IMS INTERNATIONAL

CP/M 2.2 IMPLEMENTATION GUIDE

For the Series 5000 and Series 8000 systems

including the hard disk sub-system

Revision 1.2

July 1, 1981

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This document applies to the following software product revisions:

BIOS	2.23
COPY	2.3
CPMPAT	2.1
DSKTEST	2.1
FORMAT	2.2
IMSGEN	2.1
TRANS14	(1.0)*
DSKTSTHD	1.1
FORMATHD	2.0
HDBOOT	(1.0)
IMSGENHD	2.0

*Parentheses enclose revision numbers which are not displayed by the corresponding program product.

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*CP/M is a trademark of Digital Research

1.0 CP/M 2.2 IMPLEMENTATION

The IMS International implementation of CP/M 2.2 for the Series 5000 and Series 8000 includes the support of a CMD hard disk sub-system and extended accessing capabilities for double-density and double-sided diskettes.

1.1 Diskette systems

The Series 5000 will support two diskette formats:

Single-sided, double-density
Double-sided, double-density

5" single-density formats are not supported.

The Series 8000 will support three diskette formats:

Single-sided, single-density
Single-sided, double-density
Double-sided, double-density

8" double-sided single-density format is not supported.

Note that the system must contain double-sided drives to support double-sided formats.

In diskette based CP/M systems, the operating system is designed to reside on the first two tracks of a double-density diskette. The diskette may also be double-sided.

The storage and directory capacities for the Series 5000 and Series 8u00 diskette formats are:

diskette format	total storage	directory entries	min. block size
SERIES 5000			
double-density	152 kb	64	1 kb
double-sided	304 kb	64	2 kb
SERIES 8000			
single-density	243 kb	64	1 kb
double-density	486 kb	128	2 kb
double-sided	972 kb	256	4 kb

The BIOS automatically determines the diskette format in its first access to a drive. If after accessing a drive, it is desired to change the diskette format in that drive, a warm boot (control-C) must be executed. For example, if a single-density diskette was first accessed in a drive, and it was desired to replace it with a double-density diskette, a warm boot would be required.

In the IMS Series 8000 system, single-density formats are fully compatible in directory structure between CP/M versions 1.4 and 2.2. Double-density and double-sided formats, however, have differences in directory structure. Under CP/M 2.2, a directory entry can control multiple 16K extents, which reduces directory searching and speeds up the system. Double-density files created under CP/M 1.4 that are greater than 16K bytes in length will yield two directory listings for single-sided diskettes and four listings for double-sided diskettes. A utility program called TRANS14 is included on the CP/M 2.2 diskette to allow one disk drive to be selected for reading and writing using the CP/M 1.4 directory structure (TRANS14 will be be discussed in more detail later).

In the Series 5000 system, no incompatibilities exist between CP/M 1.4 and CP/M 2.2 (double-sided formats were not supported under CP/M 1.4).

PIP and STAT have changed for CP/M 2.2 and care should be taken to use the new versions with CP/M 2.2.

Series 5000 and Series 8000 both use 256-byte sectors. To support reading and writing of 128-byte logical records, sectors are blocked and deblocked in the BIOS. A 256-byte buffer is maintained in the BIOS for this purpose. To insure that records written to this buffer are written to diskette, open files must be closed before a diskette may be removed. Applications programs should always close files before terminating.

The IMS CP/M contains a BDOS modification to handle errors. When a disk error is encountered, a BIOS error message will be given, followed by a BDOS message. Typing a return will ignore the error and continue, while typing control-C will warm boot the system and leave drive A selected. If an attempt is made to access a drive which is not on the system, or if during the first access to a drive the BIOS cannot read the diskette, a BDOS select error is given. Typing any key will perform a warm boot and leave drive A selected. Once the BIOS has accessed a drive and the diskette format is determined, attempting to access the drive with the diskette removed will produce a "DRIVE x NOT READY" message on the console (where x is the drive number 0 to 3 corresponding to the CP/M devices A to D). If the diskette is re-inserted, the BIOS will sense drive ready and continue without user interaction. Typing any key will perform a warm boot and leave drive A selected.

Parity error detection for the 64k dynamic memory board is included in the BIOS. When a parity error is detected, all of memory is re-initialized, the parity error is reset, current console activity is interrupted, and the message "PARITY ERROR, IGNORE?" is printed on the console. If "Y" is typed, the interrupted program will continue. If any other key is typed, a warm boot is performed. Note that if the error occurred within the BIOS, a warm boot may not be sufficient to restore the system. A cold boot, however, will reload the entire operating system.

1.2 Hard disk systems

A hard disk sub-system may be added to a Series 5000 system or a Series 8000 system. A hard disk based operating system is included which is designed to reside on the removable cartridge of the hard disk. Hard disk drives are referred to by their unformatted storage capacities (32, 64, and 96 megabytes). All contain one removable cartridge of 16 megabytes, plus fixed storage of 16, 48, or 80 megabytes. The cartridge is referred to as Volume 0 and the fixed storage as Volume 1.

In hard disk systems, multiple logical devices are used to name the drive. Devices A and B are on the cartridge while the fixed storage contains devices C through L.

The BIOS for a hard disk system is upward compatible with diskette systems. Diskette formats described above and a maximum of four diskette drives are supported by the BIOS. The four diskette device names directly follow the hard disk device names. After initial system loading and execution, driver initialization is performed to determine the size of the hard disk and name the hard disk and diskette devices. A list of device names is printed on the console after the sign-on message.

The hard disk system uses a 512-byte sector format which is blocked and deblocked similar to double-density diskettes. The buffer for the hard disk is located on the controller. Access to this buffer is via a DMA channel on the diskette controller board. The same rules apply as for double-density diskette systems to insure that buffers are written to disk. Caution should be used when cnanging hard disk cartridges. To be safe, cold boot the system whenever a new cartridge is inserted.

The CP/M logical device names vary with drive size as follows:

hard disk size	cartridge	fixed	diskette drives
32 megabyte	A and B	C and D	E thru H
64 megabyte	A and B	C thru H	I thru L
96 megabyte	A and B	C thru L	M thru P

Hard disk device capacities vary in size as shown by this table:

hard disk device	total storage	directory entries	min. block size
A	6560 kb	512	8 kb
C,E,G,I,K	6576 kb	512	8 kb
B,D,F,H,J,L	6592 kb	512	8 kb

BDOS and BIOS error messages are as described for diskette systems.

2.0 CP/M START-UP PROCEDURE

2.1 Diskette CP/M system start-up

The initial start-up of a CP/M diskette system consists of the following:

1. Connect any 9600 baud CRT terminal which requires no special hand-shaking to the channel 1 serial port.

2. Apply power to the system and the CRT.

3. Insert a double-density CP/M 2.2 diskette in drive A (the left-most drive). The diskette should be inserted with the label facing right and entering the diskette drive last.

4. Close the door of the drive. Loading of the system should begin immediately with the drive activity light on and the sound of the head loading onto the diskette.

For CP/M 2.2 the standard IPL ROM does not prompt before system load (See Appendix C). The system should sign on with:

```
IMS International
64K CP/M ver 2.2n
Series 5000              (or Series 8000)
```

If the sign-on message does not appear perform the following checks:

1. Verify that the terminal cable connections are correct.

2. Verify that the terminal cable connectors are securely attached.

3. Verify that the console is properly configured.

4. Verify that the I/O board to DB-25 connector cable is in place and that UART0 signals are going to Channel 1.

5. Verify that the vector interrupts on the diskette controller are properly shunted (see Appendix A).

Retry the IPL procedure described above. If no drive activity occurs, a double-sided diskette may be mounted in a single-sided drive. If there is drive activity but the head unloads within one second, then one of the following problems may exist:

1. The diskette in drive A is a single-density diskette.

2. The diskette in drive A does not contain CP/M on the system tracks.

3. A diskette read error occurred while loading the CP/M system.

Series 8000 diskette based CP/M systems are supplied on a double-density, single-sided diskette which will load and run on single-sided or double-sided drives. The standard system diskette is configured to leave the default IPL ROM drive step rate of 6 ms unchanged. In systems with double-sided drives, the step rate should be changed to lessen drive noise during stepping. Read about CPMPAT in the utility programs section and patch MOVCPM to reset the drive step rate.

2.2 Hard disk CP/M system start-up

Since all software for the hard disk is supplied on a 5" or 8" double-density diskette, it is necessary to perform drive initialization procedures to build a hard disk system and write the system to a cartridge. The hard disk sub-system diskette contains the programs and files required. Begin first by reading this entire document and bringing up a diskette based CP/M system. This system is used to initialize hard disks and provide back-up in case of hard disk failure. After this is done, verify that the hard disk controller is in the system and connect the cables to the drive. Apply power to the drive, insert a cartridge, and press the start button on the drive front panel. A list of steps for initialization of the hard disk follows:

1. Use the hard disk formatting program FORMATHD to format all devices on the drive. Each device will take about 10 minutes to format.

2. Use the hard disk CP/M relocator MOVCPMHD (described below) to build the largest system that will fit in your memory configuration. Leave the new system in memory. DO NOT run any program except IMSGENHD.

3. Use IMSGENHD (described below) to write the system from memory to the hard disk cartridge.

4. There are two ways to perform an IPL of a hard disk operating system. The first is to run the HDBOOT program from a diskette based CP/M system. HDBOOT will load and execute the CP/M system on the hard disk cartridge. The second requires the latest revision of the IPL ROM (see Appendix C). This ROM will boot the system directly from the cartridge. Simply press reset on the computer or perform a power on sequence. When using the IPL ROM, make sure that diskette drive 0 is open or the IPL ROM will attempt to load from the diskette.

5. Depending on the size of the hard disk, diskette device names will begin at E, I, or M. All device names are listed on the console when the hard disk system signs on. Once the device names are known, use PIP to transfer files from diskette to the hard disk devices.

The hard disk based CP/M system initialization has now been completed. To initialize a new cartridge, format only hard disk devices A and B according to Step 1. To write a system to the cartridge, perform Steps 2 through 5 .

The standard distribution version of MOVCPMHD has a diskette drive step rate of 6 ms. Use CPMPAT to patch MOVCPMHD and reset the diskette drive step rate to the correct value for your drives (see CPMPAT below).

3.0 SYSTEM UTILITY PROGRAMS

Digital Research transient programs are described in the manual "An Introduction to CP/M Features and Facilities". This section explains the use of IMS utility programs provided with the system. Most of these programs are unique to IMS hardware, and will not run on other implementations of CP/M. Source files for some of these programs are provided on the system diskette. They may be assembled with the Digital Research MAC macro assembler.

3.1 General purpose utility programs

These programs are designed for use with both diskette and hard disk CP/M systems.

3.1.0 BAUD - Set printer baud rate

The BAUD program will temporarily set the printer port to the baud rate specified in the command line. BAUD will only accept the rates 110, 150, 300, 600, 1200, 4800, and 9600 unless the rate is preceeded by an "@" character, in which case any rate between 110 and 9600 may be entered. Rates other than the specified values may not be precise due to rounding by the divider circuit which generates clock pulses for the UARTs. The new baud rate on the printer port will be in effect until BAUD is run again or the IPL ROM (cold boot) is executed. Warm boots will not affect the printer baud rate.

3.1.1 MEMTEST - Memory test utility

This utililty will perform a one pass test on system memory from approximately address 300 hex to the beginning of the BIOS. No parameters are required. Once loaded, MEMTEST will begin testing. After one complete test of memory, a reboot of the system is performed. Errors are displayed with the memory address first, followed by the bytes written and read at that location. If multiple memory errors occur, control-S may be used to stop the display. The console is checked for a control-C break character.

3.1.2 TRANS14 - Translate CP/M 1.4 double-density

TRANS14 is a self-relocating program that will allow a diskette with 1.4 directory structure to be used on one drive. The drive name is specified when the program is called by entering a valid drive name (A:, B:, C:) after the program name: TRANS14 B: <cr>. The current drive may not be specified. If the current drive is named, the message "Drive name error" is printed on the console. Once a drive is set for 1.4 compatibility, double-density 1.4 diskettes may be accessed with any of the system utilities or application programs.

TRANS14 locates itself below the CCP and changes the BDOS entry address to itself, to prevent other programs from overwriting TRANS14. TRANS14 will trap warm boots and print out the message:

(Trans14 active)
(Drive n set for CP/M 1.4 compatibility)

where n stands for the drive specified when TRANS14 was called. The warm boot is then allowed to proceed, so diskettes may be changed without running TRANS14 again. If TRANS14 is run while the module is active in memory, it will clear itself from memory. All drives will then be assumed to have 2.2 directory structure. After clearing, the message:

Trans14 cleared, system restored

will be printed on the console. TRANS14.ASM is the source file for this program. It is provided for reference only, since the programs needed to generate TRANS14 are not included.

3.1.3 CPMPAT - Patch utility for MOVCPM

CPMPAT will make limited modifications to the BIOS without a second level system generation. CPMPAT allows the user to examine and alter the drive step rate, console and list device baud rates, and enable or disable handshaking with the list device. CPMPAT informs the user of the change it is ready to perform, displays the options allowed and the current value, and asks for a new value. Typing only a <cr> (carriage return) to any input request will retain the current value. The last prompt asks if all changes are correct; typing a "Y" will update MOVCPM with the new changes.

CPMPAT will only patch versions of MOVCPM which contain the current BIOS. It will verify this and print a TABLE ERROR message if the BIOS is not current. Information about the table is in the source of the BIOS. To call CPMPAT from CP/M, use the format:

A>**CPMPAT filename.typ <cr>**

where "filename.typ" is the name of the MOVCPM program which will be patched. It is suggested that a copy of MOVCPM be patched to allow recovery from the original in case of error.

CPMPAT may also be used on the relocator for hard disk systems, called MOVCPMHD.

Note that CPMPAT only changes the BIOS contained in the MOVCPM program, and not the system on tracks 0 and 1 or the system in memory. A system must be generated with MOVCPM to integrate these changes. CPMPAT.ASM is the source file for this program.

3.2 Diskette system utility programs

These programs all contain drivers for IMS diskette controllers. They are used for formatting, copying, and media validation. The source files for these programs contain the conditional assembly switch MINI. When set TRUE, the file will assemble a Series 5000 version (5" controller). With MINI set FALSE, a Series 8000 version will be generated (8" controller).

Although the current release of the BIOS for diskette systems uses interrupts for diskette routines, all these utilities disable processor interrupts and use polling. After returning to CP/M via a warm boot, processor interrupts are re-enabled by the first diskette command.

3.2.0 FORMAT - Diskette Formatting Utility

This program is used to initialize diskettes to be used with the IMS CP/M 2.2 system. It should be used on new diskettes to insure their compatibility with the system. It may be used to reformat diskettes which produce errors. FORMAT destroys all data on the diskette, so proper care should be taken to recover data before reformatting.

There are two versions of the FORMAT program, one for Series 5000 formats and one for Series 8000 formats. The following tables describe supported formats:

5" DISKETTE FORMATS

	Single-sided	**Double-sided**
Double-density	40 Tracks 16 Sectors/Track 256 Bytes/Sector	40 Tracks/side 16 Sectors/Track 256 Bytes/Sector

8" DISKETTE FORMATS

	Single-sided	**Double-sided**
Single-density	77 Tracks 26 Sectors/Track 128 Bytes/Sector	----
Double-density	77 Tracks 26 Sectors/Track 256 Bytes/Sector	77 Tracks/Side 26 Sectors/Track 256 Bytes/Sector

FORMAT first prompts for a drive name (A through D). The diskette should be inserted into the drive in which it is to be formatted. The Series 8000 version will issue a density prompt if a single-sided diskette was inserted. The Series 5000 version will issue a side prompt if the system has double-sided drives. Both versions provide an abort prompt, then begin formatting. During the format process, each track is read verified after it is formatted. The keyboard is checked for a control-C character.

The following example shows an execution of FORMAT on drive B of a Series 8000 system:

A>**FORMAT <cr>**

IMS International
8" Disk Format Utility Version 2.2

Type disk (A-D) to format or return to reboot **B <cr>**
Single or Double density (S/D)? **D <cr>**
Format will destroy all data on disk B
Press RETURN to continue or CONTROL-C to abort **<cr>**

After formatting is completed, FORMAT will again ask for a drive name. Type return to reboot CP/M. FORMAT will abort after an error and return to the drive name prompt. Drive A is always selected after program termination. FORMAT.ASM is the source file for this program.

3.2.1 COPY - Diskette Copy Utility

COPY is used to make a track for track direct copy from one diskette to another. The diskettes must have the same format or COPY will output a format error and terminate. COPY accepts three commands: ALL, DATA, or SYSTEM. COPY ALL copies the entire disk (tracks 0-39 for the Series 5000 and tracks 0-76 for the Series 8000). COPY DATA copies the directory and data areas (tracks 2-39 for the Series 5000 and tracks 2-76 for the Series 8000). COPY SYSTEM will transfer the first two tracks of the diskette which contain the CP/M 2.2 operating system. Source and destination drives (A thru D) may be specified after the copy command in the format "destination=source". COPY will default to "B=A", that is, source on drive A and destination on drive B. COPY provides read verification unless the command line is followed by a "/" character to disable this mode.

COPY is called from the command level of CP/M by entering:

COPY command [destination=source] [/]

([ ] = optional)

COPY will print the source and destination drive names, followed by an abort prompt which accepts a control-C to return to CP/M. Diskettes should be placed into the source and destination drives at this time. Type RETURN to start the COPY. Any pair of like format diskettes may be placed into the drives even if a different format was previously copied.

Errors which occur during copying are printed on the console with the message "ignore?". If a "Y" is typed, COPY will continue. If any other key is typed, COPY will terminate and return to CP/M. The keyboard is checked for a control-C character. After the copy is complete, a prompt is issued with the options of repeating the copy or returning to CP/M. COPY.ASM is the source file for this program.

3.2.2 DSKTEST - Drive/Media Verification Utility

DSKTEST is used to verify the readability of each sector on a diskette. It does not write on the diskette. DSKTEST is self prompting and requires no parameters. There is an optional long seek mode in which a seek to the last track is performed before tracks 0-middle are read, and a seek to track 0 is performed before tracks middle-last are read. If an unreadable sector is encountered, a disk error message is printed first, followed by the track number, head number (if double-sided), and sector number of the error. The console is checked for a control-C character during testing. DSKTEST.ASM is the source file for this program.

3.2.3 IMSGEN - Diskette system generation utility

IMSGEN is functionally identical to the Digital Research SYSGEN program, with the added capability of accessing double-density diskettes. With this program, systems may be brought into memory from double-density, single- or double-sided diskettes, and then written to any format diskette. Single-density diskettes are a special case in that only a partial system can be written on the operating system tracks. This may be done to allow a single-density diskette to be placed in drive A after IPL from a double-density diskette, but only warm boots are allowed after this. IPL must be done from a double-density diskette. IMSGEN.ASM is the source file for this program.

3.3 Hard disk system utility programs

These utility programs all contain driver software for the hard disk controller. They are used to format the drive, boot CP/M, test the hard disk system, and copy the operating system.

Although the current release of the BIOS uses interrupts for hard disk routines, these utility programs disable interrupts and use polling. After the program terminates, processor interrupts are re-enabled by the first disk command.

3.3.0 FORMATHD - Hard disk format utility

FORMATHD is the format program for the hard disk. The IMS hard disk controller is hard-sectored. An 8-byte header is maintained at the beginning of each 512-byte sector, making the total number of bytes per sector 520. This program must be run to initialize each sector on the drive. When the drive is brought up for the first time, all devices must be formatted. When using new cartridges, only devices A and B need be formatted.

CP/M 2.2 supports a logical storage device with a maximum size of 8 megabytes. Since the cartridge and each surface of the fixed media have roughly 13 megabytes of formatted storage capacity, multiple CP/M devices must be defined on the drive. The cartridge, with a single surface, contains the CP/M operating system on track 0. CP/M logical devices A and B are on the cartridge. Each fixed media surface contains a pair of CP/M logical devices, beginning with C and D and, depending upon the size of the drive, extending through device L. This will permit at least four CP/M diskette devices.

The logical to physical mapping of CP/M devices follows:

CP/M device	media	head	surface	tracks
A	cart	0	*	0 thru 410
B	cart	0	*	411 thru 822
C	fixed	0	1	0 thru 410
D	fixed	0	1	411 thru 822
(32 megabyte drive ends here)				
E	fixed	1	2	0 thru 410
F	fixed	1	2	411 thru 822
G	fixed	2	3	0 thru 410
H	fixed	2	3	411 thru 822
(64 megabyte drive ends here)				
I	fixed	3	4	0 thru 410
J	fixed	3	4	411 thru 822
K	fixed	4	5	0 thru 410
L	fixed	4	5	411 thru 822
(96 megabyte drive ends here)				

*Surface identifiers are used with the fixed media only.

FORMATHD first determines the size of the drive, printing on the console the logical device names and their locations. The user is then asked if instructions are desired. Next, FORMATHD will ask which device to format. Note that in the event that a portion of the drive becomes unusable, only one logical device need be reformatted. After the device name is entered, the corresponding physical parameters are listed. An abort prompt is then given. Type "Y" to continue, or "N" to abort. Formatting will take about 10 minutes per device. Bad tracks found by the program are listed on the console. After the logical device has been formatted, the user will be asked to input known bad tracks that were not detected by FORMATHD. Enter the list of bad tracks provided by the drive manufacturer. This list will refer to the bad track by track and surface number. Note that the bad track input prompt is given when formatting cartridges, although they should not contain bad tracks. If bad tracks are found by the program or entered by the user, FORMATHD will create dummy directory entries to pre-allocate those tracks. In normal CP/M operation the system will not attempt to use those tracks.

FORMATHD will terminate on these errors:

1. Drive I/O errors (except READ) - Errors in writing, seeking, or selecting heads are defined as I/O errors.

2. Bad directory track - Due to the method of handling bad tracks, the directory track can not be bad.

3. Bad system track - This error occurs only on the cartridge.

4. More than 128 bad tracks - A drive with 128 bad tracks should no longer be used.

During device formatting, FORMATHD monitors the console for a control-C character. If typed, the program will ask the user to verify that the program should be aborted. Type a "Y" to continue formatting. In this way, users may verify that FORMATHD is running.

Due to the destructive nature of formatting, FORMATHD should be used with caution. FORMATHD.ASM is the source file for this program.

3.3.1 DSKTSTHD - Hard disk test utility

DSKTSTHD is a screen-oriented test utility for the hard disk controller and drive. A help menu can be viewed by typing "HELP". Do not use the formatting command of DSKTSTHD. Use FORMATHD to format the hard disk.

The terminal dependent portion of DSKTSTHD is in one area of the program. It may be altered using the terminal dependent area source file HDTDA.ASM. To change the terminal dependent routines, edit and re-assemble HDTDA.ASM for your terminal. Integrate the new HDTDA.HEX file into DSKTSTHD as follows:

```
A>DDT DSKTSTHD.COM <cr>          ; initiate DDT
DDT VERS 2.2
NEXT PC
3800 0100
-IHDTDA.HEX <cr>                 ; initialize FCB
-R <cr>                          ; overlay new drivers
NEXT PC
3800 0000
-G0 <cr>                         ; exit DDT

A>SAVE 55 DSKTSTHD.COM <cr>      ; save modified program
```

DSKTSTHD.ASM is the source file for this program. HDT.LIB is a macro library called during assembly.

3.3.2 HDBOOT - Hard disk CP/M boot loader

HDBOOT is a secondary IPL for the hard disk system. It was written to be used in two ways. Assuming that a cartridge has been formatted and a CP/M system written to the first track, HDBOOT may be run directly from the diskette based CP/M system as a transient program. It will load and execute the CP/M system from the cartridge. This is useful for running the system the first time. HDBOOT may also be written to the first two tracks of a diskette. When a diskette prepared in this manner is booted, HDBOOT is read and executed instead of a CP/M system. HDBOOT will then load and execute the CP/M system from the cartridge. (Since the current IPL ROM contains a hard disk loader, using HDBOOT on a diskette would be redundant.)

To write the HDBOOT program to the first two tracks of a double-density diskette while running a diskette based CP/M system, perform the following steps:

```
A>DDT HDBOOT.COM <cr>      ; use DDT to read HDBOOT
DDT VERS 2.2
NEXT PC
2000 0100
-G0 <cr>

A>IMSGEN <cr>              ; now read IMSGEN

IMS International
8" Sysgen          Version 2.1
Type source drive name (or return to skip) <cr>
Type destination drive name (or return to reboot) B <cr>
Destination on B, type return to continue <cr>
Double-density function complete
Type destination drive name (or return to reboot) <cr>
```

Place this diskette in drive A and press reset to load CP/M from the hard disk. HDBOOT.ASM is the source file for this program.

3.3.3 IMSGENHD - Hard disk system generation utility

IMSGENHD is used to write an operating system to the hard disk. It can also be used to read an operating system from the hard disk and place it in memory. IMSGENHD requires no parameters when called from CP/M.

To build a 64K system with MOVCPMHD and write it to a cartridge with IMSGENHD:

```
A>MOVCPMHD 64 * <cr>              ; build a 64K system and leave in memory

CONSTRUCTING 64K CP/M ver 2.2
FOR A HARD DISK SYSTEM
READY FOR "IMSGENHD" OR
"SAVE 51 CPMHD64.COM"

A>IMSGENHD <cr>                   ; run immediately after MOVCPMHD

IMS International
Hard Disk System Generation Program        Version 2.0
Load system from Hard Disk (Y/N)? N <cr>
Write system to Hard Disk (Y/N)? Y <cr>
Function complete
Write system to Hard Disk (Y/N)? N <cr>
```

To read the system from the hard disk and write it to a file named TEST.SYS:

```
A>IMSGENHD <cr>

IMS International
Hard Disk System Generation Program        Version 2.0
Load system from Hard Disk (Y/N)? Y <cr>
Function complete
Write system to Hard Disk (Y/N)? N <cr>

A>SAVE 51 TEST.SYS <cr>
```

IMSGENHD.ASM is the source file for this program.

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4.0 THE BIOS

This section deals with the IMS International implementation of the CP/M 2.2 Basic Input/Output System (BIOS). BIOS.ASM is the source file distributed with Series 5000 and Series 8000 systems. It is assumed that the reader has a basic understanding of the BIOS, as outlined by the Digital Research "CP/M 2.2 Alteration Guide". The NEC uPD765 document will aid in understanding the diskette routines. Documentation for the IMS I/O board will aid in understanding console and list device routines. If your system includes a hard disk, the documentation for the hard disk controller will be useful.

This document describes the BIOS as supplied by IMS. Previous to the end user's delivery dealers may have altered the BIOS. Information about possible changes should be requested from your dealer.

One source file is used for the BIOS. Conditional assembly switches are used to customize the system. These switches are described in more detail in the section titled "Second Level System Generation". The BIOS contains a limited configuration table at the end of the jump table. This table is used by an initialization routine to dynamically set console and list device baud rates, patch the list driver for handshaking, and change the diskette drive step rate. CPMPAT allows the user to modify the image of this table which is contained in MOVCPM (see CPMPAT).

The IMS dynamic memory board with parity is supported by the BIOS. For proper reset of parity errors the board should be set for I/O address 0 with the I/O enable shunt "on" (see Appendix A for shunt information). When parity errors occur, memory is re-initialized and the parity error is cleared. The message "PARITY ERROR, IGNORE?" is printed on the console. If a "Y" is typed, the interrupted program is continued. If any other response is typed, the BIOS performs a warm boot. Note that if the parity error occurred in the BIOS portion of the system, a warm boot may not be sufficient to recover from the error. A cold boot should be performed.

4.1 Console and list device routines

The Model 440 I/O board (I/OBD) has two serial ports and a 24-bit parallel device (8255) with addresses which follow the serial ports. The standard system does not use the parallel device. The board can be assigned base addresses in 16 address increments. For the standard system, 10 hex is the base address. Both serial ports have software programmed baud rates. They are initially set for 9600 and 300 baud by the IPL ROM, which assumes that the 19.2 kilobaud oscillator is not present. The BIOS resets the UARTs during initialization, setting the baud rates specified in the configuration table discussed above. (See CPMPAT for more information.)

4.2 CP/M BIOS for diskette

IMS diskette controllers have a base address of 80 hex etched into the boards. This base can be moved in 16 address increments, however, this is not recommended since incompatibility will occur with diskette utilities and the IPL ROM. Diskette interrupts should be shunted to vector 5 for proper operation (see Appendix A).

4.2.0 Series 5000

The Series 5000 BIOS supports single-sided and double-sided formats. Both formats are double-density, with 256-byte sectors, 16 sectors per track, and 40 tracks per side. Reading and writing are done from a 256-byte buffer in the BIOS. Each read or write request from BDOS results in the transfer of a 128-byte logical record between the buffer and the current DMA address. Double-sided diskettes are buffered in the same way. Each track on side two of the diskette is a extension of the same track on side one. Rather than using a sector interlace table, the SECTRAN subroutine in the BIOS calculates the interlace for each disk access.

The 5" disk parameter blocks used in CP/M look like this:

	double-density	**double-density double-sided**
SPT	32	64
BSH	3	4
BLM	0111B	01111B
EXM	0	1
DSM	151	151
DRM	63	63
AL0	0C0H	080H
AL1	0	0
CKS	16	16
OFF	2	2

4.2.1 Series 8000

Single-density diskettes are used to transfer files between CP/M systems. When the BIOS is in single-density mode, diskette reading and writing is done immediately using the current DMA address. The standard Digital Research sector interlace is used. When the BIOS is in double-density mode, reading and writing are buffered as described above for 5" diskettes.

The 8" disk parameter blocks used for CP/M look like this:

	single-density	**double-density**	**double-density double-sided**
SPT	26	52	104
BSH	3	4	5
BLM	0111B	01111B	011111B
EXM	0	1	3
DSM	242	242	242
DRM	63	127	255
AL0	0C0H	0C0H	0C0H
AL1	0	0	0
CKS	16	32	64
OFF	2	2	2

4.3 CP/M BIOS for hard disk

The IMS hard disk controller has a base address of 90 hex etched into the board. This base can be moved in 8 address increments, however, this is not recommended since incompatibility will occur with hard disk utilities and the IPL ROM. Hard disk controller interrupts should be shunted to vector 5 for proper operation (see Appendix A).

The Series 5000 and 8000 hard disk BIOS are functionally identical except for diskette size. The hard disk devices are always the first CP/M logical devices. Diskettes are the next four logical devices. Warm boots are always from the cartridge or the first diskette device.

The hard disk uses 512-byte sectors with an additional 8 bytes for a header. The header contains a select code, cylinder number, sector number, and an optional CRC word. Since the controller performs a hardware CRC, the optional software CRC is not used. The hard disk sector buffer is located on the controller. Reading and writing is done via DMA channel 2 on the diskette controller.

The hard disk devices have disk parameter blocks as follows:

	A	**C,E,G,I,K**	**B,D,F,H,J,L**
SPT	128	128	128
BSH	6	6	6
BLM	0111111B	0111111B	0111111B
EXM	3	3	3
DSM	819	821	823
DRM	511	511	511
AL0	0C0H	0C0H	0C0H
AL1	0	0	0
CKS	0	0	0
OFF	1	0	411

Note that the directory check vector size (CKS) is zero for all hard disk devices, including the removable cartridge. This means that the directory integrity of the cartridge devices is dependent upon the user performing a system boot when cartridges are changed.

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5.0 SYSTEM GENERATION USING MOVCPM

System generations with MOVCPM and CPMPAT can change the memory size of the operating system, re-define the baud rate of the console or list device, switch to the 19.2kb oscillator, change the diskette step rate, and do limited configuring of the list driver. These changes can be easily implemented with CPMPAT, which will access and change the driver configuration table in the BIOS (see CPMPAT).

The IMS version of MOVCPM (or MOVCPMHD for hard disk systems) is functionally identical to MOVCPM as described by Digital Research in "An Introduction to CP/M Features and Facilities". The minimum memory size for a CP/M 2.2 system is 22K.

5.1 Diskette system generation

Before proceeding further, make a copy of the diskette provided by IMS. Use COPY ALL to do this. Place the original diskette in an archive file for backup.

Cold boot from this new diskette. Use CPMPAT to examine and/or modify the configuration table in the BIOS (see CPMPAT). Then type the command:

A>**MOVCPM * * <cr>**

This will generate the largest CP/M system that will fit in memory. After the CCP prompt returns, type in the command:

A>**IMSGEN <cr>**

IMSGEN will ask for a source drive name or "return to skip". Type a return since the system is already in memory. IMSGEN will then request a destination drive name. Type in "A" to write the system to diskette. Now reset the computer to start the IPL. The system will sign on with the new version of CP/M. Use IMSGEN to copy the system from this diskette to others, as desired.

5.2 Hard disk system generation

The procedure for generating hard disk systems is the same as that for diskettes, except for the system generation utility. The corresponding programs are MOVCPMHD and IMSGENHD.

Use CPMPAT as described above to customize MOVCPMHD. Next, run MOVCPMHD to create a CP/M image in memory. Finally, run IMSGENHD.

IMSGENHD will ask whether to load the system from the cartridge. Type "N" to skip this process, since the system is in memory. Next, the program will ask whether to write the memory image to the hard disk cartridge. Type a "Y". When it is finished, IMSGENHD will print "Function complete" and ask whether to write a system on another cartridge. Type an "N" to return to the operating system. Reset the computer to load and execute the new CP/M system.

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6.0 SECOND LEVEL SYSTEM GENERATION

This section is a guide for generating a custom BIOS for use on IMS systems. An understanding of the BIOS is assumed (see the Digital Research "CP/M 2.2 Alteration Guide"). A second level system generation is necessary to alter the BIOS routines in any way. A back-up diskette should be used to test the new system before it is written to other diskettes. Before altering the BIOS, review the appropriate sections of this document. Note that a second level system generation makes MOVCPM unusable, since it will not contain the modified BIOS routines. Also, CPMPAT is no longer useful, since it operates on MOVCPM.

Second level system generation is generally the same for all versions of IMS systems. Differences will be pointed out where they occur.

The following files are needed for a second level generation:

```
BIOS.ASM                    ; BIOS source file
ED.COM                      ; text editor
ASM.COM or MAC.COM          ; CP/M assembler
DDT.COM or SID.COM          ; debugger
```

Additional files needed for diskette system generations include:

```
MOVCPM.COM                  ; CP/M relocator
IMSGEN.COM                  ; system generation utility
```

Corresponding files for hard disk system generations are:

```
MOVCPMHD.COM                ; CP/M relocator
IMSGENHD.COM                ; system generation utility
```

STEP #1: ASSEMBLY OF THE BIOS

Using the CP/M editor ED (or another text editor), edit the BIOS assembly switches described below.

MSIZE The maximum memory size which will be used by the system (range = 22 to 64).

MINI Set TRUE to generate code for 5" diskette drives; set FALSE to generate code for 8" diskette drives.

HDSK Set TRUE to generate code for a hard disk drive.

AUTO

Set TRUE to cause the automatic execution of a file named INIT.SUB after power-up or system reset. INIT.SUB and SUBMIT.COM must be present on device A. INIT.SUB should contain the command or commands to be executed. (See the Digital Research manual "An Introduction to CP/M Features and Facilities" for more information about SUBMIT files.)

STEP$RATE

Set to the number of milliseconds required to step the diskette drive track-to-track (range = 0 to 16). Note that the 5" controller clock rate is one-half the 8" controller rate. Step rates for 5" drives will therefore be twice the value set by STEP$RATE. If STEP$RATE is set to zero, the rate remains as set by the IPL ROM.

STEP$RATE Value	8" Drive rate (ms)	5" Drive rate (ms)	Diskette drive recommendation
1	1	2	
2	2	4	5" MPI
3	3	6	5" Tandon, 8" Qume
4	4	8	
5	5	10	
6	6	12	(IPL ROM default)
7	7	14	
8	8	16	
9	9	18	
10	10	20	8" Shugart
11	11	22	
12	12	24	
13	13	26	
14	14	28	
15	15	30	
16	16	32	

LIST$DEVICE

Set to the desired list device driver from the table below. For drivers using clear to send (CTS), device buffer status must be connected to pin 4 of the printer port DB-25 connector.

LIST$DEVICE	Printer driver description
TTY	Serial driver for Teletype 33 and other devices requiring no handshaking.
TI810	Serial driver for TI810 and other devices which transmit clear to send (CTS) true to indicate buffer empty.

NECSER	Serial driver for NEC Spinwriter and other devices which transmit clear to send (CTS) false to indicate buffer empty.
DIABLO	Serial driver for Diablo and other devices which use ETX/ACK protocol to indicate buffer empty.
TTY40	Serial driver for Teletype Model 40.
NECPAR	Parallel driver for NEC Spinwriter.
CENTRPAR	Parallel driver for Centronics printer.

CONSOLE$BAUD$RATE
LIST$BAUD$RATE Set each baud rate from the table below (range = 0 to 8).

BAUD$RATE Value	Baud Rate	Comments
0	19200	requires 19.2kb oscillator
1	9600	
2	4800	
3	2400	
4	1200	
5	600	
6	300	
7	150	
8	110	two stop bits provided

OSC$192K Set TRUE if the 19.2 kilobaud oscillator is installed on the I/O board, else FALSE.

The standard IMS distribution version of the BIOS has the switches set as follows:

```
MSIZE             EQU   64          ; memory size
MINI              EQU   TRUE/FALSE  ; diskette size
HDSK              EQU   TRUE/FALSE  ; TRUE if hard disk
AUTO              SET   FALSE       ; auto-load
STEP$RATE         EQU   0           ; diskette drive step rate
LIST$DEVICE       EQU   NECPAR      ; list device selection
CONSOLE$BAUD$RATE EQU   1           ; 9600 baud console
LIST$BAUD$RATE    EQU   6           ; 300 baud list device
OSC$192K          EQU   FALSE       ; oscillator not installed
```

After the assembly switches have been set, assemble the BIOS using the Digital Research ASM or MAC assembler. (Note that ASM will produce errors on the TITLE and PAGE directives. These errors may be ignored.)

STEP #2: RELOCATING THE SYSTEM

Use MOVCPM (or MOVCPMHD) to build a system for the target memory size. Save the system on disk:

```
A>MOVCPM xx * <cr>        ; for diskette systems

          - or -

A>MOVCPMHD xx * <cr>      ; for hard disk systems

          . .
          . .
          . . . . .instructs MOVCPM to leave system in memory
          .
          . . . . . memory size in kilobytes
```

Follow the instructions given by MOVCPM (or MOVCPMHD) to save the memory image in a file named CPMxx.COM, where xx is the memory size.

STEP #3 OVERLAYING THE CUSTOM BIOS

The next task is to overlay the new BIOS.HEX over the new CP/M system. This is done using DDT or SID. Type the command:

```
A>DDT CPMxx.COM <cr>          ; xx is the system size
```

DDT will load CPMxx.COM into memory and issue the prompt "-". Type the next command to DDT:

```
-IBIOS.HEX <cr>
```

This initializes the DDT file control block for the new BIOS file. The next step is to read in the new BIOS.HEX with the proper bias to place it over the old BIOS. The bias differs with memory size. Standard read bias values are listed below, but any bias may be computed by subtracting the absolute address of the BIOS from 1F80 hex. This computation must either be done in hex or converted to hex for use with DDT.

In a 64k Series 8000 system:

The BIOS will begin at F400 hex.
1F80 hex - F400 hex = 2B80 hex (read bias for DDT).

In a 64K Series 5000 system:

The BIOS will begin at F600 hex.
1F80 hex - F600 hex = 2980 hex (read bias for DDT).

Common read bias values are:

	Diskette systems		Hard disk systems
memory size	**series 8000**	**series 5000**	**(8000 and 5000)**
32K	AB80	A980	B380
36K	9B80	9980	A380
40K	8B80	8980	9380
44K	7B80	7980	8380
48K	6B80	6980	7380
52K	5B80	5980	6380
56K	4B80	4980	5380
60K	3B80	3980	4380
64K	2B80	2980	3380

Once the read bias is known, enter the next DDT command to read BIOS.HEX:

-Rxxxx <cr> ; xxxx is the read bias

At this point the new CP/M 2.2 system is in memory and ready to be written to diskette. Leave DDT by typing:

-G0 <cr>

STEP #4: WRITING THE NEW SYSTEM TO DISK

After leaving DDT, no program except IMSGEN (or IMSGENHD) should be run. Type the next command:

A>**IMSGEN <cr>** ; for diskette systems

- or -

A>**IMSGENHD <cr>** ; for hard disk systems

IMSGEN will ask whether to load the system into memory or skip this process. Type a return to skip system loading, since the new system is already in memory. Next, write the system from memory to diskette (or hard disk). For IMSGEN, enter the destination drive name, then a carriage return. For IMSGENHD, enter a "Y" to write the system to the cartridge.

Reset the computer to load and execute the new system. Test the operation of modified routines. For diskette systems, write the new CP/M and BIOS to other diskettes as desired.

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APPENDIX A
CP/M and MP/M Interrupt Vector Shunting

DISKETTE CONTROLLERS:

Model 400 (8" controller) and Model 430 (5" controller)
Location (JB) is the interrupt selection strip. Shunt only the pins labeled "5" and no others.

HARD DISK CONTROLLER:

Model 490
Location (JD) is the interrupt selection strip. Shunt only the pins labeled "5" and no others.

64K DYNAMIC MEMORY:

Model 460
Location (JG) is the interrupt selection strip. Shunt only the pins labeled "2" and no others. Also, for software to reset the parity error detection logic, the I/O enable shunt (JE) must be "on", and the board address must be set to 0 (all pins shunted at location (JC)).

The following shunts are mandatory for MP/M operation, but will not affect CP/M operation:

I/O BOARDS:

Model 440 (2-serial, 24-bit parallel)
Location (JJ) is the interrupt selection strip for the relative time clock. Shunt only the pins labeled "7" and no others. Locations (JK) and (JL) are the interrupt selection strips for UART receive and transmit status. Shunt only the pins labeled "6" on both strips and no others.

Model 480 (4-serial)
Locations (JC), (JD), (JE), and (JF) are the interrupt selection strips for each of the UARTs. Shunt only the pins labeled "5" on all strips and no others.

ADDITIONAL 64K DYNAMIC MEMORY:

Model 460
If memory bank zero in an MP/M system is a dynamic board, the shunting of this board is identical to the CP/M shunting described above. The convention for additional MP/M memory banks using the Model 460 is that each board I/O address follows the last, and additional boards are placed in the "BANK" mode with a shunt at location (JE). Enable I/O at location (JB), but do not shunt any parity interrupt vectors at location (JG).

APPENDIX B
Processor Port Assignments

ADDRESS (HEX)	ASSIGNMENT
00 - 0F	Memory management (bank switching ports): Consult operating system for breakdown.
10 - 1F	Model 440 I/O board: CP/M - MP/M default console and list device, MP/M relative time clock.
20 - 3F	Model 480 I/O board: Reserved for additional MP/M consoles.
40 - 4F	Model 440 I/O board: Reserved for additional MP/M consoles.
50 - 5F	**FREE**
60 - 7F	Model 480 4-line I/O board: Reserved for additional MP/M serial ports, modems, auxiliary list devices, etc.
80 - 8F	Models 400 and 430 diskette controllers: Includes 8257 DMA device with four channels.
90 - 97	Model 490 hard disk controller #1: Default controller in hard disk subsystem. DMA provided through FDC at base address 80 hex.
98 - 9F	Model 490 hard disk controller #2: Expansion controller (reserved).
A0 - BF	** FREE **
C0 - CF	Models 400 and 430 diskette controllers: Optional expansion for 8 diskette drives of either type or dual 8" and 5" systems.
DO - FF	** FREE **

APPENDIX C
Initial Program Loader (IPL)

(16-bit checksum = 7297 Hex)

The IPL ROM loads the CP/M operating system into memory and jumps to the BOOT entry point in the BIOS jump table. The current release of the IPL ROM supports all IMS disk/diskette formats, including the hard disk:

SERIES 5000 FORMATS

CP/M 1.4 double-density
CP/M 2.2 double-density
CP/M 2.2 double-density, double-sided
CP/M 2.2 hard disk system

SERIES 8000 FORMATS:

CP/M 1.4 double-density
CP/M 1.4 double-density, double-sided
CP/M 2.2 double-density
CP/M 2.2 double-density, double-sided
CP/M 2.2 hard disk system

The origin of this ROM in all systems is 0. The board in which the ROM is located (the Model 440) should be shunted to enable the ROM after power-on or system reset.

The following is a summary of the steps executed by the IPL ROM after a power-on or system reset:

1. All of memory is moved into the CPU accumulator, then back to memory. This step will initialize a 64K dynamic memory board if present and also copy the contents of the ROM into system memory beginning at 0. Note that only the first 1K of memory is altered. The ROM is then disabled, and the IPL program continues execution from RAM memory.

2. The standard UART baud rates are set.

3. The hard disk controller is initialized and tested for its presence in the system.

4. The default step rate for 8" diskette drives is set.

5. The IPL program waits in a loop for the hard disk drive or diskette drive 0 to become ready. If the hard disk becomes ready, the program proceeds to step 6. If diskette drive 0 becomes ready, the program proceeds to step 7.

6. The hard disk is tested for a valid CP/M system. If CP/M is not present, the IPL goes back to step 5. If CP/M is present, the starting address is determined and the system is loaded and executed.

7. The system is tested for a 5" diskette to determine the CP/M load address and increase the step rate.

8. The disk is tested for a CP/M operating system. If CP/M is not found, the IPL goes back to step 5. If CP/M is found, it is tested to determine load and execution addresses.

9. The operating system is loaded from the disk and executed.

IPL.ASM is the source for the ROM. It is supplied on the system diskette. Normally the origin of the IPL is at address 0, but a conditional assembly switch exists for testing the IPL. Set TRUE, the origin of the IPL is moved to 100 hex to permit loading and execution as a standard CP/M COM file.

ADDENDUM TO CP/M 2.23B

Notice to users of CP/M 2.23B:

The names of some of the programs provided with this revision of CP/M have been changed to permit easier identification and avoid confusion with previous versions. The list which follows gives the previous names and the new names. When refering to the IMS CP/M Implementation Guide for program instructions, use the previous name.

PREVIOUS NAME	5" UTILITIES	8"UTILITIES
COPY	COPY5	COPY8
DSKTEST	DSKTEST5	DSKTEST8
DSKTSTHD	DSKTSTH5	DSKTSTH8
FORMAT	FORMAT5	FORMAT8
FORMATHD	FORMATH5	FORMATH8
HDBOOT	H5BOOT	H8BOOT
IMSGEN	IMSGEN5	IMSGEN8
IMSGENHD	IMSGENH5	IMSGENH8

Note also that CP/M 2.23B is configured for a 490 controller at interrupt vector 4 and a 440 I/O controller with an optional oscillator enabled. The system console is still set to 9600 baud.