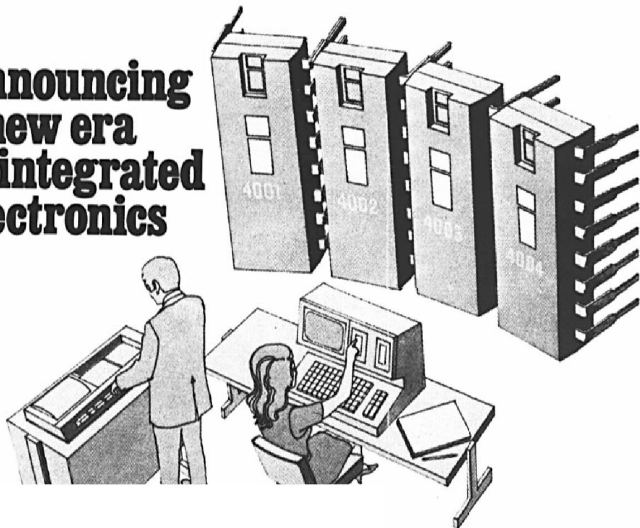


The Altair 8800 Computer The Start of the Personal Computer Revolution

Stephen A. Edwards

April 11, 2018

Announcing a new era of integrated electronics



A micro-programmable computer on a chip!

Intel introduces an integrated CPU complete with a 4-bit parallel adder, sixteen 4-bit registers, an accumulator and a push-down stack on one chip. It's one of a family of four new ICs which comprise the MCS-4 micro computer system—the first system to bring you the power and flexibility of a dedicated general-purpose computer at low cost in as few as two dual in-line packages.

MCS-4 systems provide complete computing and control functions for test systems, data terminals, billing machines, measuring systems, numeric control systems and process control systems.

The heart of any MCS-4 system is a Type 4004 CPU, which includes a powerful set of 45 instructions. Adding one or more Type 4001 ROMs for program storage and data tables gives you a fully functioning micro-programmed computer. To this you may add Type 4002 RAMs for read-write memory and Type 4003 registers to expand the output ports.

Using no circuitry other than ICs from this family of four, you can create a system with 4096 8-bit bytes of ROM storage and 5120 bits of RAM storage. When you require rapid turn-around or need only a few systems, Intel's erasable and re-programmable ROM, Type 1701, may be substituted for the Type 4001 mask-programmed ROM.

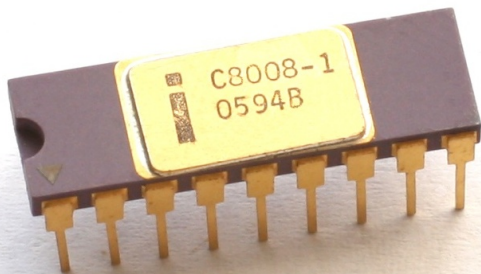
MCS-4 systems interface easily with switches, keyboards, displays, teletypewriters, printers, readers, A-D converters and other popular peripherals.

The MCS-4 family is now in stock at Intel's Santa Clara headquarters and at our marketing headquarters in Europe and Japan. In the U.S. contact your local Intel representative for technical information and literature. In Europe, contact Intel at Avenue Louise 216, B-1050 Brussels, Belgium. Phone 492003. In Japan, contact Intel Japan, Inc., Parkside Flat Bldg. No. 4-2-2, Sendagaya, Shinjuku-Ku, Tokyo 151. Phone 33-03-403-4747. Intel Corporation now produces micro computers, memory devices and memory systems at 3065 Bowers Avenue, Santa Clara, Calif. 95051. Phone (408) 246-7501.

intel
delivers.

1971: Intel's 4004. The first single-chip processor. 4-bit

1972: Intel's 8-bit 8008



By Konstantin Lanzet - CPU Collection Konstantin LanzetCamera: Canon EOS 400D, GFDL,
<https://commons.wikimedia.org/w/index.php?curid=5694177>

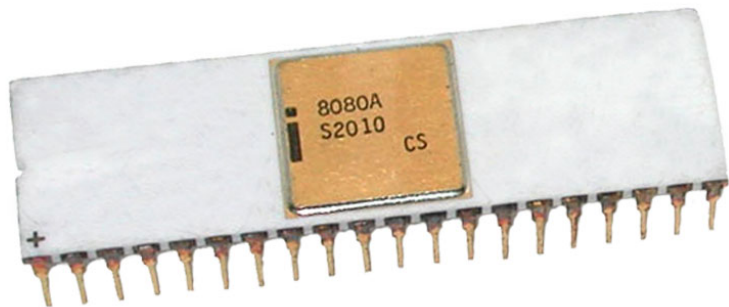
1974 Ford Pinto



Base price \$2292

Consumer Guide's Best Buy Subcompact of the Year

1974: Intel's 8-bit 8080



Initial price: \$360

Roughly \$1900 in 2018

HOW TO "READ" FM TUNER SPECIFICATIONS

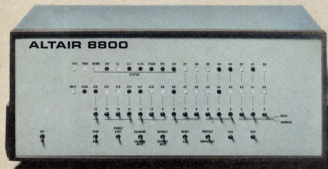
Popular Electronics

WORLD'S LARGEST-SELLING ELECTRONICS MAGAZINE JANUARY 1975 / 75¢

PROJECT BREAKTHROUGH!

World's First Minicomputer Kit to Rival Commercial Models...

"ALTAIR 8800" **SAVE OVER \$1000**



ALSO IN THIS ISSUE:

- An Under-\$90 Scientific Calculator Project
- CCD's—TV Camera Tube Successor?
- Thyristor-Controlled Photoflashers



TEST REPORTS:

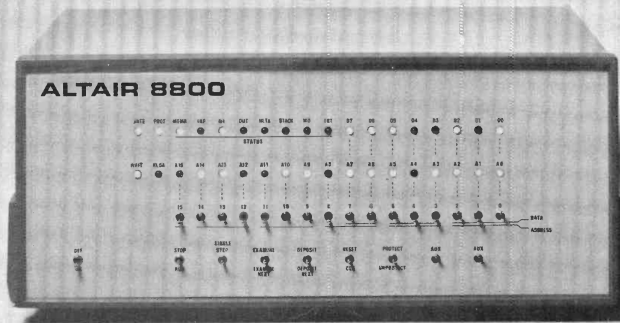
Technics 200 Speaker System
Pioneer RT-1011 Open-Reel Recorder
Tram Diamond-40 CB AM Transceiver
Edmund Scientific "Kirlan" Photo Kit
Hewlett-Packard 5381 Frequency Counter



EXCLUSIVE!

ALTAIR 8800

The most powerful minicomputer project ever presented—can be built for under \$400





1974: Complete kit: \$397; Assembled and tested: \$498
Sold thousands: 2500 by May 1975; 5000 by August.

“Roberts was able to acquire the new and powerful Intel 8080 CPU for \$75 each in large volume, when they normally sold for over \$300 each. These cosmetically blemished chips worked just as well as the more expensive ones, and allowed the Altair 8800 to be released at a very low price.”

—oldcomputers.net

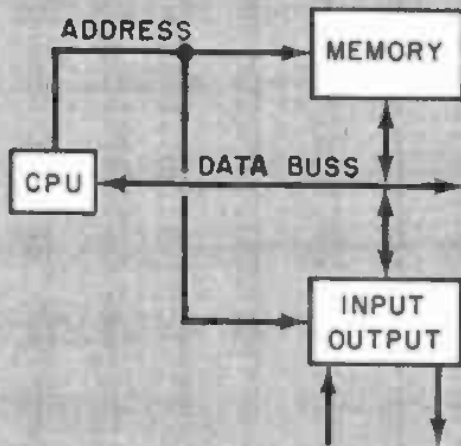
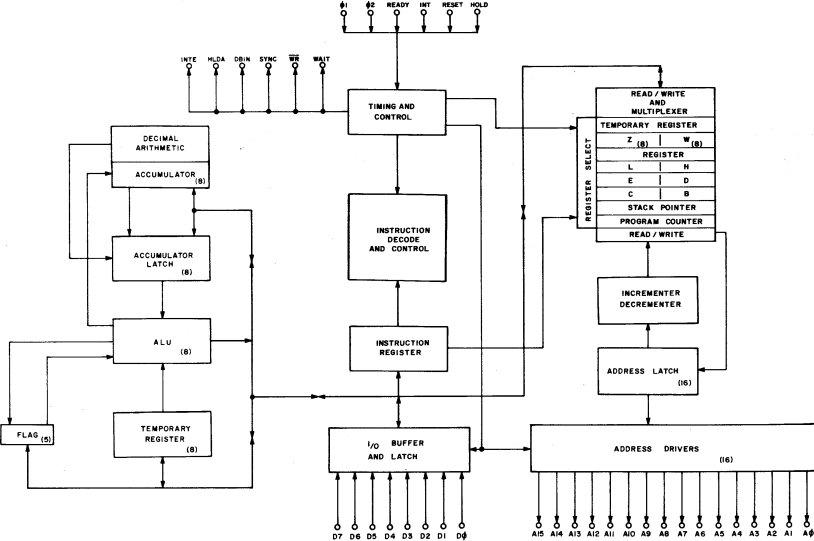


Fig. 1. Basic block diagram of computer parts and operation.

Intel 8080 Block Diagram



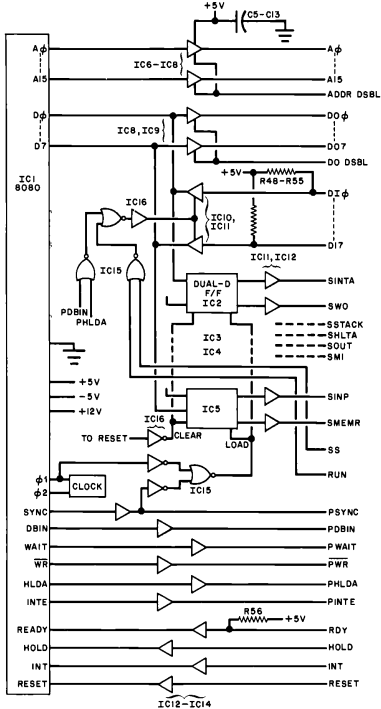
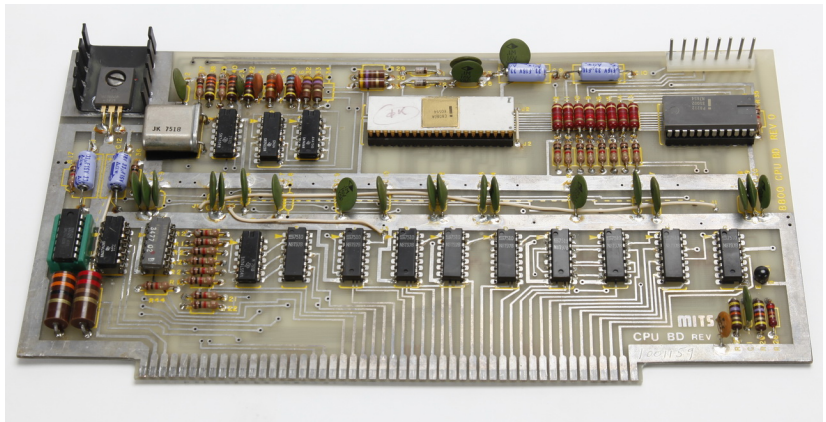


Fig. 3. The logic associated with the CPU (ICI) is shown at left. All of the buffers and latches are on a single pc board. Connecting wiring is through a 100-line buss.

Altair 8800 CPU Board



Power regulator, 2 MHz crystal, 8080 CPU, 8212 system status latch

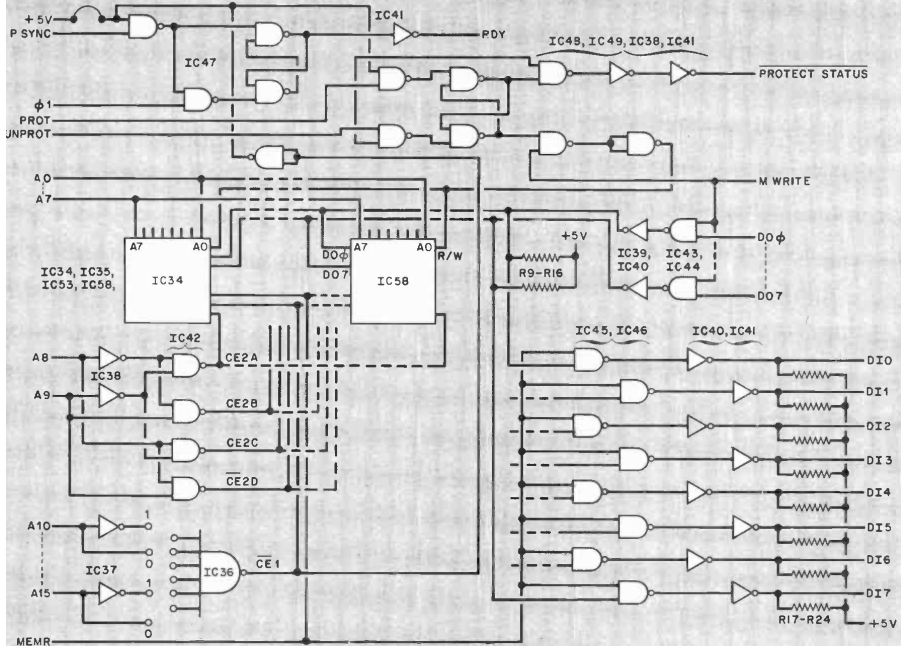
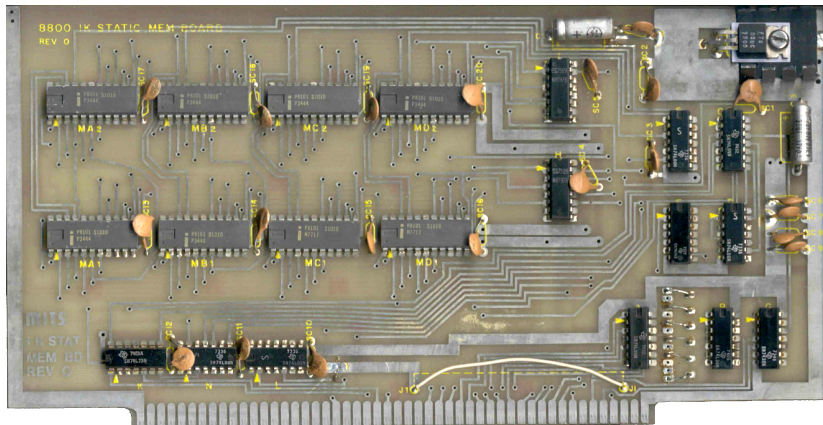
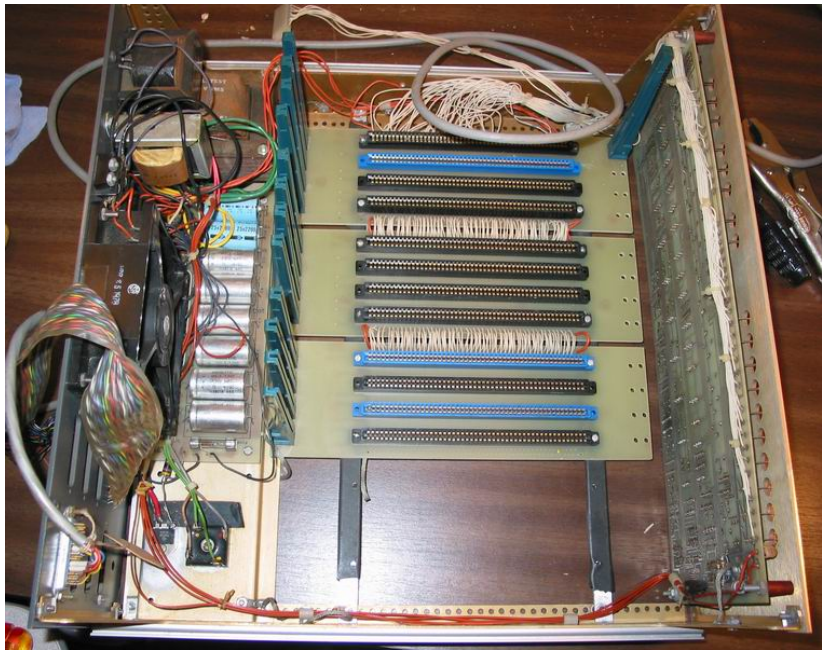


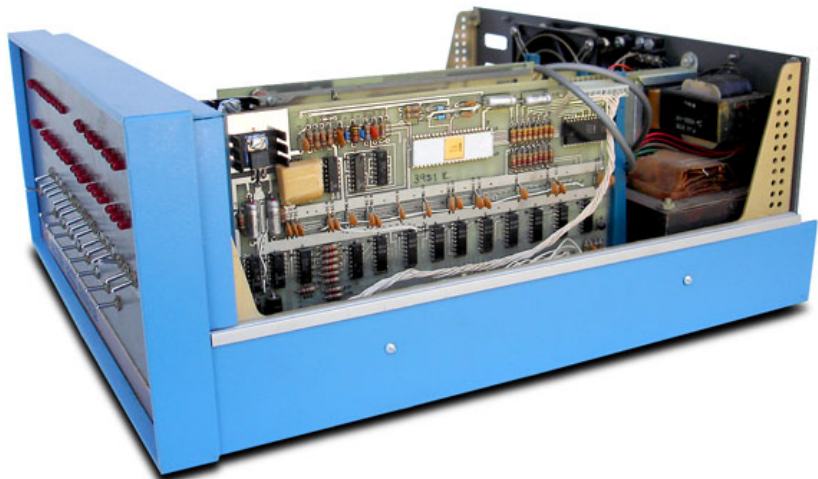
Fig. 5. The basic memory contains up to eight 256 x 4 RAM's.

1K RAM Board



8 Intel 8101 256 × 4-bit static RAMs





Altair 8800 Front Panel



Altair 8800 with Terminal



1975: MITS ALTAIR BASIC

1964: BASIC language developed at Dartmouth



10 Read about Altair in *Popular Electronics*

20 Contact MITS founder Ed Roberts

30 Offer to demo BASIC interpreter

40 Roberts agrees to meet

50 Write interpreter on Harvard's PDP-10

60 Present (working) interpreter to Roberts

\$150 (4K) or \$200 (8K)

```
10 INPUT A,B
20 IF A<=B THEN 50
30 PRINT "A IS BIGGER"
40 GOTO 10
50 IF A<B THEN 80
60 PRINT "THEY ARE THE SAME"
70 GOTO 10
80 PRINT "B IS BIGGER"
90 GOTO 10
```

1975: MITS ALTAIR BASIC

1964: BASIC language developed at Dartmouth



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If any immediate problems with MITS software are encountered, feel free to give us a call at (505) 265-7553. The Software Department is at Ext. 3; and the joint authors of the ALTAIR BASIC Interpreter, Bill Gates, Paul Allen and Monte Davidoff, will be glad to assist you.

—ALTAIR BASIC reference manual, 1975

The S-100 Bus

24 address lines (originally 16)

8 data-in lines

8 data-out lines

8 status lines

11 control lines

8 interrupt lines

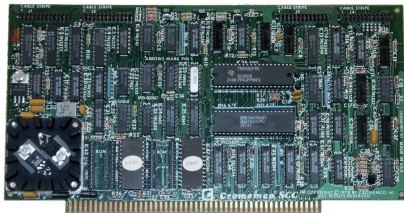
8 DMA lines

16 "utility" lines

9 power lines (+8V, $\pm 16V$)

100 pins

Standardized as IEEE 696-1983



Cromemco SCC, c. 1978

December 1975: The IMSAI 8080. Kit w/ 1K, \$439

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INTERCHANGEABLE CPU, MEMORY, and I/O BOARDS

	KIT	ASSEMBLED
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2K PROM 80-1RD Fourth Form	1.75.00	195.00
I/O MODULE IMS 222-TTY-TTL*	119.00	138.00
COMBINATION VECTORED INTERRUPT & R.T. CLOCK	119.00	138.00

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FLOPPY DISK DRIVE IN CABINET	264.00	264.00
FLOPPY DISK CONTROLLER (4 DRIVES)	2095.00	2095.00
DIABLO/HY TYPE PRINTER CAB. & P.S.	115.00	142.00
HYTYPE CONTROLLER BOARD	200.00	1995.00
200 LPM LINE PRINTER, CAB. & P.S.	260.00	340.00
LINE PRINTER CONTROLLER	77,800.00	76,500.00
50 MEGABYTE DISK CONTROLLER, CABINET AND DISKS		

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ALL BOARDS AND SOFTWARE INTERCHANGEABLE BETWEEN IMSAI 8080 AND ALTAIR 8800

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CHIPS: (FACTORY TESTED, FIRST RUN, PRIME)

1702 A	\$17.00	\$080	\$39.00
8111 or 2102 (500 m-)	4.00	8224	15.00
8080 8224/8228 SET	125.00	8228	15.00

7400 SERIES T.T.L. PINOUT HANDBOOK

COVERS ENTIRE 5400/7400 SERIES D.I.P. I.C.'s PIN CONNECTIONS, FUNCTIONAL SPECS

CROSS REFERENCE \$3.99

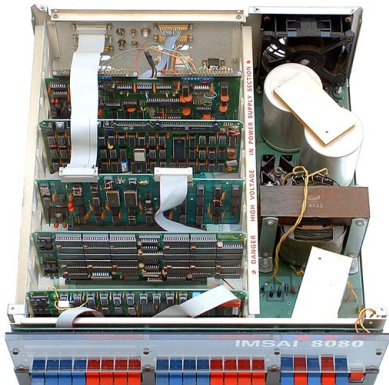
*Registered Trademark

IMS ASSOCIATES INC.
1922 REPUBLIC AVE., SAN LEANDRO, CALIF. 94577

TERMS: CHECK, M.O., BANKAMERICA, MASTER CHARGE 25% DEPOSIT ON C.O.D.

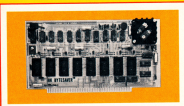
ADD 5% POSTAGE AND HANDLING.
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PRICES SUBJECT TO CHANGE WITHOUT NOTICE

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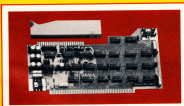


Four ways to get more out of (or into) your computer

Here are four of our most popular computer peripherals. They let you do a lot more with your Altair 8800 or IMSA 8080. They are simple to use and simple to install. And they all have the combined quality and low price that has made Cromemco the leading name in microcomputer peripherals. Cromemco's delivery is prompt, too. Watch this space for other exciting new Cromemco products to come.



The easy way to put programs into PROM. Cromemco's Byteviewer™ gives you a place for up to 8K of PROM memory using 2704/2708 PROMs. Also gives you a built-in PROM programmer (leave buying one separately). Enough memory capacity to hold powerful programs such as 8K BASIC, KR (Model KBKS-K): \$195. Assembled (Model KBKS-W): \$295.



Fast analog I/O with 7 channels. Couples your digital computer to an analog world. This advanced board lets you input 7 channels of analog to your computer and output 7 channels of analog to feed to output devices. Also has an 8-bit parallel I/O port. Very fast conversion—only 5 microseconds. Kit (Model D-7A-K): \$145. Assembled (Model D-7A-W): \$245. **JOYSTICK ALSO AVAILABLE:** Kit (Model JS-1-K): \$65. Assembled (Model JS-1-W): \$95.



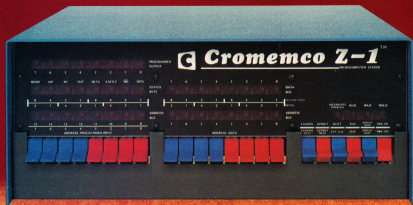
Let your color TV be your display terminal. You can have a full-color computer display terminal at unbelievably low cost with the Cromemco TV Dazzler™. You can display multi-colored charts, graphs, educational material, games. Requires only 2K-byte memory for 128 x 128-element picture. Kit (Model GGI-K): \$215. Assembled (Model GGI-W): \$390.



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Cards (Byte, September 1976)



This is the industry's most powerful microcomputer (it's also a powerful Z-80 μ P development system)

Uses high-speed Z-80 μ P

You see here a major new development in microcomputers: the Cromemco Z-1.

It is the fastest and most powerful microcomputer available.

It gets its speed and power from a selected version of the new Z-80 microprocessor that can operate at a 4 MHz clock rate. (The Z-1 also lets you switch to 2 MHz to be compatible with older systems.)

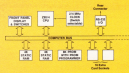
μ P development system

In addition to being a powerful microcomputer the Z-1 is a major μ P development system. It will give you a big head start in developing your circuits around the Z-80 μ P.

All you need do is plug your breadboards into the Z-1's 16 or more extra sockets. You're right into the computer bus.

Broad "S-100" support

What's more, the Z-1 offers you all kinds of peripherals and software. It uses the standard "S-100"



bus supported by over a dozen manufacturers. And all Cromemco peripherals (PROM memory and programmers, RAM memory, analog I/O, color TV interface, etc.) just plug into the Z-1's extra sockets.

Cromemco also provides complete software support: a monitor, assembler, BASIC interpreter and more to come soon.

Another thing you can bet the Z-1 won't be obsolete. Future CPU cards can plug in for the present CPU card.

Not a kit

The Z-1 comes completely assembled and tested. It's a quality, commercial-grade microcomputer. It

is not available as a kit. Just plug it into the 110-volt line and you're ready to go.

The Z-1's ready, too. It's being shipped. And for all you get, the low \$2495 price is a pleasant surprise. It's especially pleasant when you compare it with the price of any complete, assembled microcomputer with all the Z-1's features.

Call now and get our brochure on this new system which is so important in working with the Z-80.

Z-1 components

- Z-80/4 CPU
- 8K static RAM
- Capacity for 8K PROM
- PROM programmer
- Resident monitor in PROM
- RS-232 I/O
- Full 22-slot motherboard and connectors
- Fan installed
- Not a kit; completely assembled

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Computers (January 1977)

Cromemco Systems and Processor Cards

Z-80 System	Year	Slots	Floppies	Hard Disk
Z-1	1976	21	-	-
Z-2	1977	21	-	-
System Two Z-2D	1978	21	2 × 5.25"	-
System Three	1978	21	4 × 8"	-
System Zero	1980	4	-	-
System Two Z-2H	1980	12	2 × 5.25"	11 MB
System One CS-1	1981	8	2 × 5.25"	-
System One CS-1H	1981	8	1 × 5.25"	5 MB

Card	Year	Processor	Clock	Whetstones
ZPU	1976	Z-80A	4 MHz	7,000
DPU	1982	Z-80A + MC68000	4 + 8 MHz	40,000
XPU	1984	Z-80B + MC68010	5 + 10 MHz	50,000
XXU	1986	MC68020	16.7 MHz	1,050,000

Source: Wikipedia

The CP/M Operating System


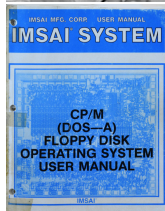
1974: Gary Kildall develops CP/M to run on an Intel 8080 development board with a 5.25" floppy

1976: Glenn Ewing approaches Kildall on behalf of IMSAI to port CP/M to their machines with floppies.

1977: IMSAI releases CP/M (DOS-A)

1980: IBM approaches Digital Research to license CP/M for the forthcoming IBM PC. Talks fail and IBM instead contracts with Microsoft to produce MS-DOS.

Ultimately, CP/M sold over 250,000 copies



CP/M™
LOW-COST
MICRO-COMPUTER
SOFTWARE

CP/M™ OPERATING SYSTEM:

- Editor, Assembler, Debugger and Utilities.
- For 8080, 280, or Intel 8085.
- For IBM-compatible floppy disks.
- **\$100** Diskette and Documentation.
- **\$25** Documentation (Set of 6 manuals) only.

MAC™ MACRO ASSEMBLER:


- Compatible with new Intel macro standard.
- Complete guide to macro applications.
- **\$50** Diskette and Manual.

SID™ SYMBOLIC DEBUGGER

- Symbolic memory references
- Built-in assembler/disassembler.
- **\$75** Diskette and Manual.

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- Powerful text formatting capabilities.
- Text prepared using CP/M Editor.
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CP/M's Greatest Hits

Many important commercial programs started on CP/M.

Programs very portable across CP/M machines (3,000 machine configurations)

Program	Application
WordStar	word processor
dBase II	database
Zork	text adventure
Turbo Pascal	compiler
SuperCalc	spreadsheet
AutoCAD	computer-aided design

August 1981: The IBM PC (Intel 8088-based)



Altair-Duino

\$150 from <http://www.altairduino.com>

Built with an Arduino Due

32-bit ARM Cortex M3 processor

84 MHz

96 KB RAM

512 KB Flash

Runs an 8080 emulator

SD card for storage



STATUS

RTE	PROT	MEMR	WP	MI	OUT	HLTA	STACK	WO	INT	D7	D6	D5	D4	D3	D2	D1	D0
WRT	HLDA	AS	AM	AS	MZ	AJ	AD	AS	AB	A7	A6	A5	A4	A3	A2	A1	A0
		S	S	S	S	S	S	S	S	S	S	S	S	S	S	S	S
		D	D	D	D	D	D	D	D	D	D	D	D	D	D	D	D
		S	S	S	S	S	S	S	S	S	S	S	S	S	S	S	S

OFF STOP SINGLE STEP EXAMINE DEPOSIT RESET PROTECT ALX ALX
ON RUN EXAMINE DEPOSIT CLR UNPROTECT

ALTAIR 8800 COMPUTER

MAIN CIRCUIT BOARD

- 1 x Product Book
- 1 x DC Switch
- 1 x 8-pin Reed LED
- 1 x 12-pin LED Standoff
- 1 x 10-pin Standoff
- 1 x 1200 Resistor
- 1 x 100K Resistor
- 1 x 470K Resistor
- 1 x 1K Ohm Diode
- 1 x Front Panel
- 1 x MAX232 DB9
- 1 x 2K 100 Ohm Resistor
- 1 x 10K Potentiometer
- 1 x 20-pin Standoff
- 1 x 25-pin Standoff
- 1 x 20-pin Header
- 1 x 25-pin Header
- 1 x 10K Potentiometer
- 1 x 10K Potentiometer
- 1 x 10K Potentiometer

More saving...
THE HOME

1 x Bag of blue jumpers

1 x Keyboard cable

1 x Bag of components

1 x Power supply unit

