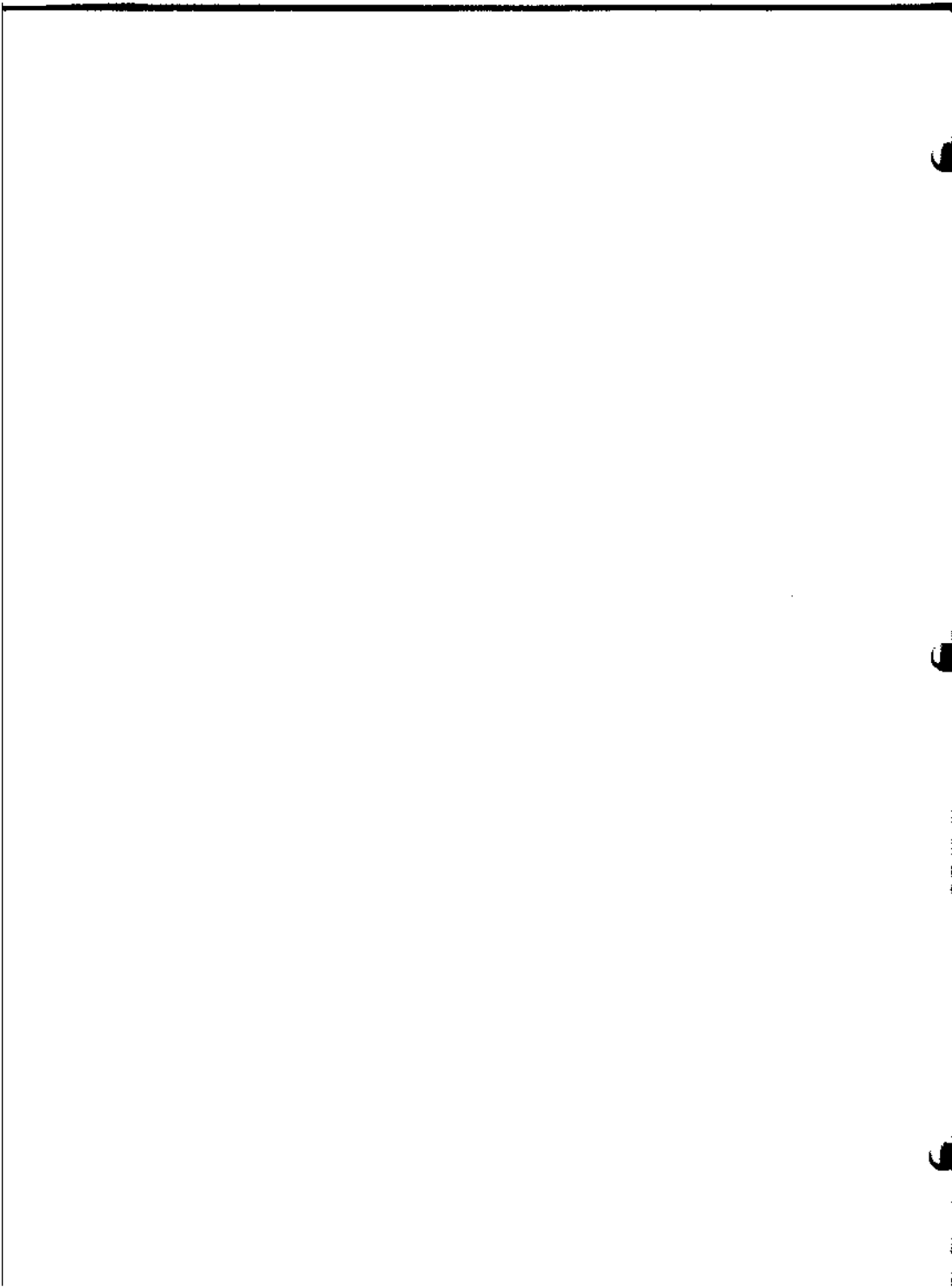


**DELTA PRODUCTS, INC.**

P.O. Box 1147, Dept. PE, Grand Junction, Colo. 81501  
303-242-9000

|                      |             |                             |             |
|----------------------|-------------|-----------------------------|-------------|
| Mark Ten B assembled | \$84 US ppd | Standard Mark Ten assembled | \$49.96 ppd |
| Mark Ten B kit       | \$49.95 ppc | DeltaKit®                   | \$34.95 ppd |

CIRCLE NO 25 ON FREE INFORMATION CARD 37



# MITS ALTAIR 8800

## PRICE LIST

AUG. 1, 1975

| PART NUMBER                                    | DESCRIPTION   | KIT             | ASSEM     | DAYS<br>DELIVERY |
|--|---|-----------------|-----------|------------------|
| <u>Computers, Terminals &amp; Line Printer</u> |   |                 |           |                  |
| *8800  | Altair 8800 Computer                                  | \$ 439.00       | \$ 621.00 | 60               |
| COMTER II                                      | Terminal w/ Built in Audio Cassette I/O               | 780.00          | 920.00    | 60               |
| CT-256   | Comter 256 Terminal                                   | 745.00          | 885.00    | 45-60            |
| CT-256   | Comter 256 in Aluminum Suitcase                       | --              | 985.00    | 90               |
| CT257, 8 or 9                                  | Pages 2, 3 or 4 for CT-256                            | 95.00           | 105.00    | 45-60            |
| CT-8096  | CRT Terminal  | TBD             | TBD       | TBD              |
| 88-VLCT  | Low Cost Terminal                                     | 129.00          | 169.00    | 45-60            |
| 88-80LP  | Line Printer & Controller, 110 char/sec               | 1,750.00        | 1,975.00  | 90               |
| 88-TTY   | Teletype ASR-33                                       | 1,500.00        | 1,500.00  | 60-90            |
| <u>Memory</u>                                  |   |                 |           |                  |
| 88-MM  | Adds 256 words to 88-MCS                              | 14.00           | 26.00     | 60               |
| 88-1MCS  | 1K Static Memory                                      | 97.00           | 139.00    | 60               |
| 88-2MCS  | 2K Static Memory                                      | 145.00          | 195.00    | 60               |
| 88-4MCD  | 4K Dynamic Memory                                     | 264.00          | 338.00    | 60               |
| 88-DCDD  | Disc Controller, 1 Disc Drive & Multiplexer           | 1,480.00        | 1,980.00  | 60               |
| 88-DISC  | Disc Drive in cabinet with added Multiplexer          | 1,180.00        | 1,600.00  | 60               |
| 88-DMAC  | Direct Memory Access Controller                       | 88.00           | 149.00    | TBD              |
| 88-DMAE  | Direct Memory I/O Channel--External                   | 126.00          | 186.00    | TBD              |
| 88-MAI   | Direct Memory I/O Channel--Internal                   | 123.00          | 183.00    | TBD              |
| <u>I/O and Expansion Devices</u>               |   |                 |           |                  |
| 88-PIO   | Parallel I/O  | 92.00           | 114.00    | 60               |
| 88-SIOA  | Serial I/O RS-232 compatible                          | 119.00          | 138.00    | 60               |
| 88-SIOB  | Serial I/O--TTL                                       | 124.00          | 146.00    | 60               |
| 88-SIOC  | Serial I/O--TTY                                       | 124.00          | 146.00    | 60               |
| *88-EC   | Expander Mother Board (adds 4 slots to 8800)          | 18.00           | 31.00     | 60               |
| 88-MB  | 88-EC including all edge connectors and card guides   | 65.00           | 138.00    | 30               |
| 88-EBG   | Expander Cabinet fadd'l case, P/S, etc. for 16 slots) | 394.00          | 485.00    | 60               |
| 88-EXC   | Extender Card   | 57.00           | 83.00     | 60               |
| 88-ACR   | Audio Cassette Record Interface                       | 128.00          | 174.00    | 60               |
| <u>Miscellaneous</u>                           |   |                 |           |                  |
| 88-VI  | Vectored Interrupt                                    | 126.00          | 179.00    | 90               |
| 88-RTC   | Real Time Clock                                       | 53.00           | 84.00     | 90               |
| 88-ACC   | Altair Cyclops Camera                                 | 180.00          | 235.00    | 90               |
| 88-CCC   | Camera Controller Card                                | 260.00          | 340.00    | 90               |
| 88-KB  | ASCII Keyboard  | 198.00          | 254.00    | 60               |
| 88-32DU  | 32 char Alpha/Numeric Display                         | 498.00          | 549.00    | 60               |
| 88-PPCB  | Prototype P.C. Board                                  | 57.00           | 84.00     | 60               |
| 88-FAN   | Cooling Fan   | 16.00           | 20.00     | 15               |
| 88-25DB  | Pr. Connectors--1 each 7325-DB25P & S + cover         | 11.00           | 11.00     | 15               |
| MS-416   | MilScope-4 channel scope                              | 127.00          | 189.00    | 60               |
| <u>PROM</u>                                    |   |                 |           |                  |
| 88-PMC   | PROM Memory Card (Holds 2K Bytes)                     | CONTACT FACTORY |           | 90               |
| 88-PROM  | PROM'S (256x8 Bytes)                                  | CONTACT FACTORY |           | 90               |
| 88-PPC   | PROM Programmer Card                                  | CONTACT FACTORY |           | 90               |

ASSEM DELIVERY  
DAYS

Suggested Systems

|     |                              |          |           |     |
|-----|------------------------------|----------|-----------|-----|
| I   | ALTAIR Basic I               | 1,850.00 | 2,391.00  | 60  |
| II  | ALTAIR Extended Basic II     | 2,100.00 | 2,756.00  | 60  |
| III | ALTAIR DOS/Basic III         | 4,990.00 | 6,649.00  | 90  |
| IV  | ALTAIR Extended Engr/Actg IV | 8,490.00 | 10,489.00 | 120 |

(To substitute teletype for Computer II add \$720 to kit or \$580 to assembled price.)  
Postage & handling is \$16 for Systems I, II & III and \$40 for System IV.

Software

|    |                |          |                 |            |
|----|----------------|----------|-----------------|------------|
| 15 | 4K BASIC       | \$950.00 | 4K memory, I/O  | \$60.00    |
| 15 | 8K BASIC       | \$500.00 | 8K memory, I/O  | \$75.00    |
| 15 | EXT BASIC      | \$750.00 | 12K memory, I/O | \$150.00   |
| 60 | Package I      | \$500.00 | 8K memory, I/O  | \$30.00    |
| 90 | DOS            | \$500.00 | 12K memory, I/O | \$150.00   |
| 30 | DEBUG          | \$100.00 | 4K memory, I/O  | \$25.00    |
|    | 4K & 8K Source |          |                 | \$3000.00* |
|    | DEBUG Source   |          |                 | \$75.00    |

Purchasers of 8800 plus:

NOTE: Software cannot be shipped until Software License Agreement is received by factory. Specify paper tape or audio tape when ordering.  
Miscellaneous Parts (A) P/N 88-CPU Complete CPU Board 310.00 360.00 60  
USERS GROUP ... \$30/yr Free w/8800 (Foreign add \$5)

|                                  |  |         |
|----------------------------------|--|---------|
| ..Manuals - Terminal CT-256      | Operators  | \$ 6.50 |
| ..Manuals - Altair 8800 Computer | Operators  | 10.00   |
|                                  | Assembly   | 10.00   |
|                                  | Theory of Operation, Schematics & Trouble Shooting | 10.00   |
| ..Manuals - Modular Boards       | Operators  | 7.50    |
|                                  | Assembly   | 9.00    |
|                                  | Theory of Operation, Schematics & Trouble Shooting | 9.00    |
|                                  | One Year up-date to theory manual                  | 10.00   |
|                                  | BASIC Language Documentation                       | \$10.00 |
|                                  | Assembler, Monitor, Editor                         | \$7.50  |
|                                  | Debug  | \$5.00  |
| ..Manuals - Modular Boards       | Combination Operators & Assembly (each)            | 5.00    |

Postage & Terms

- Terms: Cash with order, Mastercharge or BankAmericard
- Postage & Handling:
  - 1) Add \$8.00 each for Terminal, Computer, Line Printer, Teletype and Disc
  - 2) Add for Modular Boards
  - (a) - if ordered with computer
  - (b) \$3.00 if ordered separately
- 3) Postage included in price of manuals
- 4) Canada, Hawaii & Alaska: postage charges subject to quotation.

(\*) Note: Basic unit has 4 slots available, one of which is used up with CPU Board. When ordering more than 3 added boards, add 88-EC required for each 4 boards.  
(\*\*) Note: Manuals are included at no cost with purchased units.  
NOTE: Prices, specifications, development and delivery all subject to change without notice.

