

# **AltairZ80 Simulator Usage**

**05-Jan-2007**

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Original code for the AltairZ80 part published in 2002-2007, written by Peter Schorn

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This memorandum documents the Altair 8800 Simulator with Z80 support.

## 1 Simulator Files

sim/scp.h

sim\_console.h

sim\_defs.h

sim\_fio.h

sim\_rev.h

sim\_sock.h

sim\_timer.h

sim\_tmxr.h

scp.c

sim\_console.c

sim\_fio.c

sim\_sock.c

sim\_timer.c

sim\_tmxr.c

sim/AltairZ80/altairz80\_defs.h

altairz80\_cpu.c

altairz80\_dsk.c

altairz80\_hdsk.c

altairz80\_net.c

altairz80\_sio.c

altairz80\_sys.c

## 2 Revision History

- 05-Jan-2007, Peter Schorn (added networking capability, included CP/NET and CPNOS)
- 26-Nov-2006, Peter Schorn (SIO can now be attached to a file, SIO rewritten for better efficiency)
- 15-Oct-2006, Peter Schorn (updated CP/M 2 operating system and application software description)
- 17-Sep-2006, Peter Schorn (added Altair Basic 5.0 to the sample software, corrected TTY/ANSI description)
- 21-Aug-2006, Peter Schorn (added MINOL and VTL-2 software, retyping courtesy of Emmanuel ROCHE, fixed a bug in memory breakpoints and added a create ("C") switch to the attach command)
- 24-Jan-2006, Peter Schorn (transcribed documentation to Word / PDF format)
- 05-Apr-2005, Peter Schorn (removed bogus t-state stepping support)
- 24-Jul-2004, Peter Schorn (updated CP/M 2 and SPL packages)

- Original version of this document written by Charles E Owen

The MITS (Micro Instrumentation and Telemetry Systems) Altair 8800 was announced on the January 1975 cover of Popular Electronics, which boasted you could buy and build this powerful computer kit for only \$397. The kit consisted at that time of only the parts to build a case, power supply, card cage (18 slots), CPU card, and memory card with 256 \*bytes\* of memory. Still, thousands were ordered within the first few months after the announcement, starting the personal computer revolution as we know it today.

## 4 Hardware

<b>CPU</b>	Altair 8800 with Intel 8080 CPU board 62KB of RAM, 2K of EPROM with start boot ROM.
<b>SIO</b>	MTS 88-2SIO Dual Serial Interface Board. Port 1 is assumed to be connected to a serial "glass TTY" that is your terminal running the Simulator.
<b>PTR</b>	Paper Tape Reader attached to port 2 of the 2SIO board.
<b>PTP</b>	Paper Tape Punch attached to port 2 of the 2SIO board. This also doubles as a printer port.
<b>DSK</b>	MTS 88-DISK Floppy Disk controller with up to eight drives.

We have 2 CPU options that were not present on the original machine but are useful in the simulator. We also allow you to select memory sizes, but be aware that some sample software requires the full 64K (i.e. CP/M) and the MITS Disk Basic and Altair DOS require about a minimum of 24K.

SIMH AltairZ80

SET CPU Z80	Simulates the Z80 CPU. Note that some software (e.g. most original Altair software such as 4K Basic) requires an 8080 CPU and will not or not properly run on a Z80. This is mainly due to the use of the parity flag on the 8080 which has not always the same semantics on the Z80.
SET CPU ITRAP	Causes the simulator to halt if an invalid opcode is detected (depending on the chosen CPU).
SET CPU NOITRAP	Does not stop on an invalid opcode. This is how the real 8080 works. Note that some software such as 4K Basic apparently tries to execute nonexistent 8080 instructions. Therefore it is advisable in this case to SET CPU NOITRAP.
SET CPU 4K	All these set various CPU memory configurations.
SET CPU 8K	
SET CPU 12K	
SET CPU 16K	
... (in 4K steps)	
SET CPU 64K	
SET CPU BANKED	Enables the banked memory support. The simulated memory has eight banks with address range 0..'COMMON' (see registers below) and a common area from 'COMMON' to 0FFFF which is common to all banks. The currently active bank is determined by register 'BANK' (see below). You can only switch to banked memory if the memory is set to 64K. The banked memory is used by CP/M 3.
SET CPU NONBANKED	Disables banked memory support.
SET CPU ROM	Enables the ROM from address 'ROMLOW' to 'ROMHIGH' (see below under CPU Registers) and prevents write access to these locations. This is the default setting.
SET CPU NOROM	Disables the ROM.
SET CPU ALTAIRROM	Enables the slightly modified but downwards compatible Altair boot ROM at addresses 0FF00 to 0FFFF. This is the default.
SET CPU NOALTAIRROM	Disables standard Altair ROM behavior.
SET CPU WARNROM	Enables warning messages to be printed when the CPU attempts to write into ROM or into non-existing memory. Also prints a warning message if the CPU attempts to read from non-existing memory.
SET CPU NOWARNROM	Suppresses all warning message of "WARNROM". Note that some software tries on purpose to write to ROM in order to detect the available RAM.

The BOOT EPROM card starts at address 0FF00 if it has been enabled by 'SET CPU ALTAIRROM'. Jumping to this address will boot drive 0 of the floppy controller (CPU must be set to ROM or equivalent code must be present). If no valid bootable software is present there the machine crashes. This is historically accurate behavior.

The real 8080, on receiving a HLT (Halt) instruction, freezes the processor and only an interrupt or CPU hardware reset will restore it. The simulator is a lot nicer, it will halt but send you back to the simulator command line.

CPU Registers include the following:

<b>Name</b>	<b>Size</b>	<b>Comment</b>
PC	16	The Program Counter
AF	16	The accumulator (8 bits) and the flag register F = S Z - AC - P/V N C S = Sign flag. Z = Zero Flag. - = not used (undefined) AC = Auxiliary Carry flag. P/V = Parity flag on 8080 (Parity / Overflow flag on Z80) - = not used (undefined) N = Internal sign flag C = Carry flag.
BC	16	The BC register pair. Register B is the high 8 bits, C is the lower 8 bits
DE	16	The DE register pair. Register D is the high 8 bits, E is the lower 8 bits.
HL	16	The HL register pair. Register H is the high 8 bits, L is the lower 8 bits.
AF1	16	The alternate AF register (on Z80 only)
BC1	16	The alternate BC register (on Z80 only)
DE1	16	The alternate DE register (on Z80 only)
HL1	16	The alternate HL register (on Z80 only)
IX	16	The IX index register (on Z80 only)
IY	16	The IY index register (on Z80 only)
IFF	8	Interrupt flag (on Z80 only)
INT	8	Interrupt register (on Z80 only)
SR	16	The front panel switches (use D SR 8 for 4k Basic).
WRU	8	The interrupt character. This starts as 5 (Control-E) but some Altair software uses this keystroke so best to change this to something exotic such as 035 (which is Control-J).
BANK	3	The currently active memory bank (if banked memory is activated - see memory options above)
COMMON	16	The starting address of common memory. Originally set to 0C000 (note this setting must agree with the value supplied to GENCPM for CP/M 3 system generation)
ROMLOW	16	The starting address of the ROM. Default is 0FF00.
ROMHIGH	16	The final address of the ROM. Default is 0FFFF.

CLOCK	32	The clock speed of the simulated CPU in kHz or 0 to run at maximum speed. To set the clock speed for a typical 4 MHz Z80 CPU, use D CLOCK 4000. The CP/M utility SPEED measures the clock speed of the simulated CPU.
-------	----	---

## 4.2 The Serial I/O Card (2SIO)

This simple programmed I/O device provides 2 serial ports to the outside world, which could be hardware jumpered to support RS-232 plugs or a TTY current loop interface. The standard I/O addresses assigned by MITS was 10-11 (hex) for the first port, and 12-13 (hex) for the second. We follow this standard in the simulator.

The simulator directs I/O to/from the first port to the screen. The second port reads from an attachable "tape reader" file on input, and writes to an attachable "punch file" on output. These files are considered a simple stream of 8-bit bytes.

The SIO can be configured in SIMH with the following commands:

SET SIO ANSI	Bit 8 is set to zero on console output
SET SIO TTY	Bit 8 is not touched on console output
SET SIO ALL	Console input remain unchanged
SET SIO UPPER	Console input is transformed to upper case characters only (This feature is useful for most Altair software). SET SIO MAP must also have been executed for this option to take effect - otherwise no mapping occurs.
SET SIO BS	Map the delete character to backspace SET SIO MAP must also have been executed for this option to take effect - otherwise no mapping occurs.
SET SIO DEL	Map the backspace character to delete SET SIO MAP must also have been executed for this option to take effect - otherwise no mapping occurs.
SET SIO QUIET	Do not print warning messages
SET SIO VERBOSE	Print warning messages (useful for debugging) The register SIOWL determines how often the same warning is displayed. The default is 3.
SET SIO MAP	Enable mapping of characters (see also SET SIO ALL/UPPER/BS/DEL)
SET SIO NOMAP	Disable mapping of characters (see also SET SIO ALL/UPPER/BS/DEL)
SET SIO BELL	Displaying ^G (Control-G) sounds the bell
SET SIO NOBELL	Do not display ^G (Control-G, bell character. This feature is useful when a simulated program makes excessive use of the bell character.

You can also attach the SIO to a port or a file:

ATTACH SIO 23	Console IO goes via a Telnet connection on port 23 (often requires root privileges, you can also use another port and use telnet with this port)
ATTACH SIO <filename>	Console input is taken from the file with name <filename> and output goes to the SIMH console. Note that sometimes this does not work as expected since some application programs or operating system commands periodically check for input.
DETACH SIO	Console IO goes via the regular SIMH console

### 4.3 The SIMH pseudo device

The SIMH pseudo device facilitates the communication between the simulated ALTAIR and the simulator environment. This device defines a number of (most R/O) registers (see source code) which are primarily useful for debugging purposes.

The SIMH pseudo device can be configured with

SET SIMH QUIET	Do not print warning messages
SET SIMH VERBOSE	Print warning messages (useful for debugging)
SET SIMH TIMERON	Start periodic timer interrupts
SET SIMH TIMEROFF	Stop the periodic timer interrupts

The following variables determine the behavior of the timer:

TIMD	This is the delay between consecutive interrupts in milliseconds. Use D TIMD 20 for a 50 Hz clock.
TIMH	This is the address of the interrupt handler to call for a timer interrupt.

### 4.4 The 88-DISK controller

The MITS 88-DISK is a simple programmed I/O interface to the MITS 8-inch floppy drive, which was basically a Pertec FD-400 with a power supply and buffer board built-in. The controller supports neither interrupts nor DMA, so floppy access required the sustained attention of the CPU. The standard I/O addresses were 8, 9, and 0A (hex), and we follow the standard. Details on controlling this hardware are in the altairz80\_dsk.c source file.

The only difference is that the simulated disks may be larger than the original ones: The original disk had 77 tracks while the simulated disks support up to 254 tracks (only relevant for CP/M). You can change the number of tracks per disk by setting the appropriate value in TRACKS[.]. For example "D TRACKS[0] 77" sets the number of tracks for disk 0 to the original number of 77. The command "D TRACKS[0-7] 77" changes the highest track number for all disks to 77.

For debugging purposes you can set the trace level of some disk I/O functions. To do so the following bits in TRACE (a register of the disk) have been defined with the following meaning:

1	Trace all IN and OUT instructions on the disk ports 8 and 9
2	Trace all read and writes to full sectors on the disk
4	Print a message whenever an unnecessary step-in or step out of the disk head occurs (often an indication of an infinite loop)
8	Print a message whenever the disk head appears to be waiting for a sector which does not show up (often an indication of an infinite loop)

For example the command "D TRACE 10" will trace options 2+8 from above.

The DSK device can be configured with

SET DSK<n> QUIET	Do not print warning messages for disk <n>.
SET DSK<n> VERBOSE	Print warning messages for disk <n> (useful for debugging). The register DSKWL determines how often the same warning is displayed. The default is 3.
SET DSK<n>WRITEENABLED	Allow write operations for disk <n>.



SET DSK<n> LOCKED                      Disk <n> is locked, i.e. no write operations will be allowed.

## 4.5 The simulated hard disk

In order to increase the available storage capacity, the simulator features 8 simulated hard disks with a capacity of 8MB (HDSK0 to HDSK7). Currently only CP/M supports two hard disks as devices I: and J:.

For debugging purposes one can set the trace flag by executing the command "D HDTRACE 1". The default for "HDTRACE" is 0 (no trace).

The HDSK device can be configured with

SET HDSK<n> QUIET	Do not print warning messages for hard disk <n>.
SET HDSK<n> VERBOSE	Print warning messages for hard disk <n> (useful for debugging).
SET HDSK<n> WRITEENABLED	Allow write operations for hard disk <n>.
SET HDSK<n> LOCKED	Hard disk <n> is locked, i.e. no write operations will be allowed.

## 4.6 The simulated network

The simulator supports networking via sockets (TCP/IP) for simulating operating systems such as CP/NET (see section 5.4) and CPNOS (see section 5.5) which require at least two machines connected by a network.

The NET device can be configured with

SET NET CLIENT	Puts this machine into client mode.
SET NET SERVER	Puts this machine into server mode.
ATTACH NET <IP-addr>:<port>	Attaches the machine to the given IP address and listening on the specified port. The IP address is given in a.b.c.d format ( $0 \leq a, b, c, d \leq 255$ ). A typical example is "ATTACH NET 127.0.0.1:4000" which attaches to the local host at port 4000. Note that certain "small" port numbers might require special permissions.
DETACH NET	Detaches the machine from the network.

# 5 Sample Software

Running an Altair in 1977 you would be running either MITS Disk Extended BASIC, or the brand new and sexy CP/M Operating System from Digital Research. Or possibly, you ordered Altair DOS back when it was promised in 1975, and are still waiting for it to be delivered in early 1977.

We have samples of all three for you to check out. We can't go into the details of how they work, but we'll give you a few hints.

## 5.1 CP/M Version 2.2

This version is my own port of the standard CP/M to the Altair. There were some "official" versions but I don't have them. None were endorsed or sold by MITS to my knowledge, however.

To boot CP/M:

```
sim> attach dsk cpm2.dsk
```

```
sim> boot dsk
```

CP/M feels like DOS, sort of. DIR will work. I have included all the standard CP/M utilities, plus a few common public-domain ones. I also include the sources to the customized BIOS and some other small programs. TYPE will print an ASCII file. DUMP will dump a binary one. LS is a better DIR than DIR. ASM will assemble .ASM files to hex, LOAD will "load" them to binary format (.COM). ED is a simple editor, #A command will bring the source file to the buffer, T command will "type" lines, L will move lines, E exits the editor. 20L20T will move down 20 lines, and type 20. Very DECish. DDT is the debugger, DO is a batch-type command processor. A sample batch file that will assemble and write out the bootable CP/M image (on drive A) is "SYSCPM2.SUB". To run it, type "DO SYSCPM2".

In order to efficiently transfer files into the CP/M environment use the included program R <filename.ext>. If you have a file named foo.ext in the current directory (i.e. the directory where SIMH is), executing R FOO.EXT under CP/M will transfer the file onto the CP/M disk. Transferring a file from the CP/M environment to the SIMH environment is accomplished by W <filename.ext> for text files or by W <filename.ext> B for binary files. The simplest way for transferring multiple files is to create a ".SUB" batch file which contains the necessary R resp. W commands.

If you need more storage space you can use a simulated hard disk on drives I: and J:. To use do "attach HDSK0 hdi.dsk" and issue the "XFORMAT I:" resp. "XFORMAT J:" command from CP/M to initialize the disk to an empty state.

The disk "cpm2.dsk" contains the following files:

Name	Ext	Size	Comment
ASM	.COM	8K	CP/M assembler
BDOS	.MAC	66K	Basic Disk Operating System assembler source code
BOOT	.COM	2K	transfer control to boot ROM
BOOT	.MAC	2K	source for BOOT.COM
BOOTGEN	.COM	2K	put a program on the boot sectors
CBIOSX	.MAC	48K	CP/M 2 BIOS source for Altair
CCP	.MAC	26K	Console Command Processor assembler source code, original Digital Research
CCPZ	.MAC	50K	Console Command Processor assembler source code, Z80 replacement with some extra features
CCPZ	.TXT	40K	documentation for CCPZ
CFGCCP	.LIB	2K	configuration file for system generation, original CCP
CFGCCPZ	.LIB	2K	configuration file for system generation, with CCPZ
COPY	.COM	2K	copy disks
CPU	.COM	2K	get and set the CPU type (8080 or Z80)
CPU	.MAC	2K	source for CPU.COM
CREF80	.COM	4K	cross reference utility
DDT	.COM	6K	8080 debugger
DDTZ	.COM	10K	Z80 debugger
DIF	.COM	4K	determine differences between two files

Name	Ext	Size	Comment
DO	.COM	4K	batch processing with SuperSub (SUBMIT.COM replacement)
DSKBOOT	.MAC	8K	source for boot ROM
DUMP	.COM	2K	hex dump a file
ED	.COM	8K	line editor
ELIZA	.BAS	10K	Eliza game in Basic
EX	.MAC	48K	source for EX8080.COM, EXZ80DOC.COM, EXZ80ALL.COM
EX	.SUB	2K	benchmark execution of EX8080.COM, EXZ80DOC.COM, EXZ80ALL.COM
EX8080	.COM	12K	exercise 8080 instruction set
EXZ80ALL	.COM	12K	exercise Z80 instruction set, undefined status bits taken into account
EXZ80DOC	.COM	12K	exercise Z80 instruction set, no undefined status bits taken into account
FORMAT	.COM	2K	format disks
GO	.COM	0K	start the currently loaded program at 100H
HALT	.COM	2K	execute the HALT operation for returning to the sim> command prompt – useful as the last command in a script
HDSKBOOT	.MAC	6K	boot code for hard disk
L80	.COM	12K	Microsoft linker
LADDER	.COM	40K	game
LADDER	.DAT	2K	high score file for LADDER.COM
LIB80	.COM	6K	library utility
LOAD	.COM	2K	load hex files
LS	.COM	4K	directory utility
LU	.COM	20K	library utility
M80	.COM	20K	Microsoft macro assembler
MBASIC	.COM	24K	Microsoft Basic interpreter
MC	.SUB	2K	assemble and link an assembler program
MCC	.SUB	2K	read, assemble and link an assembler program
MCCL	.SUB	2K	assemble, link and produce listing
MOVER	.MAC	2K	moves operating system in place
OTHELLO	.COM	12K	Othello (Reversi) game
PIP	.COM	8K	Peripheral Interchange Program
PRELIM	.COM	2K	preliminary CPU tests
PRELIM	.MAC	6K	source code for PRELIM.COM
R	.COM	4K	read files from SIMH environment. Supports wild card expansion on UNIX and Windows for reading multiple files.
RSETSIMH	.COM	2K	reset SIMH interface

Name	Ext	Size	Comment
RSETSIMH	.MAC	2K	assembler source for RSETSIMH.COM
SHOWSEC	.COM	2K	show sectors on a disk
SID	.COM	8K	debugger for 8080
SPEED	.COM	2K	utility to measure the clock speed of the simulated CPU
STAT	.COM	6K	provide information about currently logged disks
SUBMIT	.COM	2K	batch processing
SURVEY	.COM	2K	system survey
SURVEY	.MAC	16K	assembler source for SURVEY.COM
SYSCOPY	.COM	2K	copy system tracks between disks
SYSCPM2	.SUB	2K	create CP/M 2 on drive A:, Digital Research CCP and BDOS
SYSCPM2Z	.SUB	2K	Create CP/M 2 on drive A:, CCPZ and Digital Research BDOS
TIMER	.COM	2K	perform various timer operations
TIMER	.MAC	2K	source code for TIMER.COM
UNCR	.COM	8K	un-crunch utility
UNERA	.COM	2K	un-erase a file
UNERA	.MAC	16K	source for UNERA.COM
USQ	.COM	2K	un-squeeze utility
W	.COM	2K	write files to SIMH environment. Supports CP/M wild card expansion for writing multiple files.
WM	.COM	12K	word master screen editor
WM	.HLP	4K	help file for WM.COM
WORM	.COM	4K	worm game for VT100 terminal
XFORMAT	.COM	2K	initialize a drive (floppy or hard disk)
XSUB	.COM	2K	support for DO.COM
ZAP	.COM	10K	SuperZap 5.2 disk editor configured for VT100
ZSID	.COM	10K	debugger for Z80
ZTRAN4	.COM	4K	translate 8080 mnemonics into Z80 equivalents

## 5.2 CP/M Version 3 with banked memory

CP/M 3 is the successor to CP/M 2.2. A customized BIOS (BIOS3.MAC) is included to facilitate modification if so desired. The defaults supplied in GENCPM.DAT for system generation can be used. BOOTGEN.COM is used to place the CP/M loader (LDR.COM) on the boot tracks of a disk.

Running CP/M 3 with banked memory:

```
sim> attach dsk cpm3.dsk
sim> reset cpu
sim> set cpu banked
```

```
sim> set cpu itrap
```

```
sim> boot dsk
```

Executing "DO SYSCPM3" will re-generate the banked version of CP/M 3. You can boot CP/M 3 with or without a Z80 CPU. The Z80 CPU is needed for both sysgens due to the use of BOOTGEN.COM which requires it.

The disk "cpm3.dsk" contains the following files:

Name	Ext	Size	Comment
ASM	.COM	8K	CP/M assembler
ASSIGN	.SYS	2K	
BDOS3	.SPR	10K	
BIOS3	.MAC	28K	CP/M 3 BIOS source for Altair SIMH
BIOS3	.SPR	4K	
BNKBDOS3	.SPR	14K	
BNKBIOS3	.SPR	4K	
BOOT	.COM	2K	transfer control to boot ROM
BOOTGEN	.COM	2K	put a program on the boot sectors
CCP	.COM	4K	
COPYSYS	.COM	2K	
CPM3	.SYS	18K	
CPMLDR	.MAC	38K	CP/M 3 loader assembler source
DATE	.COM	4K	date utility
DDT	.COM	6K	8080 debugger
DDTZ	.COM	10K	Z80 debugger
DEFS	.LIB	2K	include file for BIOS3.MAC to create banked CP/M 3
DEVICE	.COM	8K	
DIF	.COM	4K	determine differences between two files
DIR	.COM	16K	directory utility
DO	.COM	6K	batch processing (SUBMIT.COM)
DUMP	.COM	2K	
ED	.COM	10K	
ERASE	.COM	4K	
GENCOM	.COM	16K	
GENCPM	.COM	22K	
GENCPM	.DAT	4K	CP/M generation information for banked version
GENCPMNB	.DAT	4K	CP/M generation information for non-banked version
GET	.COM	8K	

Name	Ext	Size	Comment
HELP	.COM	8K	help utility
HELP	.HLP	62K	help files
HEXCOM	.CPM	2K	
HIST	.UTL	2K	
INITDIR	.COM	32K	
L80	.COM	12K	Microsoft linker
LDR	.COM	4K	CP/M loader with optimized loader BIOS
LDRBIOS3	.MAC	14K	optimized (for space) loader BIOS
LIB	.COM	8K	Digital Research librarian
LINK	.COM	16K	Digital Research linker
LOAD	.COM	2K	
M80	.COM	20K	Microsoft macro assembler
MC	.SUB	2K	assemble and link an assembler program
MCC	.SUB	2K	read, assemble and link an assembler program
PATCH	.COM	4K	
PIP	.COM	10K	Peripheral Interchange Program
PROFILE	.SUB	2K	commands to be executed at start up
PUT	.COM	8K	
R	.COM	4K	read files from SIMH environment
RENAME	.COM	4K	
RESBDOS3	.SPR	2K	
RMAC	.COM	14K	Digital Research macro assembler
RSETSIMH	.COM	2K	reset SIMH interface
SAVE	.COM	2K	
SCB	.MAC	2K	
SET	.COM	12K	
SETDEF	.COM	6K	
SHOW	.COM	10K	
SHOWSEC	.COM	4K	show sectors on a disk
SID	.COM	8K	8080 debugger
SYSCOPY	.COM	2K	copy system tracks between disks
SYSCPM3	.SUB	2K	create banked CP/M 3 system
TRACE	.UTL	2K	
TSHOW	.COM	2K	show split time

Name	Ext	Size	Comment
TSTART	.COM	2K	create timer and start it
TSTOP	.COM	2K	show final time and stop timer
TYPE	.COM	4K	
UNERA	.COM	2K	un-erase a file
W	.COM	4K	write files to SIMH environment
XREF	.COM	16K	cross reference utility
ZSID	.COM	10K	Z80 debugger

### 5.3 MP/M II with banked memory

MP/M II is an acronym for MultiProgramming Monitor Control Program for Microprocessors. It is a multi-user operating system for an eight bit microcomputer. MP/M II supports multiprogramming at each terminal. This version supports four terminals available via Telnet. To boot:

```
sim> attach dsk mpm.dsk
sim> set cpu itrap
sim> set cpu z80
sim> set cpu rom
sim> set cpu banked
sim> attach sio 23
sim> d common b000
sim> boot dsk
```

Now connect a Telnet session to the simulator and type "MPM" at the "A>" prompt. Now you can connect up to three additional terminals via Telnet to the Altair running MP/M II. To re-generate the system perform "DO SYSPM" in the CP/M environment (not possible under MP/M since XSUB is needed).

The disk "mpm.dsk" contains the following files:

Name	Ext	Size	Comment
ABORT	.PRL	2K	abort a process
ABORT	.RSP	2K	
ASM	.PRL	10K	MP/M assembler
BNKBDOS	.SPR	12K	banked BDOS
BNKXDOS	.SPR	2K	banked XDOS
BNKXIOS	.SPR	4K	banked XIOS
BOOTGEN	.COM	2K	copy an executable to the boot section
CONSOLE	.PRL	2K	print console number
CPM	.COM	2K	return to CP/M
CPM	.MAC	2K	source for CPM.COM
DDT	.COM	6K	MP/M DDT

Name	Ext	Size	Comment
DDT2	.COM	6K	CP/M DDT
DDTZ	.COM	10K	CP/M DDT with Z80 support
DIF	.COM	4K	difference between two files
DIR	.PRL	2K	directory command
DO	.COM	2K	batch processing (SUBMIT.COM)
DSKRESET	.PRL	2K	disk reset command
DUMP	.MAC	6K	source for DUMP.PRL
DUMP	.PRL	2K	dump command
ED	.PRL	10K	MP/M line editor
ERA	.PRL	2K	erase command
ERAQ	.PRL	4K	erase command (verbose)
GENHEX	.COM	2K	
GENMOD	.COM	2K	
GENSYS	.COM	10K	
L80	.COM	12K	Microsoft linker
LDRBIOS	.MAC	14K	loader BIOS
LIB	.COM	8K	library utility
LINK	.COM	16K	linker
LOAD	.COM	2K	loader
M80	.COM	20K	Microsoft macro assembler
MC	.SUB	2K	assemble and link an assembler program
MCC	.SUB	2K	read, assemble and link an assembler program
MPM	.COM	8K	start MP/M II
MPM	.SYS	26K	MP/M system file
MPMD	.LIB	2K	define a banked system
MPMLDR	.COM	6K	MP/M loader without LDRBIOS
MPMSTAT	.BRS	6K	status of MP/M system
MPMSTAT	.PRL	6K	
MPMSTAT	.RSP	2K	
MPMXIOS	.MAC	26K	XIOS for MP/M
PIP	.PRL	10K	MP/M peripheral interchange program
PIP2	.COM	8K	CP/M peripheral interchange program
PRINTER	.PRL	2K	
PRLCOM	.PRL	4K	



Name	Ext	Size	Comment
R	.COM	4K	read a file from the SIMH environment
RDT	.PRL	8K	debugger for page relocatable programs
REN	.PRL	4K	rename a file
RESBDOS	.SPR	4K	non-banked BDOS
RMAC	.COM	14K	Digital Research macro assembler
RSETSIMH	.COM	2K	reset SIMH interface
SCHED	.BRS	2K	schedule a job
SCHED	.PRL	4K	
SCHED	.RSP	2K	
SDIR	.PRL	18K	fancy directory command
SET	.PRL	8K	set parameters
SHOW	.PRL	8K	show status of disks
SPOOL	.BRS	4K	spool utility
SPOOL	.PRL	4K	
SPOOL	.RSP	2K	
STAT	.COM	6K	CP/M stat command
STAT	.PRL	10K	MP/M stat command
STOPSPLR	.PRL	2K	stop spooler
SUBMIT	.PRL	6K	MP/M submit
SYSCOPY	.COM	2K	copy system tracks
SYSMPM	.SUB	2K	do a system generation
SYSTEM	.DAT	2K	default values for system generation
TMP	.SPR	2K	
TOD	.PRL	4K	time of day
TSHOW	.COM	2K	show split time
TSTART	.COM	2K	create timer and start it
TSTOP	.COM	2K	show final time and stop timer
TYPE	.PRL	2K	type a file on the screen
USER	.PRL	2K	set user area
W	.COM	4K	write a file to SIMH environment
XDOS	.SPR	10K	XDOS
XREF	.COM	16K	cross reference utility
XSUB	.COM	2K	for CP/M DO

## 5.4 CP/NET

This software is included as part of the archive **cpnet.zip**. To bring up the server component:

```
sim> attach dsk cpnetserver.dsk
sim> d common ab00
sim> set cpu 64k
sim> set cpu itrap
sim> set cpu z80
sim> set cpu rom
sim> set cpu banked
sim> set simh timeroff
sim> attach sio 23
sim> set net server
sim> at net 127.0.0.1:4000
sim> boot dsk
```

You can also execute “AltairZ80 cpnetserver” for the same effect or type “do cpnetserver<return>” at the “sim>” command prompt. Then connect via Telnet to the simulator and type “mpm <return>” at the “0A>” command prompt to start the MP/M CP/NET server.

To bring up a client, start another instance of AltairZ80 and type the following at the command prompt:

```
sim> attach dsk cpnetclient.dsk
sim> set cpu 64k
sim> set cpu noitrap
sim> set cpu z80
sim> set cpu altairrom
sim> set cpu nonbanked
sim> reset cpu
sim> set sio ansi
sim> set net client
sim> at net 127.0.0.1:4000
sim> boot dsk
```

You can also execute “AltairZ80 cpnetclient” for the same effect or type “do cpnetclient<return>” at the “sim>” command prompt. Then

```
A>cpnetldr<return>    ; loads CP/NET client
A>login<return>       ; to login
A>network b:=a:       ; to map server drive A: to client drive B:
A>dir b:              ; shows the contents of the server drive A:
```

The MP/M server is configured to accept one or two network clients. So you can repeat the previous procedure for a second client if you wish.

Note that all system specific sources (SNIOS.MAC, NETWRKIF.MAC, MPMXIOS.MAC) are included on cpnetclient.dsk respectively cpnetserver.dsk. When executing "GENSYS" for re-creating MP/M, keep in mind to include SERVER.RSP and NETWRKIF.RSP as this is not automatically suggested by GENSYS.

## 5.5 CPNOS

CPNOS is a thin client front-end for the CP/NET server. This software is also included as part of the archive **cpnet.zip**. In order to execute, first bring up a CP/NET server as described in section 5.4. Then for the client, start another instance of AltairZ80:

```
sim> set cpu 64k
sim> set cpu noitrap
sim> set cpu z80
sim> set cpu noaltairrom
sim> set cpu norom
sim> set cpu nonbanked
sim> reset cpu
sim> set sio ansi
sim> set net client
sim> at net 127.0.0.1:4000
sim> load cpnos.com f000
sim> g f000
```

For the same effect you can also execute "AltairZ80 cpnos" or type "do cpnos<return>" at the "sim>" command prompt. At the "LOGIN=" prompt, just type return and you will see the familiar "A>" prompt but the drive is the A: drive of the MP/M CP/NET server (you can also attach other disks to the server and they will become available to the CPNOS client). You can also connect a second CPNOS client to the same CP/NET server – further connection attempts will block after logging in until another CPNOS client is disconnected (e.g. by typing ^E to stop the simulator and then typing "bye<return>" at the simh command prompt). It is also possible to have both a CP/NET client and a CPNOS thin client connect to the same CP/NET server.

Note that all system specific sources (CPBIOS.MAC and CPNIOS.MAC) are included on cpnetclient.dsk.

## 5.6 CP/M application software

There is also a small collection of sample application software containing the following items:

- SPL                a Small Programming Language with a suite of sample programs
- PROLOGZ        a Prolog interpreter written in SPL with sources
- PASCFORM     a Pascal pretty printer written in Pascal
- Pascal MT+    Pascal language system needed to compile PASCFORM

The sample software comes on "app.dsk" and to use it do

```
sim> attach dsk1 app.dsk
```

before booting CP/M.

The disk "app.dsk" contains the following files:

Name	Ext	Size	Comment
ACKER	.COM	2K	compute the Ackermann function
ACKER	.SPL	4K	compute the Ackermann function, SPL source
BOOTGEN	.COM	2K	copy the operating system to the rights sectors and tracks
BOOTGEN	.SPL	6K	SPL source for BOOTGEN.COM
C	.SUB	2K	batch file for compiling an SPL source file
CALC	.PRO	4K	Prolog demo program: Calculator
DIF	.COM	4K	
DIF	.SPL	10K	SPL source for DIF.COM
FAC	.COM	2K	compute the factorial
FAC	.SPL	4K	compute the factorial, SPL source
FAMILY	.PRO	4K	Prolog demo program: Family relations
FORMEL	.COM	4K	calculator
FORMEL	.SPL	6K	calculator, SPL source
INTEGER	.PRO	2K	Prolog demo program: Integer arithmetic
KNAKE	.PRO	2K	Prolog demo program: Logic puzzle
LINKMT	.COM	12K	Pascal MT+ 5.5 linker
MTERRS	.TXT	6K	Pascal MT+ error messages
MTPLUS	.000	14K	Pascal MT+ 5.5 compiler file
MTPLUS	.001	12K	Pascal MT+ 5.5 compiler file
MTPLUS	.002	8K	Pascal MT+ 5.5 compiler file
MTPLUS	.003	8K	Pascal MT+ 5.5 compiler file
MTPLUS	.004	18K	Pascal MT+ 5.5 compiler file
MTPLUS	.005	8K	Pascal MT+ 5.5 compiler file
MTPLUS	.006	6K	Pascal MT+ 5.5 compiler file
MTPLUS	.COM	36K	Pascal MT+ 5.5 compiler
PASCFORM	.COM	36K	Pascal formatter
PASCFORM	.PAS	54K	Pascal formatter source code
PASCFORM	.SUB	2K	create Pascal formatter
PASLIB	.ERL	24K	Pascal MT+ 5.5 run time library
PINST	.COM	4K	terminal installation program for PROLOGZ
PINST	.SPL	16K	terminal installation program for PROLOGZ, SPL source
PRIM	.COM	2K	compute prime numbers
PRIM	.SPL	2K	compute prime numbers, SPL source
PROLOGZ	.COM	16K	PROLOGZ interpreter and screen editor

Name	Ext	Size	Comment
PROLOGZ	.SPL	54K	SPL source for PROLOGZ
PROLOGZ	.TXT	40K	PROLOGZ documentation in German
PROLOGZU	.MAC	2K	helper functions for PROLOGZ in assembler
QUEEN	.PRO	2K	Prolog demo program: N-queens problem
READ	.COM	4K	transfer a file from the file system to the CP/M disk, see also WRITE.COM
READ	.SPL	10K	SPL source for READ.COM
RELDUMP	.COM	4K	dump a .REL file to the console
RELDUMP	.SPL	10K	dump a .REL file to the console, SPL source
SHOWSEC	.COM	2K	show a disk sector
SHOWSEC	.SPL	6K	SPL source for SHOWSEC.COM
SIEVE	.COM	2K	compute prime numbers with a sieve
SIEVE	.SPL	6K	compute prime numbers with a sieve, SPL source
SPEED	.COM	2K	utility to measure the clock speed of the simulated CPU
SPEED	.SPL	4K	SPL source for SPEED.COM
SPL	.COM	28K	the SPL compiler itself
SPL	.TXT	50K	SPL language and compiler documentation
SPLERROR	.DAT	8K	error messages of the compiler
SPLRTL	.REL	2K	SPL runtime library
SYSCOPY	.COM	2K	copy the system tracks between disks
SYSCOPY	.SPL	6K	SPL source for SYSCOPY.COM
WC	.COM	6K	word count and query facility
WC	.SPL	14K	word count and query facility, SPL source
WRITE	.COM	2K	write a CP/M file to the file system, see also READ.COM
WRITE	.SPL	8K	SPL source for W.COM
XFORMAT	.COM	2K	format a regular disk or a hard disk
XFORMAT	.SPL	6K	SPL source for XFORMAT.COM

## 5.7 MITS Disk Extended BASIC Version 4.1

This was the commonly used software for serious users of the Altair computer. It is a powerful (but slow) BASIC with some extended commands to allow it to access and manage the disk. There was no operating system it ran under. This software is part of the archive **altsw.zip**. To boot:

```
sim> set cpu 8080                ;Z80 will not work
sim> attach dsk mbasic.dsk
sim> set sio upper
sim> go ff00
```

```

MEMORY SIZE? [return]
LINEPRINTER? [C return]
HIGHEST DISK NUMBER? [0 return] (0 here = 1 drive system)
NUMBER OF FILES? [3 return]
NUMBER OF RANDOM FILES? [2 return]
44041 BYTES FREE
ALTAIR BASIC REV. 4.1
[DISK EXTENDED VERSION]
COPYRIGHT 1977 BY MITS INC.
OK
[MOUNT 0]
OK
[FILES]

```

## 5.8 Altair DOS Version 1.0

This was long promised but not delivered until it was almost irrelevant. A short attempted tour will reveal it to be a dog, far inferior to CP/M. This software is part of the archive **altsw.zip**. To boot:

```

sim> d tracks[0-7] 77 ;set to Altair settings
sim> set cpu altairrom
sim> attach dsk altdos.dsk
sim> set sio upper
sim> go ff00
MEMORY SIZE? [return]
INTERRUPTS? N [return]
HIGHEST DISK NUMBER? [0 return] (3 here = 4 drive system)
HOW MANY DISK FILES? [3 return]
HOW MANY RANDOM FILES? [2 return]

056449 BYTES AVAILABLE
DOS MONITOR VER 1.0
COPYRIGHT 1977 BY MITS INC
.[MNT 0]

.[DIR 0]

```

## 5.9 Altair Basic 3.2 (4k)

In order to run the famous 4k Basic, use the following commands (the trick is to get the Switch Register right). This software is part of the archive **altsw.zip**.

```

sim> set cpu 8080      ;note 4k Basic will not run on a Z80 CPU
sim> set sio upper      ;4k Basic does not like lower case letters as input
sim> set cpu noitrap    ;4k Basic likes to execute non 8080 instructions-ignore
sim> set sio ansi       ;4k Basic produces 8-bit output, strip to seven bits
sim> d sr 8            ;good setting for the Switch Register
sim> load 4kbas.bin 0    ;load it at 0
sim> go 0              ;and start it
MEMORY SIZE? [return]
TERMINAL WIDTH? [return]
WANT SIN? [Y]

61911 BYTES FREE

BASIC VERSION 3.2
[4K VERSION]

OK

```

## 5.10 Altair 8k Basic

Running 8k Basic follows the procedure for 4k Basic. This software is part of the archive **altsw.zip**.

```

sim> set cpu 8080      ;note 8k Basic will not run on a Z80 CPU
sim> set sio upper      ;8k Basic does not like lower case letters as input
sim> set sio ansi       ;8k Basic produces 8-bit output, strip to seven bits
sim> d sr 8            ;good setting for the Switch Register
sim> load 8kbas.bin 0    ;load it at 0
sim> go 0              ;and start it
MEMORY SIZE? [A]

WRITTEN FOR ROYALTIES BY MICRO-SOFT

MEMORY SIZE? [return]
TERMINAL WIDTH? [return]
WANT SIN-COS-TAN-ATN? [Y]

58756 BYTES FREE
ALTAIR BASIC REV. 4.0
[EIGHT-K VERSION]

```

COPYRIGHT 1976 BY MITS INC.

OK

## 5.11 Altair Basic 4.0

This software is part of the archive **altsw.zip**. Execute the following commands to run Altair Extended Basic:

```
sim> set sio upper      ;Extended Basic requires upper case input
sim> set sio ansi       ;Extended Basic produces 8-bit output, strip to 7 bits
sim> d sr 8             ;good setting for the Switch Register
sim> load exbas.bin 0    ;load it at 0
sim> go 0               ;and start it
16384 Bytes loaded at 0.
```

MEMORY SIZE? [return]

WANT SIN-COS-TAN-ATN? [Y]

50606 BYTES FREE

ALTAIR BASIC REV. 4.0

[EXTENDED VERSION]

COPYRIGHT 1977 BY MITS INC.

OK

## 5.12 Altair Disk Extended Basic Version 300-5-C

This version of Basic was provided by Scott LaBombard. This software is part of the archive **altsw.zip**. To execute use the following commands:

```
sim> d tracks[0-7] 77      ;set to Altair settings
sim> at dsk extbas5.dsk
sim> g 0
```

MEMORY SIZE? [return]

LINEPRINTER? [C]

HIGHEST DISK NUMBER? [0]

HOW MANY FILES? [3]

HOW MANY RANDOM FILES? [3]

42082 BYTES FREE

ALTAIR DISK EXTENDED BASIC

VERSION 300-5-C [01NOV78]



COPYRIGHT 1978 BY MITS INC.

OK

### 5.13 Altair Disk Extended Basic Version 5.0

This version of Basic can be found on Andrew Kessel's <http://www.altairage.com/> site. Note that the MBL files on this site need to be converted to plain binary files using the Python script in the appendix. This software is part of the archive **altsw.zip**. To execute use the following commands:

```
sim> d tracks[0-7] 77      ;set to Altair settings
sim> at dsk disbas50.dsk
sim> d sr 8
sim> load disbas50.bin 0
sim> g 0
```

```
MEMORY SIZE? [return]
LINEPRINTER? [C]
HIGHEST DISK NUMBER? [return]
HOW MANY FILES? [3]
HOW MANY RANDOM FILES? [3]
```

```
41695 BYTES FREE
ALTAIR BASIC 5.0 [14JUL78]
[DISK EXTENDED VERSION]
COPYRIGHT 1978 BY MITS INC.
OK
```

### 5.14 Altair programming languages VTL-2 and MINOL

Emmanuel ROCHE retyped the manuals and assembler code for these two tiny languages. You need the archive **minolvtl.zip** which contains full documentation, sources and command files to execute the simulator.

## 6 Special simulator feature: Memory access breakpoints

In addition to the regular SIMH features such as PC queue, breakpoints etc., this simulator supports memory access breakpoints. A memory access breakpoint is triggered when a pre-defined memory location is accessed (read, write or update). To set a memory location breakpoint enter

```
sim> break -m <location>
```

Execution will stop whenever an operation accesses <location>. Note that a memory access breakpoint is not triggered by fetching code from memory (this is the job of regular breakpoints). This feature has been implemented by using the typing facility of the SIMH breakpoints.

## 7 Brief summary of all major changes to the original Altair simulator

- Full support for Z80. CP/M software requiring a Z80 CPU now runs properly. DDTZ and PROLOGZ are included for demonstration purposes.
- Added banked memory support.
- PC queue implemented.
- Full assembler and dis-assembler support for Z80 and 8080 mnemonics. Depending on the current setting of the CPU, the appropriate mnemonics are used.
- The BOOT ROM was changed to fully load the software from disk. The original code basically loaded a copy of itself from the disk and executed it.
- ROM and memory size settings are now fully honored. This means that you cannot write into the ROM or outside the defined RAM (e.g. when the RAM size was truncated with the SET CPU commands). This feature allows programs which check for the size of available RAM to run properly (e.g. 4k Basic). In addition one can enable and disable the ROM which is useful in special cases (e.g. when testing a new version of the ROM).
- The console can also be used via Telnet. This is useful when a terminal is needed which supports cursor control such as a VT100. PROLOGZ for example has a built-in screen editor which works under Telnet.
- Simplified file exchange for CP/M. Using the READ program under CP/M one can easily import files into CP/M from the regular file system. Note that PIP does not work properly on non-text files on PTR.
- The WRITE program can be used to transfer files from the CP/M environment to the regular environment (binary or ASCII transfer).
- The last character read from PTR is always Control-Z (the EOF character for CP/M). This makes sure that PIP (Peripheral Interchange Program on CP/M) will terminate properly.
- Fixed a bug in the BIOS warm boot routine which caused CP/M to crash.
- Modified the BIOS for CP/M to support 8 disks.
- Added CP/M 3 banked version as sample software
- Changed from octal to hex
- Made the DSK and SIO device more robust (previously malicious code could crash the simulator)
- Added memory access break points
- Added periodic timer interrupts (useful for MP/M)
- Added additional consoles (useful for MP/M)
- Added MP/M II banked version as sample software
- Added networking support for CP/NET and CPNOS

## 8 Appendix: Python script for converting MBL files to plain binary files

```
#!/usr/bin/python
# -*- coding: UTF-8 -*-
# formatted for tab-stops 4
#
```

```

# By Peter Schorn, peter.schorn@acm.org, September 2006
#
#
# Transform an MBL file to a binary file suitable for loading with SIMH
#
# Structure of MBL files is as follows:
# <byte>+ 0x00 0x00
# (checksum<byte> 0x3c count<byte> loadLow<byte> loadHigh<byte>
# <byte> * count)+
# where the lower 8 bit of the load address are determined by loadLow
# and the upper 8 bit of the load address are determined by loadHigh
# For checksum the following rules hold:
# For the first load record: 0
# For the second load record: (sum of all load bytes of the first
# load record) mod 256
# For the third and higher load records: (sum of all load bytes of
# the preceding load record - 1) mod 256
# A header with count = 0 or second position is unequal to 0x3c denotes
# end of file.

import sys

CHR0 = 2 # i.e. first header is prefixed by 2 chr(0)

if len(sys.argv) <> 3:
    print 'Usage %s inputmbl.bin output.bin\n' % sys.argv[0]
    sys.exit(1)

f = file(sys.argv[1], 'rb')
b = f.read()
f.close()
i = b.index(chr(0) * CHR0 + chr(0) + chr(0x3c)) + CHR0 + 2
result = [chr(0)] * len(b)

k = 0
count = ord(b[i])
while count and (ord(b[i - 1]) == 0x3c):
    l = ord(b[i + 1]) + (ord(b[i + 2]) << 8)
    checksum = 0
    for j in range(count):
        result[l + j] = b[i + 3 + j]
        checksum += ord(b[i + 3 + j])
    expectedChecksum = ord(b[i-2])
    receivedChecksum = expectedChecksum
    if k == 1:
        receivedChecksum = previousChecksum & 255
    elif k > 1:
        receivedChecksum = (previousChecksum - 1) & 255
    if receivedChecksum <> expectedChecksum:
        print 'Checksum error in record %i. Got %02X and expected %02X ' % (
            k, receivedChecksum, expectedChecksum)
    i += count + 5
    count = ord(b[i])
    k += 1
    previousChecksum = checksum

i = len(result)

```

```
while result[i - 1] == chr(0):  
    i -= 1  
  
f = file(sys.argv[2], 'wb+')  
for c in result[:i]:  
    f.write(c)  
f.close()  
print '%i load records processed and %i bytes written to %s' % (k, i,  
    sys.argv[2])
```