DIGITAL MICROSYSTEMS, INC.

DSC-3 / DSC-4 / HiNet System Manual

Version 2.00

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1. Introduction

This manual describes Digital Microsystems' DSC-3 and DSC-4 computer systems. These systems are based on the Z-80A microcomputer chip. The DSC-3 is a single board system, while the DSC-4 is a Multibus-compatible system capable of supporting up to 512 Kbytes of memory. The features of these two systems are summarized below:

Z-80A at 4 MHz
64K dynamic RAM on the DSC-3
128K to 512K dynamic RAM plus 1K static RAM on the DSC-4
1K PROM monitor
3 RS-232 ports, 1 RS-232 or RS-422 port
2 8-bit bidirectional parallel ports
Up to 4 floppy disks, single or double density
single or double sided
8" and 14" hard disk options, 10.6 Mbytes to 28 Mbytes
CP/M, MP/M, OASIS, and HiNet operating systems

The DSC-3 and DSC-4 are available in these configurations:

DSC-3	Floppy disk system
DSC-3/101,102,4004,4008	Hard disk systems
DSC-3/A25	HiNet CRT station
DSC-3/B	Basic user station
DSC-4	Floppy disk system
DSC-4/101,102,4004,4008	Hard disk systems
HDO-4004,4008	Hard disk add-on units
SO-STD	Streamer tape option
STD-20	Streamer tape add-on unit

Each of these systems is packaged differently; however, the bulk of the hardware and software for the different models is identical. This manual describes the characteristics of all these systems; distinctions between systems will be mentioned when necessary.

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DSC-3 Floppy disk system

This system includes a processor board, power supply, cabinet, and 2 to 4 floppy drives. It can act as a complete stand-alone computer system, with a CRT. It can also be used as a user station when it is connected to the HiNet.

DSC-3/101,102,4004,4008 Hard disk system

This system includes a processor board, a hard disk controller board, 1 to 4 floppy drives, and a hard disk. If an 8 inch hard disk is selected, the system is packaged in the same cabinet as the DSC-3; the hard disk takes the place of one of the floppy disks. If a 14 inch hard disk is selected, the system is packaged in a larger cabinet. These systems can be used as stand-alone systems, or as HiNet masters.

DSC-3/A25 HiNet CRT station

An A25 HiNet CRT station includes a processor board packaged inside an ADDS REGENT-25 terminal. This system connects to the HiNet. It is an independent work station capable of supporting a single user.

DSC-3/B Basic User station

The basic user station consists of a processor board with 3 serial ports and 1 parallel port. It allows the user to select the terminal which best fits the application requirements. The basic user station supports the use of parallel or serial printers.

DSC-4 and DSC-4/101,102,4004,4008

These systems are similar to their DSC-3 counterparts, except that they are multiple board systems. A minimal system contains two boards - the CPU board, and one 128 Kbyte memory board. Up to 4 memory boards may be included in a single system. Other Multibus boards may be added to the system to customize the system to the user's requirements. The DSC-4 is primarily used to run a multiple user operating system, such as MP/M or OASIS.

STD-20 or SO-STD Streamer tape drives

A 20 Mbyte streamer tape drive may be added to a hard disk system (STD-20 option) or may replace the floppy normally included in a hard disk system (SO-STD option). If the SO-STD option is chosen, floppies cannot be used to transfer programs onto the system. If the STD-20 option is chosen, the tape drive and controller will occupy a normal DSC-3 cabinet by themselves.

2. Check-out and power-up

When you first receive your DSC-3 or DSC-4, it is suggested that you perform a careful visual inspection of the hardware. The computer undergoes extensive tests at the factory and is carefully packaged for shipment; however, it still may be upset in transit.

If you have a floppy disk or hard disk system, remove the phillips screws holding the lid to the chassis and remove the lid. Check that all socketed integrated circuits are firmly seated. Check that all of the cable connections described in section 6.1 are in place, and that the cables themselves are not damaged in any way. Look for any loose material in the cabinet and listen for anything loose.

Check that you are plugging the computer into the correct voltage as indicated by the serial number tag on the rear of the cabinet. If the unit is a DSC-3/B check that the line voltage selector switch is set to the correct voltage. This switch is adjacent to the power cord at the rear of the cabinet.

Check all the jumper connections on the CPU board. These are described in section 6.2. When all appears in order, check that the ON/OFF switch is in the OFF position, and attach the power cord to the back side of the cabinet. Check that your CRT is set for 9600 baud, 2 stop bits, "space" parity.

2.1 DSC-3 or DSC-4 Floppy disk system

Use an RS-232 cable to connect a 9600 baud terminal to serial port 0 (uppermost) on the back side of the cabinet. Turn the power switch to the ON position. You should hear the fan go on. Press the INT switch. While holding the INT switch down, press and release the RST switch. You should see the message "PROM Monitor 1.09" displayed on the screen of your terminal (1.09 is the version number). If not, there is a problem, and you should refer to section 5 or 6 of this manual.

The computer will now be waiting for you to enter a PROM Monitor command. These commands are described in section 5.2. Insert a CP/M system diskette into drive A (this is the right hand drive on a dual drive system). Close the door and type "BF". The system should bootstrap from the floppy diskette and respond with the message:

```
CP/M 1.4xx (or CP/M 2.2xx)
A>
```

If this does not happen, refer to section 5 or 6 of this manual.

2.2 DSC-3 or DSC-4/101,102,4004,4008 Hard disk system

Use an RS-232 cable to connect a 9600 baud terminal to serial port 0 (uppermost). If you have an 8" hard disk, remove the front panel (assuming the top is off because of your previous inspection) by gently pulling towards you and up. When the front cover comes loose from the locating tabs at the bottom, pivot it up and to the right. On top of the hard disk drive is a white plastic handle. It is presently to the right of center as you face it. Remove the tape and move this handle to the left. This unlocks the read/write heads for the disk drive.

If you have a 14" hard disk, you should have received it packaged separately from the main unit. Remove the spindle locking screw located in the black belt cover. Be sure to save this screw because it should be reinstalled prior to long distance transportation. Also, never rotate the disk spindle counter-clockwise because the disk media may be damaged.

For a 14" hard disk, remove the front cover and install the drive in the cabinet. Connect the drive to the power supply with the DC power cord. Connect the AC power cord to the drive. Connect the ribbon cable from the hard disk controller PC board to the drive. Fasten the drive with the eight screws supplied with the disk. Turn the power switch to the ON position. You should hear the fan and disk drive go on. Next, remove the clip which locks the read/write heads on their inner-most track. This must be done after you have powered up to avoid damage to the disk media. Fasten the front cover in place. The hard disk should now be ready for use.

2.3 DSC-3/A25 HiNet CRT station

Use an RS-422 cable to connect the station to the main HiNet cable. Verify that the network master computer is operational. Turn the power on by flipping the switch on the lower righthand side of the terminal. The light immediately above the switch should glow. Pull the INT switch (it is located on the lefthand bottom side of the terminal). While pulling the INT switch, pull and release the RST switch (it is located on the righthand bottom side of the terminal). You should see the message "PROM Monitor 1.09" displayed on the screen. Type "BN". The network loader should be loaded into your station and display the following message:

```
HiNET 1.4xx (or HiNet 2.2xx)

Login please...
  Name:
```

If this does not happen, refer to chapter 5. Otherwise, enter your name and password. The system should respond with the normal command prompt "A>".

2.4 DSC-3/B Basic user station

Use an RS-422 cable to connect the station to the main HiNet cable. Use an RS-232 cable to connect your CRT to serial port 0 on the station (this is the lower port at the left of the cabinet). Verify that the network master computer is operational. Before powering on, verify that the 110/220 voltage selection switch on the back of the box is in the correct position. Turn the power on. The red light on the front of the box should glow. Press the INT switch (on the right as you face the box). While holding the INT switch down, press and release the RST switch (on the left as you face the box). You should see the message "PROM Monitor 1.09" displayed on the screen of your terminal. Type "BN". The network loader should be loaded into your station and display the following message:

```
HiNET 1.4xx (or HiNet 2.2xx)

Login please...
  Name:
```

If this does not happen, refer to chapter 5. Otherwise, enter your name and password. The system should then respond with the normal command prompt "A>".

2.5 HDO-4004,4008 Hard disk add-on units

Remove the spindle locking screw located in the black belt cover. Be sure to save this screw because it should be reinstalled prior to long distance transportation. Also, never rotate the disk spindle counter-clockwise because the disk media may be damaged.

Remove the front cover, install the drive in the cabinet, connect the power cord to the connector on the drive and the board and turn the power switch to the ON position. You should hear the fan and disk drive go on. Next, remove the clip which locks the read/write heads on their inner-most track. This must be done after you have powered up to avoid damage to the disk media. Also, a 25 conductor ribbon cable with DB25P connectors with pins 1 and 13 removed (DMS part 83-0048) must be used to connect the hard disk controller in the HDO to the system CPU. Fasten the front cover in place. The hard disk should now be ready for use.

2.6 STD-20 Streamer tape add-on unit

The STD-20 connects to the system by means of a DB-25S cable (DMS part 83-3214) and a short 26 pin cable (DMS part 83-3213) to be installed between J4 on the system CPU and the rear panel of the system chassis (use the hole immediately above the I/O PC board). The system CPU must be modified as detailed in section 10.

Turn on the power switch on the STD-20. You should hear the fan, and after a few seconds, a short series of clicks from the streaming tape drive. Use the chassis-to-chassis cable to connect the STD-20 to the main system. Your STD-20 is now ready for use.

3. CP/M Operating System

3.1 Overview

CP/M stands for 'Control Program for Microcomputers'. It is an operating system which manages the resources of a microcomputer so that the computer is easy and convenient to use. CP/M is described in detail in the reference manuals in Appendix C. These manuals are:

An Introduction to CP/M Features and Facilities
CP/M Assembler (ASM) - User's Guide
CP/M Dynamic Debugging Tool (DDT) User's Guide
CP/M Context Editor (ED) User's Guide
CP/M System Alteration Guide
CP/M Interface Guide
CP/M 2.2 User's Guide

The primary purpose of CP/M is to handle disk files. CP/M was originally intended to be used only on IBM standard single density diskettes. However, it has been expanded significantly since its original release. It can now support many different types of floppy disks and hard disks. This manual describes how CP/M is used to access files on Digital Microsystems computers.

CP/M file names consist of two parts - a 'primary name' of up to 8 characters, and a 'secondary name' of up to 3 letters; the two parts of the name are separated by period. The secondary name usually denotes the type of file. Some file types are:

ASM	source file for ASM (the CP/M assembler)
HEX	object file produced by ASM
PRN	listing file produced by ASM
COM	binary core image - usually a command file
BAS	source file for a BASIC compiler
INT	object file produced by a BASIC compiler, used as source for the RUN package
SUB	source file for SUBMIT command

CP/M is divided into three major components:

(1) CCP - Console Command Processor

This component handles communication with the user at the system console. The CCP prompts the user with:

x> (where 'x' is the currently active drive)

The user may then type a command, terminated by a carriage return. The CCP has the following built-in commands:

DIR	[filemask]	Display directory entries
ERA	filemask	Erase file(s)
REN	newname=oldname	Rename file
SAVE	length filename	Save contents of memory
TYPE	filename	Display an ASCII file

If the user types a name which is not a built-in command, the disk directory is searched for a COM file by that name. If found, the file is loaded into memory beginning at 100 hex, and the command is executed. The commands which are supplied by DMS are described in section 3.2.

(2) BDOS - Basic Disk Operating System

The BDOS controls disk allocation, and the reading and writing of sequential or random records on a disk. It also provides the interface between user applications and I/O devices, and manages the allocation of files and directories.

(3) BIOS - Basic I/O System

The BIOS controls the actual reading and writing of particular tracks and sectors on a disk. Each computer manufacturer who supplies CP/M normally rewrites the BIOS so that CP/M will operate on its particular hardware. Digital Microsystem's version of the BIOS provides many features which enhance the capabilities of CP/M. These include typeahead on console 0, floppy and hard disk buffering, many different printer drivers, time of day, and front-panel interrupts.

Differences between CP/M 1.4 and CP/M 2.2

CP/M 1.4 is an earlier release of CP/M, while CP/M 2.2 is the most recent release of CP/M. One must be aware of the release number of CP/M when using some compilers or application programs. Both releases are available from Digital Microsystems. The primary differences between version 1.4 and 2.2 are as follows:

a. CP/M 2.2 allows 8Mbyte disk partitions, while CP/M 1.4 only allows disk partitions up to 4Mbytes.

b. CP/M 1.4 allows sequential files up to 1Mbyte, but random files can only be up to 512Kbytes long. CP/M 2.2 allows a single file to occupy an entire disk partition (i.e., up to 8Mbytes).

c. CP/M 2.2 allows up to 1024 directory entries on 4Mbyte or 8Mbyte partitions. CP/M 1.4 allows only 256 directory entries on 4Mbyte partitions.

d. CP/M 2.2 requires approximately 2.5K more for the operating system than CP/M 1.4.

All utility programs (e.g, ASSIGN, ALLOC, TIME) will run under both systems. However, files on hard disk partitions which were created under version 1.4 of CP/M CANNOT be read under CP/M 2.2 (and vice versa). Thus, the two versions CANNOT be mixed on the same hard disk. However, floppy disk files created under CP/M 1.4 can be read under CP/M 2.2, thus files can be moved between versions, if desired.

3.2 CP/M Commands

Standard CP/M commands

These commands are described in the CP/M manuals in Appendix C.

Command	Description
ASM filename.sbp	CP/M assembler
DDT [filename]	CP/M dynamic debugger
DUMP filename	Display a binary file
ED filename	CP/M editor
LOAD filename	Convert HEX to COM file
PIP [command]	File copy utility
STAT [command]	File status utility
SUBMIT filename	Submit utility
SYSGEN	System generation utility
XSUB	Used in conjunction with SUBMIT

Digital Microsystems CP/M commands

These commands are described on the following pages. They are supplied with all DMS systems, and are available only on DMS equipment. Some commands can be used only with a single user CP/M system, while other commands can be used under HiNet. The operating systems which apply to each command are listed in the upper righthand corner of the first page of each command description.

Command	Description
ALLOC	Maintain hard disk allocation table
ASSIGN [disk device]	Assign disk device to A,B,C, or D
DIRHARD	Display hard disk partition names
FDCOPY	Floppy disk copy utility
FORMAT	Floppy disk format utility
HARDBACK	Hard disk to floppy backup utility
HARDHELP	Hard disk test and diagnosis
READ0 [file t s secs]	Read from hard disk partition 0 to a file
SETBAUD [port baudrate]	Set baud rate of a serial port
SETTIME	Set the time-of-day
TIME	Display the time-of-day
WRUN0 [file trk sec]	Write to hard disk partition 0 from a file

Initialize and/or Modify the Disk Allocation Table

Command: ALLOC	Can be used on:	
ALLOC is used to initialize or modify the hard disk allocation table.	Single user system	YES
	HiNet user station	NO
	HiNet master station	YES
	MP/M	YES

ALLOC allows the user to initialize or modify the hard disk allocation table. The allocation table is stored on partition 0 of the hard disk. CP/M cannot handle hard disk partitions larger than 8 Mbytes (4 Mbytes for CP/M 1.4), thus it is necessary to split the hard disk into smaller partitions. The allocation table indicates the size (1 byte), name (8 characters), and password (6 characters) of each partition. The control byte option is currently not used. A partition can occupy from 256 Kbytes to 8 Mbytes. Each partition has its own directory, and can support anywhere from 64 files to 1024 files.

The following table shows the legal values for the size byte, and the corresponding disk size for each value.

Size byte	Actual size	File Limit	
1	256 Kbytes	64 files	
2	512 Kbytes	128 files	
3	1024 Kbytes	256 files	
4	2048 Kbytes	512 files	
5	4096 Kbytes	1024 files	
6	8192 Kbytes	1024 files	(available in CP/M 2.2 only)

ALLOC commands are as follows:

A - Add an entry to the table
D - Delete an entry in the table
E - Erase directory on disk (MP/M only)
H - Print this Help summary
L - List out current table
M - Modify an entry in the table
Q - Quit the program (exit to system)
S - Save as the permanent table
Z - Zero out the entire table

It is very important to note that no permanent changes are made to the allocation table until the "S" command is used.

Be careful not to overallocate the disk. The disk space limits for each hard disk model are shown below:

Model 101 - 10,560 Kbytes
Model 102 - 21,120 Kbytes
Model 4004 - 13,600 Kbytes
Model 4008 - 27,200 Kbytes

Also, be careful not to change the size of a partition in the middle of the allocation table. This will cause the operating system to think that all partitions above the changed partition have been moved to new locations on the disk, when in fact, only the allocation table has been changed. The correct procedure is to copy all partitions to floppies (or to another hard disk), re-format the entire disk, construct a new allocation table, and then copy all partitions back to the hard disk. Don't forget that the HARDBACK program will not restore a partition whose size has changed.

One more note: the word "partition" and the word "unit" both mean the same thing.

The following example shows how to use ALLOC to change the name and password of a partition:

```
A>ALLOC

 Command?L
   Unit Size   Name    Password Ctrl
   ---- ----   ----    -------- ----
    00   01                     FF
    01   01   USER1A             FF
    02   02   USER1B             FF
    03   03   USER1C             FF
    04   04   USER1D             FF
    05   01   USER2A             FF
    06   02   USER2B             FF
    07   03   USER2C             FF
    08   04   USER2D             FF

Allocated disk space: 7,936 Kbytes

 Command?M
    Unit     (0,1,..63)? 2
   Unit Size   Name    Password Ctrl
   ---- ----   ----    -------- ----
    02   02   USER1B             FF
Is this the entry to modify? Y
    Size     (1,2,..6) ? 2
    Name (up to 8 chrs)? PRIVATE
Password (up to 6 chrs)? HIDE
 Control     (0,1,..FF)?
   Unit Size   Name    Password Ctrl
   ---- ----   ----    -------- ----
    02   02   PRIVATE  HIDE     FF
Is this listing correct? Y
Function Completed

 Command ?L
   Unit Size   Name    Password Ctrl
   ---- ----   ----    -------- ----
    00   01                     FF
    01   01   USER1A             FF
    02   02   PRIVATE  HIDE     FF
    03   03   USER1C             FF
    04   04   USER1D             FF
    05   01   USER2A             FF
    06   02   USER2B             FF
    07   03   USER2C             FF
    08   04   USER2D             FF

  Command ?S
WAIT - Saving Disk Allocation Table
Function Completed
 Command ?Q
```

Use the "L" command to list the current allocation table.

Be careful to avoid overallocation!

Use the "M" command to modify unit 2.

Enter "Y" if yes.

The control byte is currently ignored

Enter "Y" if new entry is correct.

List the new alloc table.

Use the "S" command to save the table.

Return to the CCP.

Assign a CP/M disk to a storage device

Command: ASSIGN [disk device]	Can be used on:	
ASSIGN is used to assign a CP/M disk (A,B,C,D) to a storage device, or the printer (P) to an output port.	Single user system HiNet user station HiNet master station MP/M	YES YES YES YES

Arguments:

```
disk   = A, B, C, or D (CP/M disk name) or P (printer)
device = S0, S1, ... S7 (single density floppy)
         D0, D1, ... D7 (double density floppy)
         Partition name (hard disk or HiNet partition)
         PORT0, PORT1, PORT2, PORT3 (serial printer port)
         PORTP (parallel printer port)
         SPOOL (HiNet spooler)
         CUSTOM (Customized printer driver)
```

CP/M drives A, B, C, and D, and the CP/M LST: device are initially assigned to default physical devices. The ASSIGN command can be used to change the disk or printer assignments if the defaults are unsatisfactory. The defaults depend on the type of system, as shown in the following table.

Disk name	Boot from flop:	Boot from hard:	HiNet station
A	D0	partition 1	see USERS, sec 4.2:
B	D1	partition 2	see USERS, sec 4.2:
C	S1	partition 3	see USERS, sec 4.2:
D	D1	partition 4	see USERS, sec 4.2:
Printer	PORT2	PORT2	see USERS program

"D0" refers to double density floppy drive 0. This is usually the drive on the righthand side in a dual-drive DSC-3 system, or the top drive in a DSC-4 system. "S1" refers to single density floppy drive 1. Drive 1 is usually the drive on the lefthand side of a DSC-3, or the bottom of a DSC-4. For double-sided floppies, drives 4 to 7 refer to the opposite sides of drives 0 to 3. Thus, on a normal double-sided dual-drive system, drives 0 and 4 refer to the two sides of the righthand (or top) drive, while drives 1 and 5 refer to the two sides of the lefthand (or bottom) drive.

If no arguments are specified in the "ASSIGN" command, then the current disk and printer assignments will be displayed.

Any drive can be "unassigned" by assigning it to "U:". For example, the command "ASSIGN D U:" makes the D drive inaccessible. A "*** CALL error" will result if a user attempts to access an "unassigned" drive.

To assign a drive to a private local hard disk under HiNet, precede the partition name with "H:". For example, use the command "ASSIGN D H:PAYROLL" to assign the "D" drive to the PAYROLL partition on a private hard disk.

The ASSIGN command can also be used to assign the CP/M LST: device to different output ports. For example, the command "ASSIGN P PORTP" will assign the printer to the parallel port.

The 7 different printer drivers which are supported by the ASSIGN command are as follows:

PORT0 : serial port 0 - To print using the AUX port on a DSC-3/A25 system, assign the printer to PORT0.

PORT1 : serial port 1 - This port cannot be accessed under HiNet. It can only be accessed under a single user CP/M system.

PORT2 : serial port 2 - This is the standard default serial printer port. Note that port 2 is also used for print spooling on the master station.

PORT3 : serial port 3 - This is a spare serial port which is usually not used. However, it can be used to access another serial printer if desired.

PORTP : parallel port - This printer driver should be used if you have a printer which uses a parallel port interface.

SPOOL : spooler - To use the HiNet spooler, the LST: device should be assigned to SPOOL (see section 4.8).

CUSTOM : customized printer driver

- It is possible to patch a non-standard printer driver into the BIOS. For instructions describing how this is done, see section 3.6.4. A driver using the XON-XOFF protocol is provided as the standard CUSTOM driver (this is suitable for printers similar to a DIABLO printer).

Some examples of the ASSIGN command are shown below:

```
A>ASSIGN D S0                                  Assign D to single
Assignment accepted.                           density on drive 0.

A>ASSIGN                                       Display current
                                               assignments.
            Current Disk Assignments
            ------------------------

A - double density, unit 00      size: 486K bytes
B - double density, unit 01      size: 486K bytes
C - single density, unit 01      size: 243K bytes
D - single density, unit 00      size: 243K bytes

Printer assigned to PORT2 (serial port 2)

A>ASSIGN C USER1A                              Assign C to a hard
Assignment accepted.                           disk partition.

A>ASSIGN D PRIVATE                             Assign D to a pass-
                                               word protected hard
Enter Password: HIDE (psw not echoed)          disk partition.
Assignment accepted.

A>ASSIGN P PORTP                               Assign the printer
Assignment accepted.                           to the parallel port

A>ASSIGN                                       Display current
                                               assignments.
            Current Disk Assignments
            ------------------------

A - double density, unit 00      size: 486K bytes
B - double density, unit 01      size: 486K bytes
C - hard disk     , USER1A       size: 256K bytes
D - hard disk     , PRIVATE      size: 512K bytes

Printer assigned to PORTP (parallel port 2)
```

Display the names of hard disk partitions

Command: DIRHARD	Can be used on:	
DIRHARD is used to display the names of all hard disk partitions.	Single user system	YES
	HiNet user station	NO
	HiNet master station	NO
	MP/M	NO

This program displays the names of all hard disk partitions as stored in the allocation table. If the user wishes to access one of the hard disk partitions, he must use the ASSIGN program. Passwords will not be displayed by DIRHARD. The ALLOC program must be used to create, delete, or change the name and/or password of a partition.

Example:

```
A>DIRHARD

                Current Hard Disk Partitions
                ----------------------------

  USER1A    256K bytes      PRIVATE   512K bytes     USER1C     1M byte
  USER1D      2M bytes      USER2A    256K bytes     USER2B   512K bytes
  USER2C      1M bytes      USER2D      2M bytes

A>
```


Copy a diskette

Command: FDCOPY	Can be used on:	
FDCOPY is used to copy a diskette from one drive to another.	Single user system	YES
	HiNet user station	NO
	HiNet master station	NO
	MP/M	NO

FDCOPY can be used to copy a diskette from one floppy drive to another. FDCOPY can copy an entire diskette, or only the system tracks (0 and 1), or only the data tracks (2 to 76). FDCOPY reads up to 5 tracks from the source disk, then copies and verifies one at time to the destination disk. This procedure is repeated until the copy operation is completed. At completion, a control-C can be entered to abort the program.

If an error is detected during the copy operation, a message will be printed. Error messages are described in section 3.4.

FDCOPY will ask for the source and destination drive numbers, instead of asking for CP/M disk names. Don't forget that drive 0 is the righthand (or top) drive, and drive 1 is the lefthand (or bottom) drive on a DSC-3 dual drive system. On a DSC-4, drive 0 is the top drive, and drive 1 is the bottom drive.

Example:

```
A>FDCOPY

Source disk (0-7) :0
Destination disk (0-7) :1
Density? (S/D) D
COPY: System tracks, Data tracks, or
      All  tracks?  (S,D, or A)?  A
Hit return when ready
Track xx copied

** JOB COMPLETED **

Source disk (0-7) :©C

A>
```


Format a diskette

Command: FORMAT	Can be used on:	
FORMAT can be used to format a diskette in either IBM 3740 standard single density or IBM 34 standard double density	Single user system	YES
	HiNet user station	NO
	HiNet master station	NO
	MP/M	NO

FORMAT can be used to format a floppy diskette. The diskette is formatted in IBM 3740 single density format or IBM System 34 double density format. There are 77 tracks, 26 sectors per track, and either 128 or 256 bytes per sector. Track 0 is always formatted in single density.

In single density, sectors are written in numerically increasing order. Thus, on each track, sector n is immediately followed by sector n+1. However, CP/M uses a logical to physical sector map so that when sectors are requested in numerical order, they will actually be interleaved. This is done to minimize disk access time. In double density, the sectors are interleaved on the diskette itself, and CP/M's map is not used.

Double density diskettes formatted on other CP/M systems may be incompatible with the format used by the DSC-3 or DCS-4. If an attempt is made to read an incompatible diskette, a "DENS error" will probably result.

Note that on double sided diskettes, both sides must be formatted separately. Drive numbers 4 thru 7 refer to the opposite sides of physical drives 0 thru 3.

Example:

```
A>FORMAT

Enter Disk Number (0-7) :0
Single or Double density? D
Type return to start.

FORMAT COMPLETE

Enter Disk Number (0-7) :©C

A>
```

Backup hard disk partition(s) onto floppies

Command: HARDBACK	Can be used on:	
HARDBACK can be used to backup hard disk partitions onto floppy diskettes.	Single user system	YES
	HiNet user station	NO
	HiNet master station	NO
	MP/M	NO

HARDBACK is a special utility program which allows one to backup hard disk partitions onto floppy diskettes. HARDBACK can backup at the rate of approximately 1 Mbyte per minute. It can also be used to reload from floppies back to the hard disk. HARDBACK uses specially formatted floppy diskettes. The diskettes are formatted with one 8K sector per track, thus a single-sided diskette can hold up to 608K data bytes, and a double sided diskette can hold 1216K data bytes. The first track of the diskette contains information which identifies the contents of the diskette. These diskettes can be formatted, read, and written only by the HARDBACK program. They cannot be read using any of the normal CP/M commands. The backup rate is approximately 14K per second, thus an entire 10M byte hard disk can be backed up in less than 12 minutes.

HARDBACK begins by printing the following message:

Select one of the following options:

0 = backup on single-sided diskettes
1 = backup on double-sided diskettes
2 = load from single-sided diskettes
3 = load from double-sided diskettes
4 = format backup diskette

Before backing up, option 4 must be used to format the backup diskettes. Once formatted, a backup diskette can be re-used as many times as desired.

If option 0 or 1 is selected, HARDBACK will ask for the current date and time. These are stored on each backup diskette, and are re-displayed when re-loading from the diskette. HARDBACK will also ask for the name of the partition to be backed up. Each partition begins on a fresh diskette; i.e., there is no way to store several partitions on a single diskette. If RETURN is typed, HARDBACK will refer to the current disk allocation table, and display each partition name it finds in the table. The partition names will be displayed one at a time. CTRL-S should be entered to skip over a partition, and RETURN should be entered to backup that particular partition.

If a floppy error occurs while backing up, the program will display an error message, and will automatically retry the floppy operation until it succeeds. Whenever a hard disk error occurs, the track, head, and sector of the error are displayed. However, HARDBACK does not attempt to recover from hard disk errors. HARDHELP must be used to repair the hard disk before attempting to reuse HARDBACK.

If option 2 or 3 is selected, HARDBACK will ask you to insert a backup diskette. The date, time, partition name, partition size, and diskette number will be read from the diskette and displayed. If the partition on the backup diskette cannot be found in the disk allocation table, or the diskette number doesn't match the expected number, the load operation will be aborted.

Important Note: HARDBACK will not run under HiNet. To get fast throughput, the DMA chip and the hard disk controller must be used exclusively for backing up; therefore, HARDBACK can only be run under a single-user system. To backup the HiNet master system, first boot CP/M from a diskette, and then execute HARDBACK.

Hard disk maintenance and diagnostic

Command: HARDHELP	Can be used on:	
HARDHELP is used to diagnose problems on the 8" and 14" hard disks.	Single user system	YES
	HiNet user station	NO
	HiNet master station	NO
	MP/M	NO

HARDHELP performs all of the following functions:

FORMAT:

The entire disk is reformatted. Some system information is saved and restored, including controller firmware, the ALLOC table, and the bad sector table.

LOAD CONTROLLER FIRMWARE:

This function loads the controller firmware onto the first 2 sectors of the disk. Different firmware is loaded depending on the size of the disk. Note that the same firmware supports CP/M, HiNet and OASIS.

DISPLAY/ADD TO BAD SECTOR TABLE:

This function displays a list of all physical sectors (track, head, sector) currently in the bad sector table and allows new sectors to be added. A separate written record of these defective sectors should be maintained. Note that only truly defective sectors should be put in the table. Any sector showing an error should be tested and put in the bad sector table only if the error is permanent and unrecoverable after being rewritten.

DISK TEST UTILITIES

These routines are used to test or access various features of the controller/drive subsystem. To access these routines, HARDHELP should be executed under DDT.

IMPORTANT NOTE: Many tests destroy data on the disk and therefore should not be used by untrained personnel.

HARDHELP is a test and diagnostic program for all DMS hard disk products and is designed to run under DDT control. HARDHELP allows the user to read or write the disk, examine the buffers, and run various disk tests. It is generally used for testing and trouble shooting but it can also be used to format the entire disk for CPM operation and to examine and modify the defective sector table.

To use HARDHELP, boot a normal CP/M diskette and enter the command "DDT HARDHELP.COM". DDT will prompt the user with a "-" when HARDHELP is ready to be run. Type G100 to initialize the program. HARDHELP will ask the size and type of disk drive being used. Next it will ask what operation the user wishes to perform. Answer "0" (all other options are designed to be run without DDT control). When control has returned to DDT ("-" prompt) type G100 to get a menu of the available diagnostic routines. Use this program carefully on a "live" disk as many of the tests (such as format) will destroy data. A sample of a HARDHELP menu is given below.

The following entry points are implemented:

100H	PRINT THIS MESSAGE
104H	SETUP INTERRUPTS FOR USE WITH DDT
108H	RESET HDC4000
10CH	ABSOLUTE SECTOR READ
110H	ABSOLUTE SECTOR WRITE
114H	VERIFY READ ENTIRE DISK
118H	FORMAT ENTIRE DISK
11CH	LOAD HDC RAM PROGRAM
120H	RUN WRITE, READ, COMPARE TEST
124H	RUN SEEK TEST
128H	GET DISK SIZE
12CH	INITIALIZE USER AREA FROM 1000H
130H	RUN INTERFACE TEST
134H	RUN MEMORY TEST
138H	GET CONTENTS OF HDC MEMORY
13CH	REPEAT READ THS
140H	REPEAT TEST THS
144H	SEND COMMAND 40H TO CONTROLLER

The abbreviation "HDC" refers to the hard disk controller. The following memory locations are used for data and command buffers.

1000H-1400H WBUFFER: Data in this buffer is transferred to the hard disk on a write command.

1800H-1C00H RBUFFER: Data that is read from the disk is stored in this buffer on disk read commands.

20H-27H COMMBUFF: This buffer is loaded and transmitted to the HDC (hard disk controller) on every HDC command. The HDC decodes the command buffer and acts on the information contained therein. Location 20H is loaded with the command byte. The rest of the buffer is loaded from location 0F00-0F06. These locations specify the disk location (track, head, sector), number of retries, and whether to perform a read after write check on a write command. Note that this command buffer is prepared automatically by the various tests.

The HDC commands that are loaded into 20H of the COMMBUFF by the various test programs are as follows.

ABSRDCOMM=1 Absolute read command

ABSWRTCOMM=2 Absolute write command

INITUSER=3 Loads the HDC user RAM area from locations 1000H. User programs can be special purpose test programs designed to operate specific parts of HDC hardware. The user RAM area of the HDC starts at 4100H, therefore all user programs should be designed to run at 4100H.

TSTINT=6 This causes the HDC program to run at 4100H where the user program HDCIT.HEX should be stored.

REREAD=7 Causes the HDC to run at 4100H. HDCIT.HEX should be at this location. Two of the entry point programs use this HDC command.

MTEST=8 Causes a memory test program to run at 4100H.

HDFORMAT=9 Causes a disk format program to run at 4100H.

Memory locations 0F00H-0F06H contain the disk location and the number of retries. HARDHELP programs manipulate these locations before loading them into COMMBUFF. The user may also manipulate these locations. For example, if the user wished to see the contents of the bad sector table, all he would have to do is change track, head, and sector to 0,0,11H respectively (for a 14" drive) or 0,0,0BH (for an 8" drive) and perform a disk read (G10C). The contents of the RBUFFER would then contain the bad sector table.

The meaning of F00-F06 is given below.

0F00=Track
0F01=Head
0F02=Sector
0F03-not used
0F04=Tag 1 -not used
0F05=Retrys -number of retries + 1

If most significant bit is 1, ECC (burst error correction) capability is used to recover from CRC errors for a read command, or read after write checking is done for a write command.

0F06=0

Description of all tests

To perform any of the tests contained in HARDHELP simply type GNNN then carriage RETURN, where NNN is the test entry location. All test programs return to DDT through a RST 06 or a manual interrupt. Several of the tests require a manual interrupt for a termination of the test and a return to DDT. The manual interrupt switch is the middle of the three switches on the front panel of the machine. Most tests terminate when an "R" is typed and show a summary when an "S" is typed.

G100	Display the directory of all entry points
G104	Enables the front panel interrupt ON DSC2 ONLY
G108	Resets the HDC See HDC OPERATION DESCRIPTION for a detailed description of a reset. (Note that G100 "falls through" and executes a G104 and G108).
G10C	Reads the sector specified by track, head, and sector. For detailed description see HDC OPERATION DESCRIPTION
G110	Writes the sector specified by track, head, and sector. For detailed description see HDC OPERATION DESCRIPTION
G11C	This program loads the HDC user area from 1000H. It is intended that the user programs will be test programs.
G114	This is a read test, it reads all sectors on the disk and reports any read errors.
G118	This test formats the entire disk. It destroys all data on the disk. The program asks the user whether he wishes to continue. The first 17 1K blocks of the disk will be saved and restored.
G120	This is a complete disk test. It writes and reads continuously over all sectors on the disk except for track 0. Two types of patterns are used; a cyclicly rotated B6D9 pattern, and a random pattern. G120 reports write errors, read errors and compare errors. An error counter at F08 counts the number of errors. Return is through front panel interrupt or "R". Typing an "S" while the program is running causes an error summary to be printed.

G124 This is a seek test program. It causes the disk to perform random, maximum, or incrementing seeks. Return is via front-panel interrupt or by typing "R".

G128 G128 gets the size of the disk and displays it on the screen. The program assumes that controller firmware has been stored on track0, head 0, sector 1.

G12C Initialize user area from 1000h. This program is very similar to G11C in that both load the HDC user memory area. The difference is that G12C also loads track 0, head 0, sectors 1 and 2 with the same program. Programs that are loaded by 12C must have the same format as the standard controller program. This function should be used ONLY if it is the first operation performed after running HARDHELP (other tests re-use the I/O buffers occupied by the controller firmware).

G130 Run interface test. This routine tests the CPU/HDC interface. This is achieved by sending data blocks to the HDC and reading them back. Three data patterns are used, a 00 pattern, FF pattern and a random pattern. Any errors are displayed on the screen.

G134 MEMTEST. This program tests the HDC RAM memory. For each test loop containing no errors, an 'OK' is printed. The program first executes at 4100H and tests C000H to FFFFH. After 256 loops it moves itself to C000H and tests 4100H to 7FFFH. If an error is found, the address, expected contents, and actual contents are printed in hex.

G138 GETMEM. This routine retrieves the HDC read buffer (F000H to F3FFH) and moves it to 4000H in the host's memory. This allows examination of the header which is normally not returned by the HDC.

G13C READTHS. This routine reads the sector specified by TRACK, HEAD, and SECTOR until an error occurs.. Get summary with "S" and exit with "R".

G140 WRITETHS. This routine writes, reads, and compares the sector specified by TRACK, HEAD and SECTOR until an error occurs. Get summary with "S" and exit with "R".

G150 RDISPC. Read and display continuously. This routine calls READISP below, increments the physical sector and repeats. Exit with "R".

G154 READISP. This routine reads the sector specified by TRACK, HEAD, and SECTOR and displays the first 100H bytes.

G158 GETBST. This routine reads the Bad Sector Table and displays it. Additional entries may be added.

G15C ZROBST. This routine zeroes the Bad Sector Table. (G158 must be run immediately before G15C).

G160 COMP. Compares read and write buffers. Useful to locate byte in error after G140.

Error message format

When G120 or some of the other test routines are running, read and write errors are displayed with 6 numbers. They have the following meaning:

Error type, Error from HDC, Track, HEad, Sector, Data Pattern

ERROR TYPES:
- 00 Write
- 01 Read
- 02 Compare (data different from expected result)

ERROR RETURN FROM HDC:

- 80 Command Error
- 40 Data CRC Error
- 21 Could not find sector-1 (header)
- 22 Bad track, head, or sector # in header
- 23 Header checksum error
- 11 Write fault
- 12 Drive Not Ready
- 13 Internal timeout
- 14 Read after write compare error
- 91 Error in saving first 17K during Format
- 92 Error in restoring first 17K in Format

Read from unit 0 of the hard disk to a CP/M file

Command: READO [filename trk sec secs]	Can be used on:	
READO is used to copy from partition 0 of a hard disk onto a CP/M file.	Single user system	YES
	HiNet user station	NO
	HiNet master station	NO
	MP/M	NO

Arguments

filename	CP/M file name to be created
trk	beginning track number (in hex)
sec	beginning sector number (in hex)
secs	number of sectors to read from partition 0

This program reads data from partition 0 of the hard disk into a CP/M file. The program will read a specified number of 128-byte sectors from unit 0, starting at a selected track and sector. All numbers used in READO are hexadecimal. READO can accept all the information from the command line. If this option is used, any incorrect data will force the program to obtain its data from the console.

READO can be used to copy the bad sector table, the hard disk allocation table, and the HiNet user table onto CP/M files. This provides a degree of protection in case one of these tables is damaged. For example, to copy the allocation table onto a file, use the command "READO 0 79 8 ALLOC.TAB". See section 9.3 for a complete description of the contents of hard disk partition 0.

Example:

```
A>READO

Starting track  number (in hex)? 0
Starting sector number (in hex)? 79
Number of sectors to read (in hex)? 8

  TRACK  SECT  SECTS TO READ
  -----  ----  -------------
    00    79         08

 Is data correct?Y
Data read from hard disk
Enter file name - ALLOC.TAB
File open.
File closed.

Data written

A>
```

Change baud rate

Command: SETBAUD [port baudrate]	Can be used on:	
SETBAUD is used to change the baud rate for a selected port.	Single user system	YES
	HiNet user station	YES
	HiNet master station	YES
	MP/M	YES

Arguments

port	0, 1, 2, or 3
baudrate	110, 300, 600, 1200, 1800, 2400, 4800, or 9600

SETBAUD can be used to change the baud rate of a selected port. The only restriction is that ports 2 and 3 must always share the same baud rate. Normally, each port is initialized to 9600 baud.

Example:

```
A>SETBAUD 3 300      Set the baud rate of port 3 to 300.
                     Note that the baud rate of port 2 will
                     also be set to 300.
A>
```


Set date and time

Command: SETTIME	Can be used on:	
SETTIME is used to set the current date and time.	Single user floppy	YES
	HiNet user station	YES
	HiNet master station	YES
	MP/M	NO

Set the current date and time. The date must be entered using the format MM/DD/YY. For example, 07/04/76 is a valid date. The time is entered using the format HH:MM. Thus, 17:08 indicates 5:08 PM. The date and time are maintained by the BIOS in low core at locations 40H to 46H. These locations can be examined by the user at any time.

Example:

```
A>SETTIME

Enter date  MM/DD/YY - 07/04/76
Enter time  HH:MM - 17:08

A>
```


Display date and time

Command: TIME

TIME is used to display the current date and time.

Can be used on:

Single user system	YES
HiNet user station	YES
HiNet master station	YES
MP/M	NO

Display the current date and time. If the date and time have not yet been set, the date will be displayed as '000-00-00' and the time will indicate the elapsed time since the system was powered-on or reset.

The date and time are maintained in memory locations 40h thru 46h. Any program may examine these locations at any time.

Memory location	Contents
40h	fractions of a second (normally 1/62ths)
41h	seconds
42h	minutes
43h	hours
44h	month
45h	day
46h	year

These locations are initialized to zeroes when the system is RESET. They are set by the SETTIME program.

Example:

```
A>TIME
Date  Jul-04-76
Time  17:08:23

A>
```


Write a CP/M file to unit 0 of the hard disk

Command: WRUNO [filename trk sec]	Can be used on:	
WRUNO is used to copy from a CP/M file to partition 0 of the hard disk	Single user system	YES
	HiNet user station	NO
	HiNet master station	NO
	MP/M	NO

Arguments

filename	CP/M file name to copy to partition 0
trk	beginning track number (in hex)
sec	beginning sector number (in hex)

This program writes data contained in any CP/M file to partition 0 of the hard disk. All numbers used in WRUNO are hexadecimal. WRUNO will write an entire file of 128-byte sectors onto partition 0 (sometimes called "unit 0") starting at a selected track and sector. Make sure that the file size does not exceed the expected size, otherwise valuable data on the disk may be accidentally overwritten. WRUNO can accept all the information from the command line. If this option is used, any incorrect data will cause the program to obtain its data from the console.

WRUNO can be used to restore the bad sector table, the hard disk allocation table, or the HiNet user table from CP/M files. WRUNO can also be used to write the CP/M or HiNet operating system onto the disk. See section 3.3 for system initialization instructions.

Example:

```
A>WRUNO

Enter file name - ALLOC.TAB
File found
File in memory.  Sectors read: 08

Starting track  number (in hex)? 0
Starting sector number (in hex)? 79

  TRACK  SECT  TOTAL SECTORS
  -----  ----      -----
    00    79         08

Is data correct and ready to be written to the hard disk?Y
Data Written to Hard Disk

A>
```

3.3 System Initialization

Floppy disk systems do not require any special procedure to initialize the system. Simply place a system diskette into drive 0 and boot from the floppy. If this is successful, immediately make a copy of the diskette, and save the original diskette for backup purposes. Never write to the original system diskette.

Before using a hard disk, the disk must be formatted and the controller firmware, bad sector table, and allocation table must all be initialized. Use the HARDHELP program to format the disk, then write the appropriate controller firmware to the disk. The bad sector table is initialized at the factory prior to shipping, so normally it should not be re-initialized.

The ALLOC program should be used to write an allocation table to partition 0 on the disk before attempting to use other partitions. A default allocation table is supplied with each system disk for demonstration purposes. To write the demo table to the disk, execute the command "WRUN0 ALLOC.TAB 0 79".

After the hard disk has been initialized and tested, it is possible to re-configure the system so that one can boot CP/M directly from the hard disk instead of using a floppy each time. Simply execute the command "SUBMIT MAKEHAR1" (for CP/M 1.4) or "SUBMIT MAKEHAR2" (for CP/M 2.2). Then change the default jumpers on the CPU board so that the system is booted from the hard disk instead of the floppy disk (see section 6.2). After booting, the default assignments for the A, B, C, and D drives will be the first 4 partitions on the disk.

3.4 Error Messages

Disk-related errors may occur occasionally. An error may be caused by a minor problem, such as inserting a wrong density diskette, or a more serious problem, such as a media problem or electronic failure. The discussion in this section identifies all software generated error messages, their probable causes, and any operator action that should be taken.

All I/O related messages will be followed by the track, head, and sector of the error. For hard disk errors, this information can be used in conjunction with the HARDHELP program to eliminate the problem.

After an error message is printed, there are two possible actions which can be taken. If the RETURN key is pressed, the system will proceed as if the error did not occur. Sometimes, the system will proceed properly. Usually the system will continue to fail until the error condition is eliminated. If a CONTROL-C is entered, an attempt will be made to reload the system. This will usually succeed.

PROM error message

***I/O Error nnnn — Occurs when attempting to boot CP/M. Can be caused by any of a number of problems. Your diskette may be damaged. The hardware may have failed. If this error persists after trying a known good diskette, then it is likely that the hardware has failed. If the error number is between 0 and 3FFh, then the error occurred while attempting to read sectors 0 and 1; if the error number is between 9000 and 90FFh, then the error occurred while attempting to read elsewhere on track 0 or 1. The controller's result string is stored beginning at location 9380h; it must be examined to determine the cause of the error.

BDOS error messages

BDOS Err on X:Select — A drive other than A, B, C, or D has been selected. Press RETURN or CONTROL-C to return to the command processor.

BDOS Err on X:R/O — The directory on drive "X" has changed since the directory was last accessed. In a single user system, this error can arise only if diskettes have been switched in drive "X" without reloading the directory. A warmboot will always reload all directories.

Floppy disk error messages

*** DATA error

Data CRC error. This error can only occur on a disk read. It indicates that the data on the diskette has been damaged. If you type a RETURN, you may be able to recover the data. However, if the error is in the directory, the diskette may be unusable. It is possible that you may recover the data by reading the diskette on another drive, or by repeating the current operation. Re-writing the offending sector is likely to eliminate this error, but destroy old data.

Persistent errors can be caused by diskette wear, improper diskette care, bad diskette quality, bad disk drives, bad power supply levels, or a bad disk controller.

*** DENS error

Missing address mark. The diskette is probably formatted in the wrong density. For example, this error is generated when a single density diskette is read on a drive assigned as double density, or when an unformatted diskette is read. It is also possible that your diskette has been damaged.

*** ENDT error

Access beyond end-of-track. The DMA chip has failed to interrupt the CPU at the completion of a DMA operation. This can happen when interrupts are disabled, even for a short period of time. This can also happen if the Z-80 I register is disturbed.

*** ID error

ID CRC error. This error indicates the an ID field on a diskette has been damaged. The same comments apply to ID errors and DATA errors, except that rewriting the offending sector will probably not eliminate this type of error.

*** MADR error

Missing address mark on floppy. The address mark was not found when trying to perform a floppy disk operation. This may mean that the diskette is damaged, or the floppy drive is not functioning properly. Retry the disk operation, and if it still fails, try a freshly formatted diskette.

*** ORUN error

The floppy controller was not serviced promptly. This error may be caused by a DMA chip failure or a software failure.

*** PROT error — The diskette is write-protected. To allow writing on the diskette, the notch on the end opposite the label must be covered.

*** SECT error — Sector cannot be found. This error indicates that the ID field for the current sector cannot be found on the current track. The diskette may be damaged, or the drive may have failed to step properly during the previous seek operation, or the software may have erroneously requested a non-existent sector.

*** SEEK error — Occurs when a floppy disk drive has failed while stepping to a new track.

*** SYNC error — The NEC765 controller chip is out of phase with the CPU chip. Indicates that the NEC chip was misprogrammed, or that interrupts have been disabled or missed.

*** TRAC error — The disk read/write head is positioned over the wrong track. The previous seek operation failed to position the read/write head over the proper track. To fix this problem, try re-homing the disk (a warm boot will usually do this). If the error persists, the controller or the drive is probably at fault.

Hard disk error messages

*** HARC error — Hard disk command error. This error usually means that an attempt has been made to access a sector beyond the end of the disk. The disk allocation table should be examined to make sure that all partitions fit within the disk being used.

*** HARD error — Hard disk data error. The data within a sector has been damaged. The HARDHELP program should be used to examine the sector to try to determine whether the data is recoverable, or if the sector can be fixed. If not, the sector should be put into the bad sector table.

*** HARF error — Hard disk fault. This error usually means that the hard disk is not connected to the CPU board, or that the hard disk power has failed. Check all cable and power connections, and verify that the hard disk is spinning.

*** HARS error — Hard disk sector error. The desired sector cannot be found. This error usually means that the sector information which precedes the sector on the disk has been damaged. The erroneous sector should be put in the bad sector table if it is permanently damaged (see the HARDHELP program for further assistance).

Other error messages

*** CALL error — A non-available BIOS feature has been requested, or an attempt has been made to access non-existent hardware.

*** HALT error — An attempt was made to execute a HALT instruction. The address of the HALT instruction will be printed.

*** INT error — Bad interrupt. An interrupt has occurred, but the wrong vector was used. This usually indicates a software error.

3.5 Contents of standard CP/M distribution diskette

Standard CP/M commands:

File name	Description
ASM.COM	CP/M assembler
DDT.COM	CP/M dynamic debugger
DUMP.COM	Display a binary file
ED.COM	CP/M editor
LOAD.COM	Convert HEX to COM file
PIP.COM	File copy utility
STAT.COM	File status utility
SUBMIT.COM	Submit utility
SYSGEN.COM	System generation utility
XSUB.COM	Used in conjunction with SUBMIT (CP/M 2.2 only)

Digital Microsystems' CP/M commands:

File name	Description
ALLOC.COM	Maintain hard disk allocation table
ASSIGN.COM	Assign disk device to A,B,C, or D
DIRHARD.COM	Display hard disk partition names
FDCOPY.COM	Floppy disk copy utility
FORMAT.COM	Floppy disk format utility
HARDBACK.COM	Hard disk to floppy backup utility
HARDHELP.COM	Hard disk test and diagnosis
READ0.COM	Read from hard disk partition 0 to a file
SETBAUD.COM	Set baud rate of a serial port
SETTIME.COM	Set the time-of-day
TIME.COM	Display the time-of-day
WRUN0.COM	Write to hard disk partition 0 from a file

Other Files:

File name	Description
ALLOC.TAB	Demonstration allocation table
HARDBOOT.COM	Hard disk boot code
HARDCPM2.COM	Hard disk CP/M
MAKEHAR2.SUB	Create single user hard disk system

3.6 CP/M technical information

3.6.1 Overview

The internal operation of CP/M is primarily proprietary information of Digital Research. However, CP/M provides two interfaces which are accessible by software suppliers and hardware suppliers. The CP/M Interface Guide describes the BDOS interface. This is the interface used by all software which runs under CP/M. The CP/M Alteration Guide describes the procedures which must be used by a hardware supplier to interface to CP/M (also see section 3.6.3). In addition to the standard CP/M features, Digital Microsystems offers the following features with all releases of CP/M.

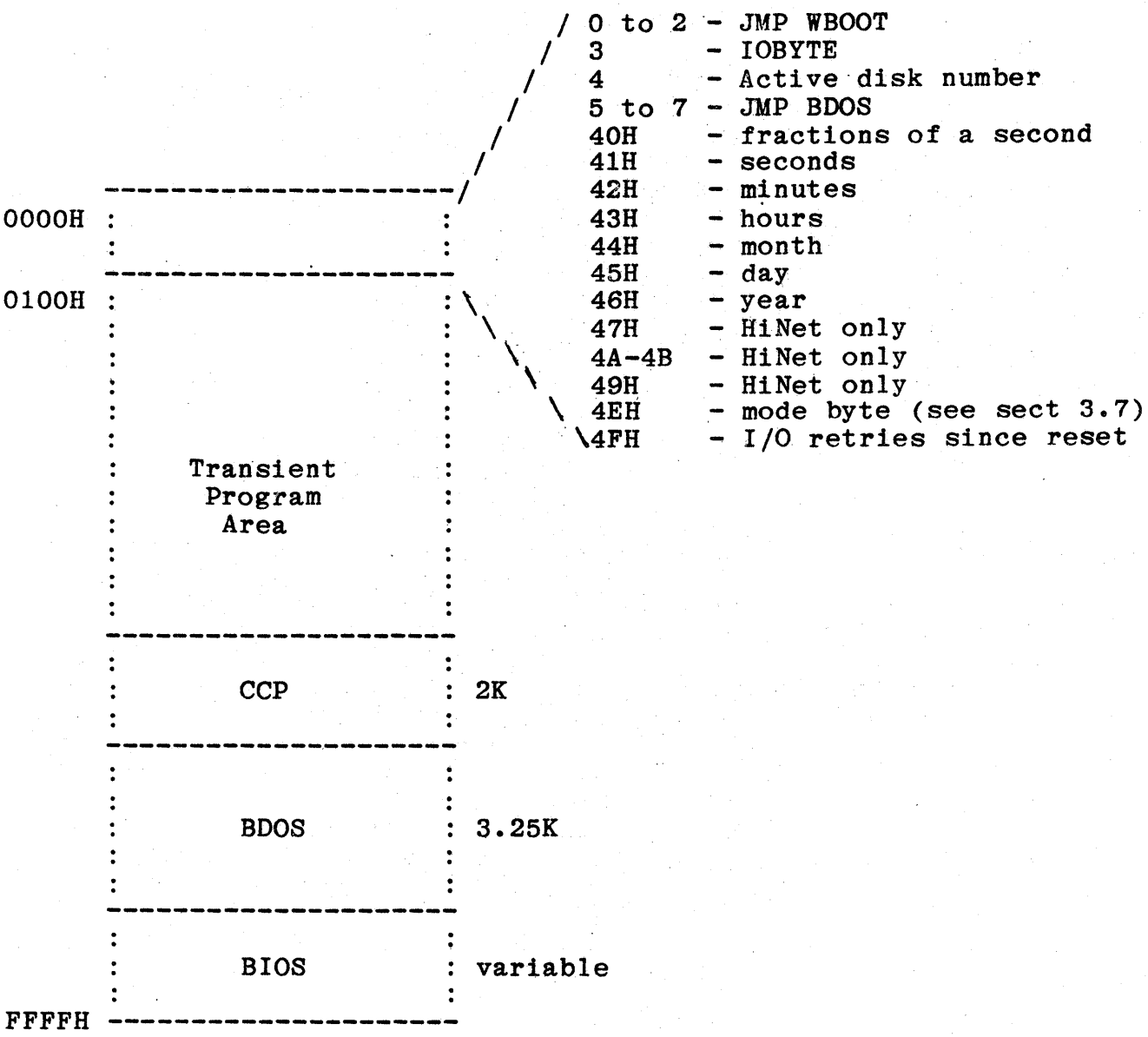
1. Type-ahead on console 0 - Up to 31 characters can be entered on the system console while the system is busy. The characters are kept in a buffer and are passed to the system when requested.

2. Time of day - The time of day is automatically computed and kept in fixed memory locations which can be examined at any time. See the TIME and SETTIME programs for more explanation.

3. Front-panel interrupt - If the INT switch (usually located next to the RESET switch) is pressed while the system is in operation, the CPU will immediately execute a jump to location 30h. This will usually cause the system to return to the command processor, but if DDT is in use, it will cause a return to DDT. This switch can be used to assist in debugging an assembly language program.

The source code of the BIOS is available to any customer who wishes to add his/her own special features to CP/M.

3.6.2 CP/M Memory Allocation



The total memory space (TPA) available to a user program is variable, depending on the hardware configuration.

3.6.3 BIOS entry points

The BIOS is the portion of the operating system which interacts directly with the hardware. At the beginning of the BIOS are a series of jump instructions which are used by the BDOS to gain access to the BIOS routines. The jump instruction at locations 0 to 2 can be used to locate the beginning of the BIOS. Each of the standard BIOS routines is described below.

Offset	Name	Description
00H	CBOOT	Initialize ports 1, 2, and 3, the real-time clock, and front-panel interrupts. Then jump to WBOOT.
03H	WBOOT	Load the CCP and the BDOS, and execute the CCP.
06H	CONST	Check console status
09H	CONIN	Console input
0CH	CONOUT	Console output
0FH	LIST	List output
12H	PUNCH	Punch output
15H	READER	Reader input
18H	HOME	Move the head of the current disk to track 0. This routine should be called once before a new diskette is read or written.
1BH	SELDSK	Select a disk drive. The disk parameter table for the current disk is written over the standard table in the BDOS.
1EH	SETTRK	Select a disk track. The seek operation is delayed until READ or WRITE is called.
21H	SETSEC	Select a disk sector.
24H	SETDMA	Set the DMA address.
27H	READ	Read a sector from a disk.
2AH	WRITE	Write a sector to a disk.
2DH	LISTST	List status (CP/M 2.2 only)
30H	SECTRAN	Sector translate (CP/M 2.2 only)

The READ and WRITE routines perform I/O on the currently selected disk, track, and sector. Normally, CP/M performs I/O in blocks of 128 bytes.

User BIOS calls

The routines in the BIOS may be called by a user program. However, a routine should never be called directly. Instead, the user should call the location in the jump table at the beginning of the BIOS. The order of the jump table is never changed, although the size of the routines in the BIOS may change from time to time. The address of the jump table is stored in locations 1-2. For example, to call the CONOUT routine, use:

```
LHLD  1         ; HL = base of vectors + 3
LXI   D,0CH-3   ; offset of JMP CONOUT
DAD   D         ; compute address of CONOUT
PCHL            ; jump to CONOUT
```

Digital Microsystems special BIOS entry points

Offset	Name	Description
5DH	CLRBUF	Flush floppy double density buffer
60H		- HiNet only -
63H	CPMMAP	Get pointer to disk assignment table
66H		- HiNet only -
69H	SETBYT	Set I/O operation byte count (floppy I/O only)
6CH		- HiNet only -
6FH		- HiNet only -
72H		- HiNet only -
75H		- HiNet only -
78H		- HiNet only -
7BH	CUSPRT	Print on user customizable printer

3.6.4 Customization guide

It is possible to perform some customizations to a standard CP/M release. For example, one can change the default IOBYTE so that a parallel printer is used instead of a serial printer. A series of "customization bytes" are stored at fixed locations in the BIOS. These bytes can be changed to customize a system to match user requirements. The address at which the customization bytes are stored is given by the following table.

CP/M 1.437	Customization bytes begin at this address:
Floppy SYSGEN	2BF0h
HARDCPM1.COM	26F0h

CP/M 2.237	Customization bytes begin at this address:
Floppy SYSGEN	2FF0h
HARDCPM2.COM	30F0h

For example, for a HiNet 1.4 hard disk system, the customization bytes begin at location 26F0h within the HARDCPM1.COM file. The DDT program can be used in conjunction with the SAVE command to modify the HARDCPM1.COM file.

The following customizations are allowed (the number preceeding the name gives the offset of that customization byte from the first byte).

0. Mode bits (default = 1) Each bit in this byte is used for a different purpose:

   Bit 0 - 0: don't retry floppy disk errors
   1: retry floppy disk errors 10 times before printing an error message

   Bits 1 thru 7 are used for HiNet only. They should be 0 for a single user system.

1. Floppy drive model (default = 0) Use 0 for single sided drives, and 1 for double sided drives.

2. Hertz rate (default = 3Eh) Normally, an internally generated clock rate of 62 hertz is used. If one wishes to use an external clock (normally 60 hertz in the U.S, and 50 hertz overseas), then this should be changed to the desired hertz rate. Use 3Ch for 60 hertz, or 32h for 50 hertz.

3-4. Baud rate for serial port 1 (default = 45h,02h) This baud rate is normally 500 Khz, and port 1 is normally used as an RS-422 port. If one wishes to use port 1 as an RS-232 port rather than an RS-422 port, one should change the baud rate to something other than 500 Khz. Also, the CPU board jumpers at JP2 and JP3 may have to be changed (see section 6.2). SIO#1 chip will then be automatically re-programmed so that port 1 will be RS-232. If port 1 is RS-232, the system should NOT be connected to the HiNet. If it is connected, the HiNet will behave in an unpredictable fashion.

5-6. Baud rate for serial ports 2 and 3 (default = 45h,0Dh) This baud rate is normally 9600 Kbaud. See section 5.7 for a list of valid baud rates and the byte ssequences which specify each rate.

7. IOBYTE for single user system (default = 54h) This value is used if you are booting a single user system from a floppy disk or a hard disk.

For example, to change the default baud rate on serial port 2 to 300 baud on a floppy-based CP/M 2.2 system, follow this procedure:

```
A>SYSGEN

Source disk name: A
Destination disk name: <cr>
Exit SYSGEN

A>SAVE 47 CPM.COM
A>DDT CPM.COM
DDT VERS 1.4
NEXT  PC
3000 0100
-S2FF5
2FF5 45 05 <cr>
2FF6 0D 34 <cr>
2FF7 ©C

A>SYSGEN

Source disk name: <cr>
Destination disk name: A (or B)
Exit SYSGEN

A>
```

Note: The diskette written by this procedure will have a new copy of the operating system (that will reflect the change) on tracks 0 and 1.

3.6.5 Implementation of the IOBYTE

The IOBYTE, at location 03h in memory, is implemented for the mapping of logical to physical devices. The mapping is performed by splitting the IOBYTE into four distinct fields called the CONSOLE, READER, PUNCH, and LIST fields, as shown below.

Bit number:	7	6	5	4	3	2	1	0
Device name:	LST:			PUN:	--	RDR:	CON:	

Whenever a reference to a logical device is made for I/O, the BIOS first looks at the appropriate bit field in the IOBYTE, and then uses one of the physical device service routines. The following table shows the association of IOBYTE values with physical devices:

Device Name	IOBYTE Value	Physical Device	Device Name Used by STAT
CON:	00	serial port 0	TTY:
	01	serial port 2	CRT:
	10	serial port 1	BAT:
	11	serial port 3	UC1:
RDR:	0	serial port 0	TTY:
	1	serial port 3	PTR:
PUN:	0	serial port 0	TTY:
	1	serial port 3	PTP:

Device Name	IOBYTE Value	Physical Device	Normal default value of IOBYTE
LST:	000	serial port 0	14h
	001	serial port 3	34h
	010	serial port 2	54h
	011	serial port 1	74h
	100	parallel port 2	94h
	101	reserved	---
	110	custom driver	D4h
	111	HiNet spooler	F4h

The normal default value for the IOBYTE is 54h. The default for the LST: device can be changed by using the ASSIGN command. The other defaults can be changed by using the STAT command. The default can be permanently changed by following the customization instructions in section 3.6.4.

4. HiNet operating system

4.1 Overview

The DMS HiNet system is a high speed local computer network. The network uses a shared disk system for data storage, and a single cable for communication. A HiNet system consists of a master computer and one or more user stations. The master provides control of the network communication lines and interfaces the user stations (and optionally a user connected directly to the master computer) to the shared disk resources.

The user stations are themselves complete computer systems. Each HiNet user station has a Z-80A CPU, 64K bytes of memory, and several I/O interfaces. In a typical installation each User Station executes locally its own copy of the CP/M operating system, using HiNet to allow sharing of the Master station's disk and printer. Any user station can, however, have local disks, printers, or other devices if the application should require their use.

Hard disk drives constitute the shared network storage. A shared hard disk is partitioned into 1 to 64 logical units. Each partition is assigned an 8 character name and a 6 character password. Each partition has a separate directory, which can be assigned for the exclusive use of one user, or for shared use by several users.

The environment seen by a HiNet user station or the local user attached to the HiNet master is that of standard CP/M 1.4 or CP/M 2.2. There are two commands, ALLOC and ASSIGN, that can be used to control the logical disks available under CP/M. ALLOC is a privileged command available only on the Master and is used to change the size, name, and password of the various hard disk partitions. ASSIGN can be used to assign any of the partitions for which the user has the correct password, or a local disk device, to the CP/M logical disks A:, B:, C:, or D:.

4.2 HiNet Commands

All standard CP/M commands should operate properly under HiNet. In addition, some (but not all) of Digital Microsystem's single user system commands will run under HiNet. The following DMS commands will run under both single user CP/M and HiNet.

Command	Description
ALLOC	Maintain hard disk allocation table
ASSIGN [disk device]	Assign disk device to A,B,C, or D
SETBAUD [port baudrate]	Set baud rate of a serial port
SETTIME	Set the time-of-day
TIME	Display the time-of-day

The ALLOC command can be used only on the master console and should not be run if any users (other than the master user) have logged on. ASSIGN, SETBAUD, SETTIME, and TIME can always be used. All of these commands are described in section 3.2, and their descriptions will not be repeated here (except for the ASSIGN command, whose description is repeated for convenience).

The following commands will not run under HiNet, but must be used occassionally to maintain the master hard disk. To use one of these commands, one must boot single user CP/M from a diskette on the master computer before executing the command. During the time that the command is being executed, HiNet cannot be used.

Command	Description
HARDBACK	Hard disk to floppy backup utility
HARDHELP	Hard disk test and diagnostics
READ0 [file t s secs]	Read from hard disk partition 0 to a file
WRUN0 [file trk sec]	Write to hard disk partition 0 from a file

---

The remainder of this section is devoted to descriptions of commands which apply only to HiNet. For convenience, the description of the ASSIGN command is repeated.

Assign a CP/M disk to a storage device

Command: ASSIGN [disk device]	Can be used on:	
ASSIGN is used to assign a CP/M disk (A,B,C,D) to a storage device, or the printer (P) to an output port.	Single user system HiNet user station HiNet master station MP/M	YES YES YES YES

Arguments:

disk = A, B, C, or D (CP/M disk name) or P (printer)
device = S0, S1, ... S7 (single density floppy)
D0, D1, ... D7 (double density floppy)
Partition name (hard disk or HiNet partition)
PORT0, PORT1, PORT2, PORT3 (serial printer port)
PORTP (parallel printer port)
SPOOL (HiNet spooler)
CUSTOM (Customized printer driver)

CP/M drives A, B, C, and D, and the CP/M LST: device are initially assigned to default physical devices. The ASSIGN command can be used to change the disk or printer assignments if the defaults are unsatisfactory. The defaults depend on the type of system, as shown in the following table.

Disk name	Boot from flop:	Boot from hard:	HiNet station
A	D0	partition 1	see USERS command
B	D1	partition 2	see USERS command
C	S1	partition 3	see USERS command
D	D1	partition 4	see USERS command
Printer	PORT2	PORT2	see USERS command

"D0" refers to double density floppy drive 0. This is usually the drive on the righthand side in a dual-drive DSC-3 system, or the top drive in a DSC-4 system. "S1" refers to single density floppy drive 1. Drive 1 is usually the drive on the lefthand side of a DSC-3, or the bottom of a DSC-4. For double-sided floppies, drives 4 to 7 refer to the opposite sides of drives 0 to 3. Thus, on a normal double-sided dual-drive system, drives 0 and 4 refer to the two sides of the righthand (or top) drive, while drives 1 and 5 refer to the two sides of the lefthand (or bottom) drive.

If no arguments are specified in the "ASSIGN" command, then the current disk and printer assignments will be displayed.

Any drive can be "unassigned" by assigning it to "U:". For example, the command "ASSIGN D U:" makes the D drive inaccessible. A "*** CALL error" will result if a user attempts to access an "unassigned" drive.

To assign a drive to a private local hard disk under HiNet, precede the partition name with "H:". For example, use the command "ASSIGN D H:PAYROLL" to assign the "D" drive to the PAYROLL partition on a private hard disk.

The ASSIGN command can also be used to assign the CP/M LST: device to different output ports. For example, the command "ASSIGN P PORTP" will assign the printer to the parallel port.

The 7 different printer drivers which are supported by the ASSIGN command are as follows:

PORT0 : serial port 0 - To print using the AUX port on a DSC-3/A25 system, assign P to PORT0.

PORT1 : serial port 1 - This port cannot be accessed under HiNet. It can only be accessed under a single user CP/M system.

PORT2 : serial port 2 - This is the standard default serial printer port. Note that port 2 is also used for print spooling on the master station, thus the local user connected to the master station cannot directly assign the printer to PORT2. Instead, he must assign P to SPOOL.

PORT3 : serial port 3 - This is a spare serial port which is usually not used. However, it can be used to access another serial printer if desired.

PORTP : parallel port - This printer driver should be used if you have a printer which uses a parallel port interface. Since the spooler may also use the parallel port, one cannot directly assign the LST: device to PORTP on the master station. Instead, one must assign P to SPOOL.

SPOOL : spooler - To use the HiNet spooler, the LST: device should be assigned to SPOOL (see section 4.8).

CUSTOM : customized printer driver

- It is possible to patch a non-standard printer driver into the BIOS (see section 3.6.4). A driver using the XON-XOFF protocol is provided as the standard CUSTOM driver (this is suitable for printers similar to a DIABLO printer).

Some examples of the ASSIGN command are shown below:

```
A>ASSIGN D S0                                  Assign D to single
Assignment accepted.                           density on drive 0.

A>ASSIGN                                       Display current
                                               assignments.
            Current Disk Assignments
            ------------------------

A - double density, unit 00      size: 486K bytes
B - double density, unit 01      size: 486K bytes
C - single density, unit 01      size: 243K bytes
D - single density, unit 00      size: 243K bytes

Printer assigned to PORT2 (serial port 2)

A>ASSIGN C USER1A                              Assign C to a HiNet
Assignment accepted.                           disk partition.

A>ASSIGN D PRIVATE                             Assign D to a pass-
                                               word protected HiNet
Enter Password: HIDE (psw not echoed)          partition.
Assignment accepted.

A>ASSIGN P PORTP                               Assign the printer
Assignment accepted.                           to the parallel port

A>ASSIGN                                       Display current
                                               assignments.
            Current Disk Assignments
            ------------------------

A - double density, unit 00      size: 486K bytes
B - double density, unit 01      size: 486K bytes
C - hard disk     , USER1A       size: 256K bytes
D - hard disk     , PRIVATE      size: 512K bytes

Printer assigned to PORTP (parallel port 2)
```

Display the names of HiNet master disk partitions

Command: DIRNET	Can be used on:	
DIRNET is used to display the names of all partitions on the shared hard disk which is located at the master station.	Single user system	NO
	HiNet user station	YES
	HiNet master station	YES
	MP/M	NO

This program displays the names of all HiNet disk partitions. If a network station has local hard disk storage, the DIRHARD command should be used to list the partitions on the local hard disk, while the DIRNET command should be used to list the partitions on the shared hard disk.

Example:

```
A>DIRNET

                Current HiNet Partitions
                ------------------------

USER1A   256K bytes    USER1B  512K bytes    USER1C    1M bytes
USER1D     2M bytes    USER2A  256K bytes    USER2B  512K bytes
USER2C     1M bytes    USER2D    2M bytes

A>
```


Log into HiNet

Command: LOGIN	Can be used on:	
LOGIN can be used to log into HiNet. It is usually used to re-login under a different user name.	Single user system	NO
	HiNet user station	YES
	HiNet master station	NO
	MP/M	NO

The normal login procedure is to boot directly from HiNet by powering on or by hitting RESET. The LOGIN program allows one to login from a system which has already been booted from a floppy or local hard disk. The LOGIN program can also be used to re-login under a different user name. After the new login, the A, B, C, and D drives will be assigned to new defaults, depending upon the name used for logging in.

Example:

```
A>LOGIN

HiNet Login version 2.1
HiNet 2.237

Login please ...
  Name: JOE
  Password:

A>
```


Spooler control

Command: SPOOL

SPOOL is used to specify the spooling mode, or to abort, retry, or wake spooling job(s).

Can be used on:

Single user system	NO
HiNet user station	NO
HiNet master station	YES
MP/M	NO

The SPOOL command is completely described in section 4.8. Its basic function is to control the operation of the HiNet spooler. Its options are summarized below (this list can be generated by executing the SPOOL command on the master console, and not specifying any arguments).

ABORT - abort current print job
RETRY - retry current print job
WAKE - activate all waiting jobs
MODE - set spooling mode

MODE1 - AUTOMATIC on serial port 2, print when done.
MODE2 - AUTOMATIC on serial port 2, wait when done.
MODE3 - AUTOMATIC on parallel port 2, print when done.
MODE4 - AUTOMATIC on parallel port 2, when when done.
MODE5 - MANUAL, print when done.
MODE6 - MANUAL, wait when done.

For example, the command 'SPOOL ABORT'
will stop the printer and erase the file
which is currently being printed

Initialize and/or Modify the User Name Table

Command: USERS	Can be used on:	
USERS is used to initialize or modify the HiNet user name table.	Single user system	NO
	HiNet user station	NO
	HiNet master station	YES
	MP/M	NO

USERS allows the user to modify the user name table. This table is permanently stored on partition 0 of the hard disk. The user name table contains the names and passwords of all legitimate HiNet users. For each user, the default assignments of the A, B, C, and D drives must be specified. Also, a default IOBYTE can be specified for each user. This allows each user to have a different default printer assignment. The USERS program also allows one to specify a default type-ahead buffer for each user. This allows a station to automatically begin executing a program immediately after a user logs in.

USERS commands are as follows:

A - Add an entry to the table
D - Delete an entry in the table
H - Print this Help summary.
L - List the current user table.
M - Modify an entry in the table.
Q - Quit the program (exit to system)
S - Save the modified User Name Table.
Z - Zero out (initialize) the table.

Each user should be assigned an 8 character name and optionally, a 6 character password. The name and password are used to log into HiNet. The password is not required. A value for the IOBYTE must also be specified for each user. See section 4.6.5 for a description of the IOBYTE.

Each user must be assigned default partition names for the A, B, C, and D drives. The USERS program will ask for four valid partition names. If you do not want a user to access a particular drive, put a "U:" in place of the partition name, and it will be unassigned. To assign a logical drive to a local floppy, use the names "D0" thru "D7" (for double density) or "S0" thru "S7" (for single density).

The default contents of the type-ahead buffer can optionally be specified for each user. Up to 31 characters can be entered into each user's type-ahead buffer. These characters will be processed by the station immediately after the user logs in. Thus, one can setup a HiNet system in which each user automatically starts running a different application program after logging in. For example, suppose a user named JOE has a DSC-3/B with a private 1200 baud printer, and JOE always runs the PAYROLL program immediately after logging in. JOE's default type-ahead buffer should be "SETBAUD 2 1200@ PAYROLL". Note that

an ampersand symbol "@" is used to represent the RETURN key in the type-ahead buffer.

The following example shows how to use USERS to add a new user to the user table.

```
A>USERS

 Command?L

Entry   Name     Password              Defaults                          IObyte
-----  --------  --------  ---------------------------------- ------
00     PETER     XYZ       A:COMMON  B:PARTB  C:PARTC  D:U:     F4
01     JOE               A:COMMON  B:JOE    C:U:     D:DO     54

 Command?A
First available line is 02
    Name (up to 8 chrs)?GEORGE
Password (up to 6 chrs)?
Defaults (up to 8 chrs) A:COMMON
                        B:PAYROLL
                        C:U:
                        D:U:
 IObyte:54
 Type ahead buffer: WHO@

Entry   Name     Password              Defaults                          IObyte
-----  --------  --------  ---------------------------------- ------
02     GEORGE            A:COMMON  B:PAYROLL C:U:     D:U:     54

Is this listing correct? Y
Function Completed

 Command?S
WAIT - Saving Name/Password/Configuration Table
Function Completed

 Command?Q
```

See who is logged into HiNet

Command: WHO	Can be used on:	
WHO displays the names of all users who are currently logged into HiNet. It also displays a list of all spool jobs.	Single user system	NO
	HiNet user station	YES
	HiNet master station	YES
	MP/M	NO

The WHO program prints the name, login time, and last HiNet request of each user who is currently connected to HiNet. A list of all active spool jobs is also displayed. See section 4.8 for instructions concerning interpretation of spool job information.

Example:

```
A>WHO

HiNet status as of 12:30:01

User name   Login Time   Last HiNet Request   Status
---------   ----------   ------------------   ------
USER1        09:12:02     11:39:57  read      active
PETER        10:15:34     12:10:43  who       active

User name   Spool Time   File Length   Status
---------   ----------   -----------   ------
PETER        12:16:43     06 records   ready

A>
```

4.3 System initialization

The following procedures should be followed to install HiNet on a freshly formatted hard disk:

1. Run the HARDHELP program, and write the hard disk controller firmware onto blocks 0 and 1 of the hard disk.

2. Construct the disk allocation table. This is done by running program WRUNO or ALLOC. WRUNO writes an existing allocation table from the floppy disk to the hard disk, while ALLOC allows one to create a new allocation table or modify an existing one. To setup a demonstration allocation table, write the file ALLOC.TAB to logical track 0, sector 79h using the WRUNO command.

3. RESET the system. This causes the hard disk controller to use the new controller software and the new disk allocation table.

4. Construct the user name table. Use the USERS program to write a new user table to the disk, or use the WRUNO program to write a demonstration user name table to the disk. To write the demonstration user table to the disk, execute the commands "WRUNO USER.TAB 3 1" and "WRUNO CONFIG.TAB 4 1".

5. Execute the command "SUBMIT MAKESYS1" for CP/M 1.4, or "SUBMIT MAKESYS2" for CP/M 2.2. The MAKESYSn.SUB files contain the commands needed to write the master BIOS and the station BIOS onto the hard disk.

6. Boot CP/M from a diskette and use the ASSIGN command to assign the "D" drive to one of the disk partitions which can be accessed by one of the users in the user table. Use the PIP command to copy at least the ASSIGN.COM file from the system diskette to a hard disk partition.

Starting the Master

1. Power on the Master Computer. Wait for the hard disk drive to become ready. Wait at least 30 seconds for an 8" hard disk, or 90 seconds for a 14" hard disk.

2. Load the operating system from the hard disk. If the CPU has been jumpered to boot from the hard disk, then this is accomplished by simply pressing the RESET switch. (See section 6.2). Otherwise, press the INT switch and then press the RESET switch. The message "PROM Monitor 1.09" should be displayed on the screen. Type "BH". This loads the operating system from the hard disk.

3. The message "HiNet Master 1.437" or "HiNet Master 2.237" should be displayed on the screen. This means that the Network Master is fully operational. The date and time can be entered, if desired (to avoid entry, hit RETURN). User stations may now log into the network. A user may also log into the Network Master although this is not recommended if there are over 4 users. The user connected directly to the master should not attempt to perform any operation which might interfere with HiNet operation (e.g., change interrupt status, or disturb memory other than the Transient Program Area).

Starting a HiNet Station

1. Turn the power on.

2. If the user station has been jumpered properly to boot from the network, press the RESET switch. The terminal should respond with the following message:

```
HiNet 1.437 or HiNet 2.237

Login please ...
 Name:
```

If this message does not appear, it should be verified that the HiNet master is operating, and that the User Station is attached to the network cable.

A user name and optional password must be entered before the user can access any network facilities. If a correct name and password are entered, the CP/M prompt A> will be displayed. A normal CP/M environment is now available to the user. The ASSIGN command may be used to change the A,B,C, and D disk assignments from the default values to the desired hard disk partitions.

4.4 Error messages

Any of the error messages generated under single user CP/M can also be generated under HiNet. These error messages are discussed in section 3.4. Floppy error messages will be generated on the console of the station which caused the error, however all master hard disk error messages will appear only on the master console. If a hard disk error occurs, the HiNet system will probably stop. The error situation should be resolved before attempting to bring HiNet up again.

Several special error messages can be generated only under HiNet. These messages are described below.

*** Waiting — Occurs when a station is waiting for a poll from the master, but no poll is received within 4 seconds. This usually means that the master has failed. The master console should be consulted to see if there are any error messages on the screen which might indicate the cause of failure.

*** User NN error — This message will appear on the master console if a protocol error has occurred. The majority of protocol errors are recoverable, and an occassional error can safely be ignored. Many error messages may indicate faulty cabling or marginal operation of one or more of the HiNet stations. The error message is followed by the address in the operating system at which the error was detected. This address must be compared against a current listing of the operating system to determine the precise cause of failure. User error messages are normally suppressed; to enable them, the mode byte in location 4Eh must be altered. See section 4.6.4 for further assistance.

4.5 Contents of standard HiNet distribution diskette

Standard CP/M commands:

File name	Description
ASM.COM	CP/M assembler
DDT.COM	CP/M dynamic debugger
DUMP.COM	Display a binary file
ED.COM	CP/M editor
LOAD.COM	Convert HEX to COM file
PIP.COM	File copy utility
STAT.COM	File status utility
SUBMIT.COM	Submit utility
SYSGEN.COM	System generation utility
XSUB.COM	Used in conjunction with SUBMIT (CP/M 2.2 only)

Digital Microsystems CP/M and HiNet commands:

File name	Description
ALLOC.COM	Maintain hard disk allocation table
ASSIGN.COM	Assign disk device to A,B,C, or D
DIRHARD.COM	Display hard disk partition names
DIRNET.COM	Display HiNet partition names
FDCOPY.COM	Floppy disk copy utility
FORMAT.COM	Floppy disk format utility
HARDBACK.COM	Hard disk to floppy backup utility
HARDHELP.COM	Hard disk test and diagnosis
LOGIN.COM	Log into HiNet
READ0.COM	Read from hard disk partition 0 to a file
SETBAUD.COM	Set baud rate of a serial port
SETTIME.COM	Set the time-of-day
SPOOL.COM	Set spooling mode
TIME.COM	Display the time-of-day
USERS.COM	Maintain user name table
WHO.COM	See who is logged into HiNet
WRUN0.COM	Write to hard disk partition 0 from a file

Other Files:

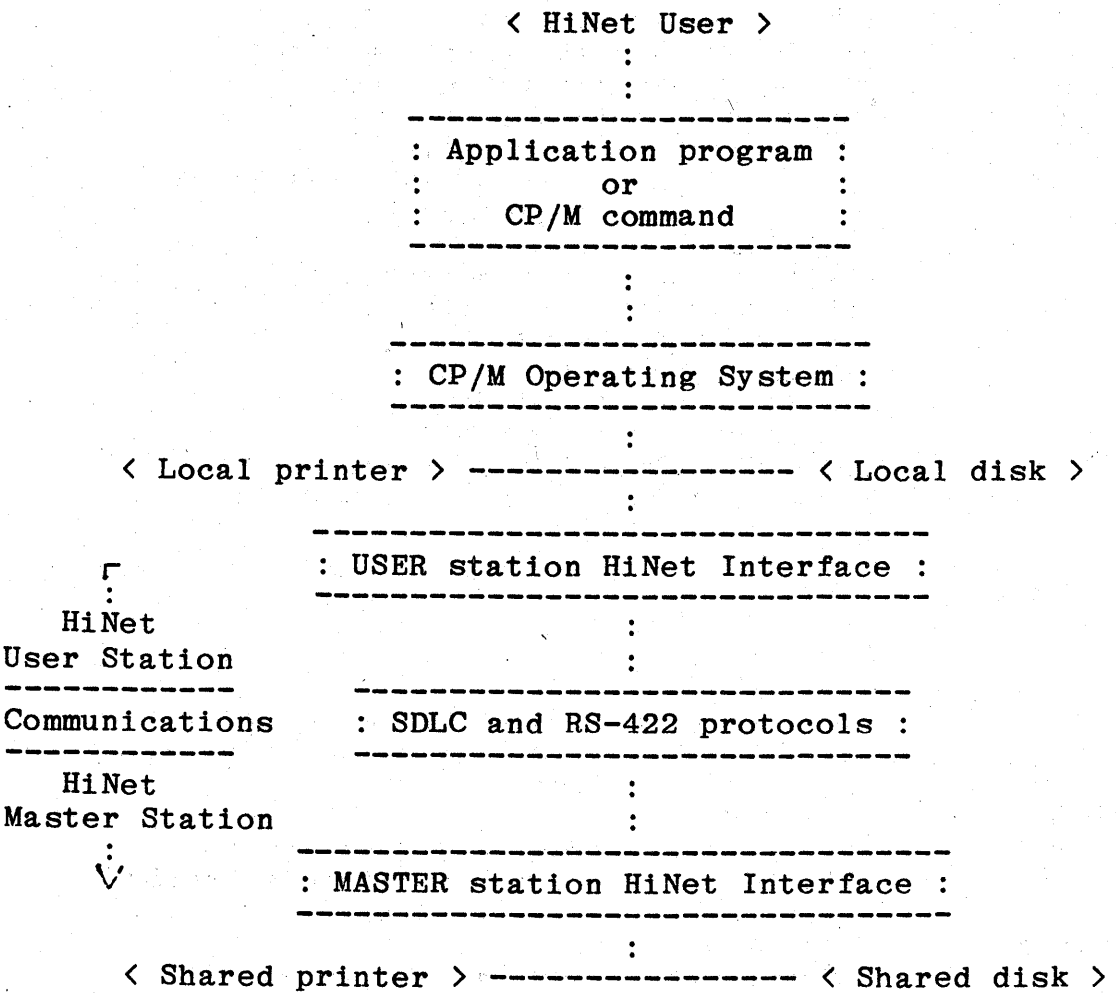
File name	Description
ALLOC.TAB	Demonstration allocation table
CONFIG.TAB	Demonstration user table (configurations)
HARDBOOT.COM	Hard disk boot code
HARDCPM2.COM	Hard disk CP/M
MAKEHAR2.SUB	Create single user hard disk system
MAKENET2.SUB	Write demo user table and invoke MAKESYS
MAKESYS2.SUB	Write master and station op sys to disk
MASTBOOT.COM	HiNet master boot code
USER.TAB	Demonstration user table (names)

4.6 HiNet technical information

4.6.1 Overview

The HiNet architecture can be viewed at several levels. At the uppermost level, different applications may be running on each of the HiNet User Stations. Some applications may be accessing local disks or printers, while other applications may be sharing the master disk or printer. Each application makes I/O requests to a local operating system. The system decides whether each request is for a local resource or a network resource. All network requests are passed to the HiNet interface. The HiNet interface provides the communication protocols which are used to handle the request. At the lowermost level are the SDLC and RS-422 protocols. These describe the electronic characteristics of the HiNet communications.

These levels are pictorially represented below. Each level is discussed in more detail in the following sections of this manual.



Application Programs and CP/M Commands

Any application program which currently runs under CP/M 1.4 or CP/M 2.2 can be run on the HiNet with few, if any, changes. Many applications, including word processing, accounts payable and receivable, payroll and inventory processing are easily installed on HiNet. A different application may be running simultaneously on each HiNet station. It is also possible for several users to share a common database.

The standard CP/M 1.4 or CP/M 2.2 commands and programs are provided with HiNet. These include DIR (list directory), STAT (directory status), PIP (file copy utility), ASM (assembler), DDT (dynamic debugger), and ED (text editor). Interpreters or compilers for BASIC, PASCAL, FORTRAN, and COBOL are also available.

Several additional commands are provided so that the user can make full use of the network facilities. For example, the ASSIGN command assigns a physical disk device or area to one of the CP/M disk names A, B, C, or D. This command allows the user to gain access to any of his local storage devices, or any part of the main network disk for which he has the appropriate password.

CP/M Operating System

The CP/M operating system processes user disk requests, such as "open file", "get next record", or "get random record". Each request is converted into one or more disk reads or writes, on a selected disk, track, and sector.

CP/M 1.4 allows for up to 4 disks (A, B, C, and D), 256 tracks per disk, and 128 sectors per track. Each sector is 128 bytes. Thus, the maximum CP/M 1.4 disk size is 4 Mbytes. This provides each user with a maximum of 16 Mbytes of direct disk access at any one time. All of the above applies to CP/M 2.2 except the maximum disk size has been increased to 8 Mbytes.

Local disk and printer requests can be handled directly by CP/M and the local BIOS. Thus, many requests can be handled entirely locally to a network station. Network requests are passed on to the next level, called the HiNet interface.

The User Station HiNet Interface

Each I/O request which cannot be processed locally is handled by the HiNet interface. The User Station waits for a poll from the Master. Normally, when a User Station is polled, it answers with an acknowledgement, indicating that it has no active requests for the Master. Legal HiNet requests include the following:

1) Read a sector from the master disk.

2) Write a sector to the master disk.

3) Log onto the network.

4) Assign named disk partition to the requesting user.

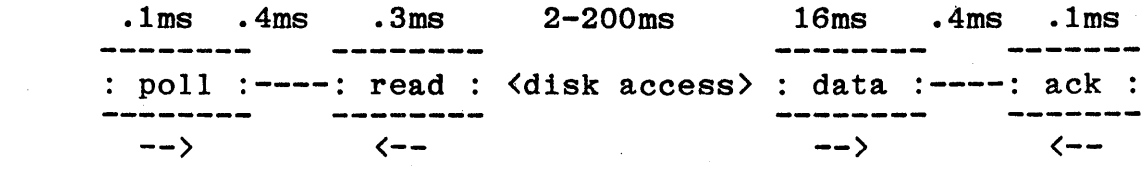
5) Spool 128 bytes to a printer.

The read/write command specifies the partition, track, and sector to be processed. The normal byte count is 128. The Master acknowledges reception of the command. For a write command, the User Station then sends the write-data to the Master. The Master acknowledges reception of the data, and the User Station then returns back to the CP/M operating system. A read command is handled in a similar fashion.

To log into the network, the User Station is programmed to receive requests for pseudo-user number 253. The Master transmits special polls to this "user" every 1/3 second. Any User Station wishing to log on must answer this poll, and if the answer is received successfully by the Master, the User Station is assigned a unique user number. This user number is used for all further communication with the Master. If several users attempt to answer this poll simultaneously, the Master responds with a negative acknowledgement, and the User Station will wait for a random period of time, and try logging in again. This will rarely happen.

As a first step in loading CP/M onto a User Station, the Master broadcasts the bootstrap code to pseudo-user number 254 once per second. Any User Station wishing to log in must execute this code. Then the User Station is assigned a user number by the login procedure above. The Master transfers CP/M to the User Station's memory. Upon completion of this transfer, the user can begin executing CP/M.

A typical HiNet transaction is illustrated below. The read request is for 1024 bytes. HiNet reads are buffered locally to achieve fast system throughput. The amount of real time required for each message, and the direction of each message is indicated. An arrow pointing to the right indicates a message from the Master to a User Station ; an arrow pointing to the left indicates a message from user to master.



The time delay between messages is needed so that the sender of a message has time to execute the necessary code to receive an answer-back message. In order to minimize this time delay, a sophisticated disk buffering scheme is used in the network master, so a typical 1K read transaction is completed in fewer than 30 ms.

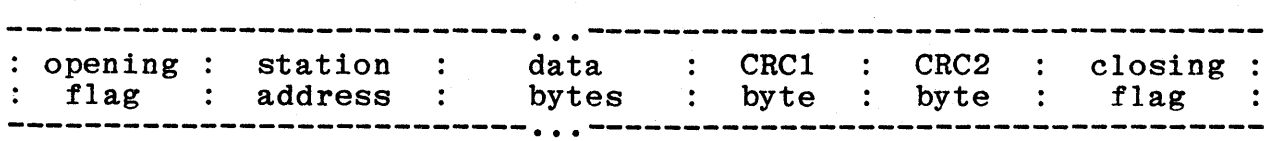
SDLC and RS-422

SDLC is an abbreviation for "Synchronous Data Link Control". It is a protocol which was originally devised by IBM for inter-computer communications. Each User Station is assigned a unique user number. A station only accepts network data which is addressed to it. An 8-bit address is assigned to each User Station; thus, there can be up to 255 network stations. Any data addressed to the special network address of all ones (i.e., 255) can be "heard" by all stations on the network.

The HiNet electrical interface between stations is RS-422. This uses a differential electrical signal carried on one twisted pair of wires. All station transmitters are connected to one pair and all except one will have their transmitters disabled at any one time. All stations (including the one transmitting) will receive data from the common wires, but only the one programmed with the destination address will accept this data. To simplify the hardware interface, a clock signal is carried on a separate twisted pair and is provided by the station that is transmitting. A fifth wire in the cable is used to provide a common ground.

Data is transmitted as a series of zeros and ones, at 500 KHz. Each transmission begins and ends with a "FLAG". This flag consists of the bit pattern 01111110. To avoid confusing data with a flag, the transmitter inserts a zero after each 5 consecutive ones, and the receiver removes the zeroes at the other end. The closing flag is preceded by a 16 bit CRC error code. This code is used to detect transmission errors. A typical data transmission is illustrated below:

SDLC frame



MASTER HiNet Interface

The MASTER HiNet interface communicates with the USER HiNet interface. The network master runs in the "background" of the master computer, while a user may run in the "foreground". The master is "awakened" every 1/60th of a second. It consults its list of users, and polls each logged-on user. A user may respond to a poll in one of three ways:

1) Negative acknowledge - this means that the user has no active requests. In this case, the master immediately polls the next user.

2) Network request (read, write, assign, ...) - the master uses the necessary protocol to handle the request.

3) No answer to poll - the master assumes that the user station has either powered off or logged out. The user station must answer every poll to remain logged in. The user station will do this automatically as long as interrupts are enabled and the operating system is functional. The master provides for a grace period of 4 seconds, during which the user station is re-polled every 1/2 second. If the user station fails to answer any of these polls, the user is officially logged off. The user number associated with that user is returned to the list of available user numbers, and may be reused later.

After each logged-in user has been polled and all requests have been processed, the CPU is returned to the user who is running on the master. For networks with greater then 4 users, the master should be dedicated to servicing the network, because a user attached to the master might experience a significant degradation in performance.

The master interface is designed so that a failure of any one particular user station will not cause the master to malfunction. A user station failure will affect only one user, and leave the rest of the network functioning normally. However, more caution must be exercised by a user attached to the master station, as a malfunction at the master could have a greater effect on overall network functions. Specifically, users with local disk storage would still be able to perform all their local computing functions, however, they would obviously be unable to access any data stored at the master station.

Sharing the System disk

A hard disk system constitutes the shared network storage. A shared hard disk is partitioned into as many as 64 logical units. Under CP/M 1.4, each unit is assigned a size from 1/4 Mbyte to 4 Mbytes. Under CP/M 2.2, each unit is assigned a size from 1/4 Mbyte to 8 Mbytes. With both systems, a unit is assigned an 8 character name, and a 6 character password. Each unit has a separate directory, which can be assigned for the exclusive use of one user, or for shared use by several users. The ASSIGN command is used to assign one of the CP/M disk names A, B, C, or D to a disk unit. For example, the command

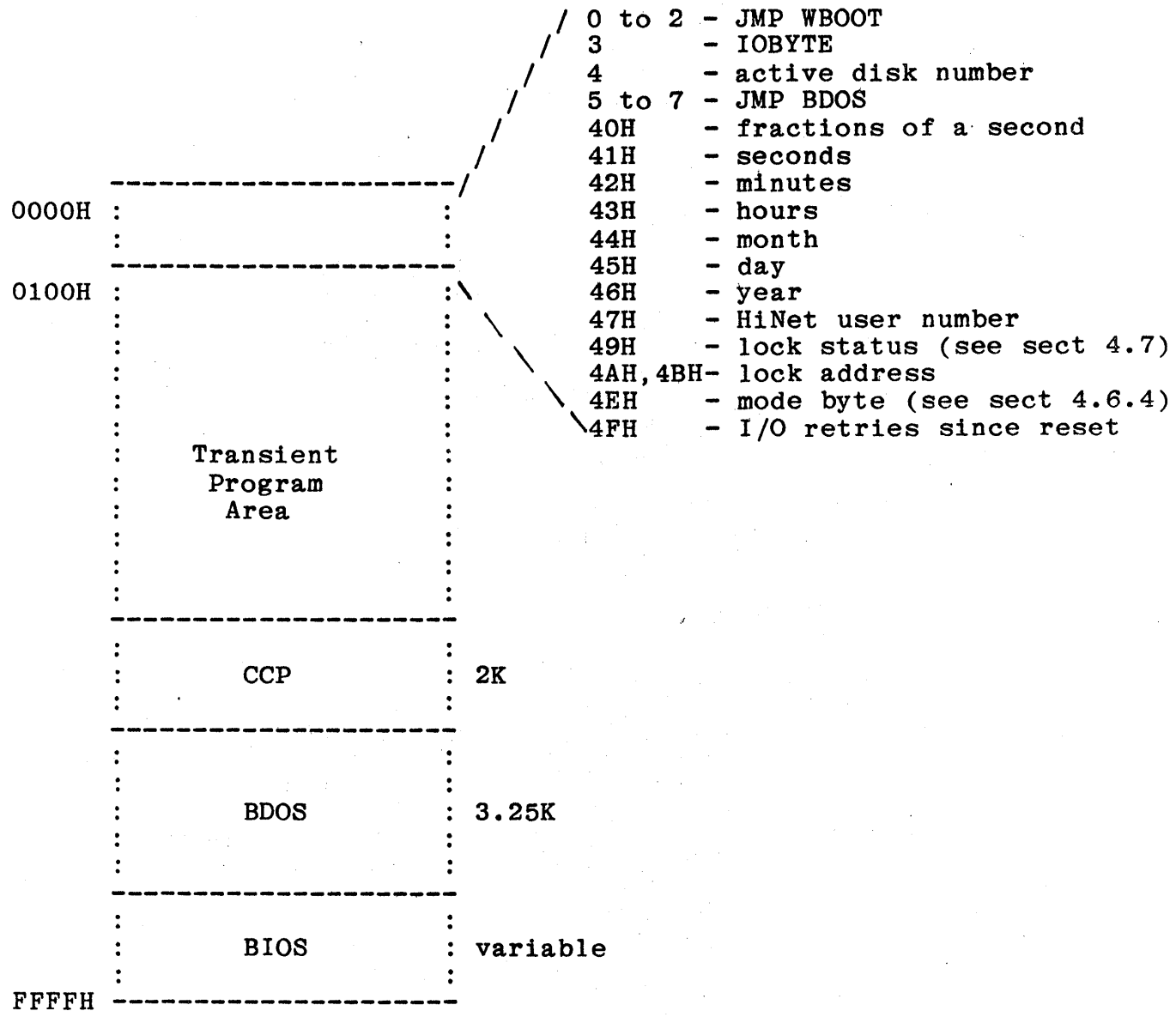
```
ASSIGN B PAYROLL
```

assigns the B disk to the hard disk partition named PAYROLL. If this unit is password-protected, the ASSIGN command will ask for a password before allowing the assignment.

The privileged user running on the master station can control the partitioning of the disk. There is a 1K table on the hard disk which contains this information. The ALLOC program constructs this table, and allows an authorized user to change this table as desired.

To provide high disk access performance, all hard disk I/O is done in 1K blocks. The 24 most recently accessed 1K blocks are kept in memory. Since most disk requests are for sequentially stored data, disk accesses can be kept to a minimum, and the speed of the system is significantly improved.

4.6.2 Memory allocation



The total memory space (TPA) available to a user program is variable, depending on the hardware configuration.

4.6.3 BIOS entry points

The BIOS is the portion of the operating system which interacts directly with the hardware. At the beginning of the BIOS are a series of jump instructions which are used by the BDOS to gain access to the BIOS routines. The jump instruction at locations 0 to 2 can be used to locate the beginning of the BIOS. Each of the standard BIOS routines is described below.

Offset	Name	Description
00H	CBOOT	Initialize ports 1, 2, and 3, the real-time clock, and front-panel interrupts. Then jump to WBOOT.
03H	WBOOT	Load the CCP and the BDOS, and execute the CCP.
06H	CONST	Check console status
09H	CONIN	Console input
0CH	CONOUT	Console output
0FH	LIST	List output
12H	PUNCH	Punch output
15H	READER	Reader input
18H	HOME	Move the head of the current disk to track 0. This routine should be called once before a new diskette is read or written.
1BH	SELDSK	Select a disk drive. The disk parameter table for the current disk is written over the standard table in the BDOS.
1EH	SETTRK	Select a disk track. The seek operation is delayed until READ or WRITE is called.
21H	SETSEC	Select a disk sector.
24H	SETDMA	Set the DMA address.
27H	READ	Read a sector from a disk.
2AH	WRITE	Write a sector to a disk.
2DH	LISTST	List status.
30H	SECTRAN	Sector translate.

The READ and WRITE routines perform I/O on the currently selected disk, track, and sector. Normally, CP/M performs I/O in blocks of 128 bytes.

User BIOS calls

The routines in the BIOS may be called by a user program. However, a routine should never be called directly. Instead, the user should call the location in the jump table at the beginning of the BIOS. The order of the jump table is never changed, although the size of the routines in the BIOS may change from time to time. The address of the jump table is stored in locations 1-2. For example, to call the CONOUT routine, use:

```
LHLD  1         ; HL = base of vectors + 3
LXI   D,0CH-3   ; offset of JMP CONOUT
DAD   D         ; compute address of CONOUT
PCHL            ; jump to CONOUT
```

Digital Microsystems' special BIOS entry points

Offset	Name	Description
5DH	CLRBUF	Flush floppy double density buffer
60H	LOCK	Lock a record
63H	CPMMAP	Get pointer to disk assignment table
66H	UNLOCK	Unlock a record
69H	SETBYT	Set I/O operation byte count (floppy I/O only)
6CH	NETCMD	Used by ASSIGN to access net
6FH	SENDNET	Send a block on the network
72H	RECNET	Receive a block from the network
75H	NACKPOLL	Intercept next poll, and don't auto-acknowledge
78H	ACKPOLL	Resume automatic poll acknowledgement
7BH	CUSPRT	Print on user customizable printer

4.6.4 Customization Guide

It is possible to perform some customizations to a standard HiNet release. A series of "customization bytes" are stored at fixed locations in the BIOS. These bytes can be changed to customize a system to match user requirements. The address at which the customization bytes are stored is given by the following table.

CP/M 1.437	Customization bytes begin at this address:
MASTER1.COM	42F0h
STATION1.COM	2FF0h

CP/M 2.237	Customization bytes begin at this address:
MASTER2.COM	4CF0h
STATION2.COM	39F0h

For example, for a HiNet 1.4 master, the customization bytes begin at location 42F0h within the MASTER1.COM file. The DDT program can be used in conjunction with the SAVE command to modify the MASTER1.COM file.

The following customizations are allowed (the number preceeding the name gives the offset of that customization byte from the first byte).

0. Mode bits (default = 1) Each bit in this byte is used for a different purpose:

   Bit 0 - 0: don't retry floppy disk errors
   1: retry floppy disk errors 10 times before printing an error message

   Bit 1 - 0: don't print USER error messages on HiNet master
   1: print USER error messages on HiNet master

   Bit 2 - 0: AUTOMATIC spool mode
   1: MANUAL spool mode

   Bit 3 - 0: use serial printer for AUTOMATIC spooling
   1: use parallel printer for AUTOMATIC spooling

   Bit 4 - 0: spool mode is "print when done"
   1: spool mode is "wait when done"

   Bits 5 thru 7 are currently not used. They should be 0.

1. Floppy drive model (default = 0) Use 0 for single sided drives, and 1 for double sided drives.

2. Hertz rate (default = 3Eh) Normally, an internally generated clock rate of 62 hertz is used. If one wishes to use an external clock (normally 60 hertz in the U.S, and 50 hertz overseas), then this should be changed to the desired hertz rate. Use 3Ch for 60 hertz, or 32h for 50 hertz.

3-4. Baud rate for serial port 1 (default = 45h,02h) This baud rate should always be 500 Khz when using HiNet.

5-6. Baud rate for serial ports 2 and 3 (default = 45h,0Dh) This baud rate is normally 9600 Kbaud. See section 5.7 for baud rate programming instructions.

7. IOBYTE for single user system (default = 54h) This value is used if you are booting a single user system from a floppy disk or a hard disk.

For example, suppose one wants to change the default spool mode to MODE5 ("MANUAL, print when done"). The following procedure can be used:

Boot a single user system from a floppy disk, then execute the following commands:

```
A>ren oldmast.com=master2.com
A>ddt oldmast.com
DDT VERS 2.2
NEXT  PC
4D00 0100
-S4CF0
4CF0 01 05
4CF1 00 .
-^C
A>save 76 master2.com
A>submit makesys2
```

The new HiNet master will be stored on the disk. Note that the old system was saved on the file "OLDMAST.COM", so if the new system does not work, the old system can be restored.

4.6.5 Implementation of the IOBYTE

The IOBYTE, at location 03h in memory, is implemented for the mapping of logical to physical devices. The mapping is performed by splitting the IOBYTE into four distinct fields called the CONSOLE, READER, PUNCH, and LIST fields, as shown below.

Bit number:	7 6	5 4	3 2	1 0
Device name:	LST:	PUN:	RDR:	CON:

Whenever a reference to a logical device is made for I/O, the BIOS first looks at the appropriate bit field in the IOBYTE, and then uses one of the physical device service routines. The following table shows the association of IOBYTE values with physical devices:

Device Name	IOBYTE Value	Physical Device	Device Name Used by STAT
CON:	00	serial port 0	TTY:
	01	serial port 2	CRT:
	10	serial port 1	BAT:
	11	serial port 3	UC1:
RDR:	0	serial port 0	TTY:
	1	serial port 3	PTR:
PUN:	0	serial port 0	TTY:
	1	serial port 3	PTP:

Device Name	IOBYTE Value	Physical Device	Normal default value of IOBYTE
LST:	000	serial port 0	14h
	001	serial port 3	34h
	010	serial port 2	54h
	011	serial port 1	74h
	100	parallel port 2	94h
	101	reserved	---
	110	custom driver	D4h
	111	HiNet spooler	F4h

The normal default value for the IOBYTE is 54h. The default for the LST: device can be changed by using the ASSIGN command. The other defaults can be changed by using the STAT command. The default can be permanently changed by following the customization instructions in section 3.6.4.

4.7 Record locking

The record locking feature can be used to avoid conflicts when two or more users are simultaneously updating the same file, or when several users are requesting access to the same system resource. To use record locking, it is necessary to modify one's application by adding a few lines of code before and after each update to a shared file.

Record locking and unlocking are invoked by first constructing a "lock string" and then calling a BIOS lock or unlock entry point. The lock string should indicate the file and record to be locked. Note that the lock string can, in fact, contain any sequence of bytes. However, to allow different applications to utilize record locking on the same HiNet system requires that a convention be established. The recommended convention is to use the file name as the first 8 characters and the record number as the last 5 characters of the lock string.

Before calling the BIOS lock or unlock entry point, locations 74 and 75 (4A and 4B hex) should point to the lock string. The string itself must begin with an integer from 1 to 13, indicating its length. The BIOS routine checks whether any other user has requested a lock using the same lock string. If so, the lock request is denied; otherwise, it is accepted. In either case, the BIOS routine immediately returns to the user program. Location 73 (49 hex) is set to 0 if the lock has been accepted, 1 if the lock has been denied, or 2 if the lock string is longer than 13 characters.

The CBASIC functions "fn.lock" and "fn.unlock" can be used to interface with the lock and unlock routines in the BIOS. Similar interface functions can easily be written for other compilers.

```
DEF FN.LOCKWORK%(STRING$,FUNC%)
    ADDR% = SADD(STRING$)
    HIGH% = (ADDR%/100h) AND 0FFh
    IF ADDR% < 0 THEN HIGH% = HIGH% - 1
    POKE 4AH,ADDR% AND 0FFH
    POKE 4BH,HIGH%
    CALL ((PEEK(2)*100h) OR PEEK(1)) + FUNC%
    FN.LOCKWORK% = PEEK(49H)
    RETURN
FEND

DEF FN.LOCK%(STRING$)
    FN.LOCK% = FN.LOCKWORK%(STRING$,5DH)
    RETURN
FEND
DEF FN.UNLOCK%(STRING$)
    FN.UNLOCK% = FN.LOCKWORK%(STRING$,63H)
    RETURN
FEND
```

The following program demonstrates how to use the record locking functions. First, a file containing 128 records is created. Several users can then simultaneously run this program, and update different records in the file at will. The program will allow only one user at a time to update any particular record; however, several users are allowed to simultaneously update DIFFERENT records in the file. The lock functions are on the "LOCKFNS.BAS" file.

Note that the statement "READ #1,R;" is needed after a write to force CBASIC to flush its I/O buffer for file number 1. Without this statement, the record will not be updated on the disk until the next random read or write to that file. This is due to a peculiarity in the I/O algorithms used by CBASIC. Similar problems may be encountered with other compilers.

```
    %INCLUDE LOCKFNS
        FILENAME$ = "DEMO.DAT"
        INPUT "ENTER 0 TO CREATE, 1 TO UPDATE DEMO FILE";I
        IF I = 0 THEN ®
           CREATE FILENAME$ RECL 128 AS 1 :®
           FOR I = 1 TO 128 :®
           PRINT #1;I :®
           NEXT I :®
           CLOSE 1
        OPEN FILENAME$ RECL 128 AS 1

100     INPUT "RECORD NUMBER";R
        LOCKSTRING$ = "DEMO    "+STR$(R)
        WHILE FN.LOCK%(LOCKSTRING$) <> 0
           WEND
        READ #1,R;I
        PRINT "OLD VALUE";I
        INPUT "NEW VALUE";I
        PRINT #1,R;I
        READ #1,R;      REM  flush the record
        I% = FN.UNLOCK%(LOCKSTRING$)
        GO TO 100
        END
```

It is important to note that the record locking feature described above does not allow several users to simultaneously create and delete files on a shared disk partition. Each user station has its own copy of the BDOS, and thus each station keeps a separate version of each active directory. When a file is created, deleted, or expanded, the directory is updated on the disk and in the local users BDOS. However, the directories maintained in other HiNet stations are not changed. Thus, other users who then try to write to the disk will get a R/O (read only) error. To avoid this problem, users who are actively creating and deleting files should be assigned to separate disk partitions.

4.8 Spooling

The HiNet system allows one or more users to share one serial and/or one parallel printer connected to the master station. Each user can create one or more "spool files". Each spool file can be printed separately; the SPOOL program can be used to control the printing of the spool files. The SPOOL program allows for 6 different modes of operation. Each mode is explained below in more detail.

The PRTSPOOL Partition

A partition named "PRTSPOOL" is used to store all spool files. If this partition cannot be found on the master hard disk, spooling will not be allowed. The PRTSPOOL partition can be any size from 256 Kbytes to 4 Mbytes. Each spool file requires 256 Kbytes. Thus, for example, a 2 Mbyte PRTSPOOL partition would allow a maximum of 8 active spool files. If a user attempts to create a spool file bigger than 256 Kbytes, the original spool file will be closed (and thus become available for printing),and a new spool file will be created. The message "SPOOL error" will be printed if the PRTSPOOL partition is full. If a spool error occurs, one or more of the spool files should be printed or aborted before continuing.

The PRTSPOOL partition is a special partition. It is used only by the spooler, and does not resemble a normal CP/M partition. One should be careful never to assign the A, B, C, or D drive to it. Thus, a password should always be associated with the PRTSPOOL partition so that users will not accidently attempt to access it directly.

How to Create a Spool File

To create a spool file, one must first assign the LST: device to the spooler. One does this by using this command:

```
ASSIGN P SPOOL
```

Note that the USERS program can be used to set the IOBYTE so that the default printer is the spooler. If this is done, there is no need to use the ASSIGN command.

To spool, one can use the standard methods that CP/M provides for printing. For example, the control-P feature can be used to re-direct all console output to the spooler. All output to the LST: device will automatically be written to a spool file. A warmboot will close the spool file; this will make it available for printing. Another way to close a spool file is to send a control-Z to the LST: device. Using this feature, a single application program can create several spool files; each file can be printed separately, and with different forms, if desired.

How to Print a Spool File

The spooler allows for 6 different modes of operation. The spooling mode determines the fate of a spool file after it has been closed. The 6 spool modes are:

MODE1 - AUTOMATIC on serial port 2, print when done.
MODE2 - AUTOMATIC on serial port 2, wait when done.
MODE3 - AUTOMATIC on parallel port 2, print when done.
MODE4 - AUTOMATIC on parallel port 2, wait when done.
MODE5 - MANUAL, print when done.
MODE6 - MANUAL, wait when done.

The mode of operation is selected by executing the SPOOL command on the master station. For example, to select mode 2, execute the command "SPOOL MODE2". MODE1 is the default mode when the master system is booted. The default mode can be permanently changed. See section 4.6.4 for details.

"AUTOMATIC" means that a spool file will automatically become available for printing when it is closed. No interaction with the master console is required. "MANUAL" means that a message will be displayed on the master console when a file is available for printing, and an operator must specify what action is to be taken. "Print when done" means that a file will be available for printing immediately after it has been closed. "Wait when done" means that a file will be put on the waiting queue when it is closed. Files on the waiting queue will not be printed until they are woken by using the "SPOOL WAKE" command.

In the MANUAL mode, the message displayed by the spooler when a spool file is ready for printing is:

```
*** USERNAME Ready to print
Enter *, S, P, W, or RETURN:
```

"USERNAME" is the name of the user who created the spool file. Enter "*" to erase the spool file (i.e., don't print it), "S" to print on serial port 2, "P" to print on parallel port 2, "W" to put the spool file on the wait queue, or RETURN to repetitively cycle though all spool files which are ready to print.

Note that if a user is running an application on the master station and the spooler is in MODE5, the spooler will interrupt the application when a spool file becomes available for printing. The user must respond to the message printed by the spooler. The application program will be suspended until all ready spool files are processed. The application program will then automatically resume.

Forms Information

It is possible for an application program at a user station to append forms information on the front of a spool file. This information will be displayed on the master console when the file is ready to print. For example, the operator at the master console can be instructed to mount a particular type of form on the printer before printing a particular spool file. The forms information will be displayed immediately following the "Ready to print" message. For example:

```
*** USERNAME Ready to print (Please mount 8x11 paper)
Enter *, S, P, W, or RETURN:
```

To append forms information to a spool file, the first character sent to the LST: device must be a left parenthesis. This should be followed immediately by the forms information, and terminated by a right parenthesis. The forms information can be up to 128 characters long.

For example, the following CBASIC program creates two spool files. The first spool file does not have any forms information, while the second spool file does have forms information. Don't forget that the LST: device must be assigned to the spooler before attempting to execute this program.

```
CNTLZ% = 26
PRINT "CREATING FIRST SPOOL FILE"
LPRINTER
PRINT "FIRST SPOOL FILE - INTEGERS FROM 1 TO 10:"
FOR I = 1 TO 10
PRINT I
NEXT I
CONSOLE
PRINT "CREATING SECOND SPOOL FILE"
LPRINTER
PRINT CHR$(CNTLZ%);"(SECOND SPOOL FILE - FORMS INFORMATION)"
PRINT "SECOND SPOOL FILE - INTEGERS FROM 11 TO 20:"
FOR I = 11 TO 20
PRINT I
NEXT I
CONSOLE
PRINT "FINISHED"
STOP
END
```

If a spool file has any forms information, a MANUAL mode will be forced. Thus, even if the system is currently using an AUTOMATIC mode, the forms information will appear on the master console, and operator action will be required at the master console. This is the only case in which a user station can, in effect, override the mode currently in effect.

The SPOOL command

As mentioned earlier, the most important feature of the SPOOL command is to set the spooling mode. The mode can be specified directly on the command line (for example, "SPOOL MODE3"). If the mode is not specified (i.e., "SPOOL MODE"), an explanation of the modes will be displayed, and the user will be asked to enter an integer from 1 to 6 to select the new mode.

The SPOOL program has several other useful options:

SPOOL WAKE - This will cause all spool files in the waiting queue to become ready for printing. If an AUTOMATIC mode is currently in use, the first file in the queue will immediately start printing. Other files will follow in succession until all files are printed. If a MANUAL mode is currently in use, each file will cause a message to be displayed on the master console, and the operator must specify what is to be done with each file.

SPOOL RETRY - This command will cause the file that is currently being printed to be automatically restarted from the beginning. This command is useful if one starts printing a file when the paper is misalligned or the wrong forms are being used.

SPOOL ABORT - The command will stop the printer, and will erase the file being printed.

Spooling from the master station

The local user at the master station may use the spooler in the same manner as any other user on the network. However, the local user is prohibited from assigning his LST: device directly to serial port 2 or the parallel port. If he attempts to print directly on one of these ports, he will immediately get a CALL error. This feature prevents a remote user and the local user from both attempting to print on the same port at the same time. The local user should always assign P to SPOOL. He is allowed to assign P directly to PORT2 or PORTP only if there is no PRTSPOOL partition on the disk.

Using the WHO command with the Spooler

The WHO command prints a list of all spool files, and the status of each file. For example:

```
        HiNet Status as of 12:45:40

User Name   Login Time   Last HiNet Request    Status
---------   ----------   ------------------    ------
JOHN         12:10:14     12:42:16  read       active
JOE           9:10:16     10:16:24  write      active
JACK         12:40:45     12:45:40  who        active

User Name   Spool Time   File Length    Status
---------   ----------   -----------    ------
JILL          8:30:23     06 records    ready
JOHN         12:41:18    144 records    spooling
JOHN         12:30:10   1009 records    waiting
```

The display indicates that 3 users are currently logged into HiNet. User JOHN has finished creating one spool file, and is in the process of creating another. JILL is no longer logged in; however, she finished creating a spool file at 8:30 A.M.; this file is now ready to print. "Spool time" indicates the time of the last HiNet spool request. "File length" indicates the length of the spool file (1 record = 128 bytes). "Status" indicates the current status of the spool file. The status can be one of the following:

Starting - The spool file has just been created.

Spooling - A user is writing to the spool file.

Ready - The spool file is ready to print.

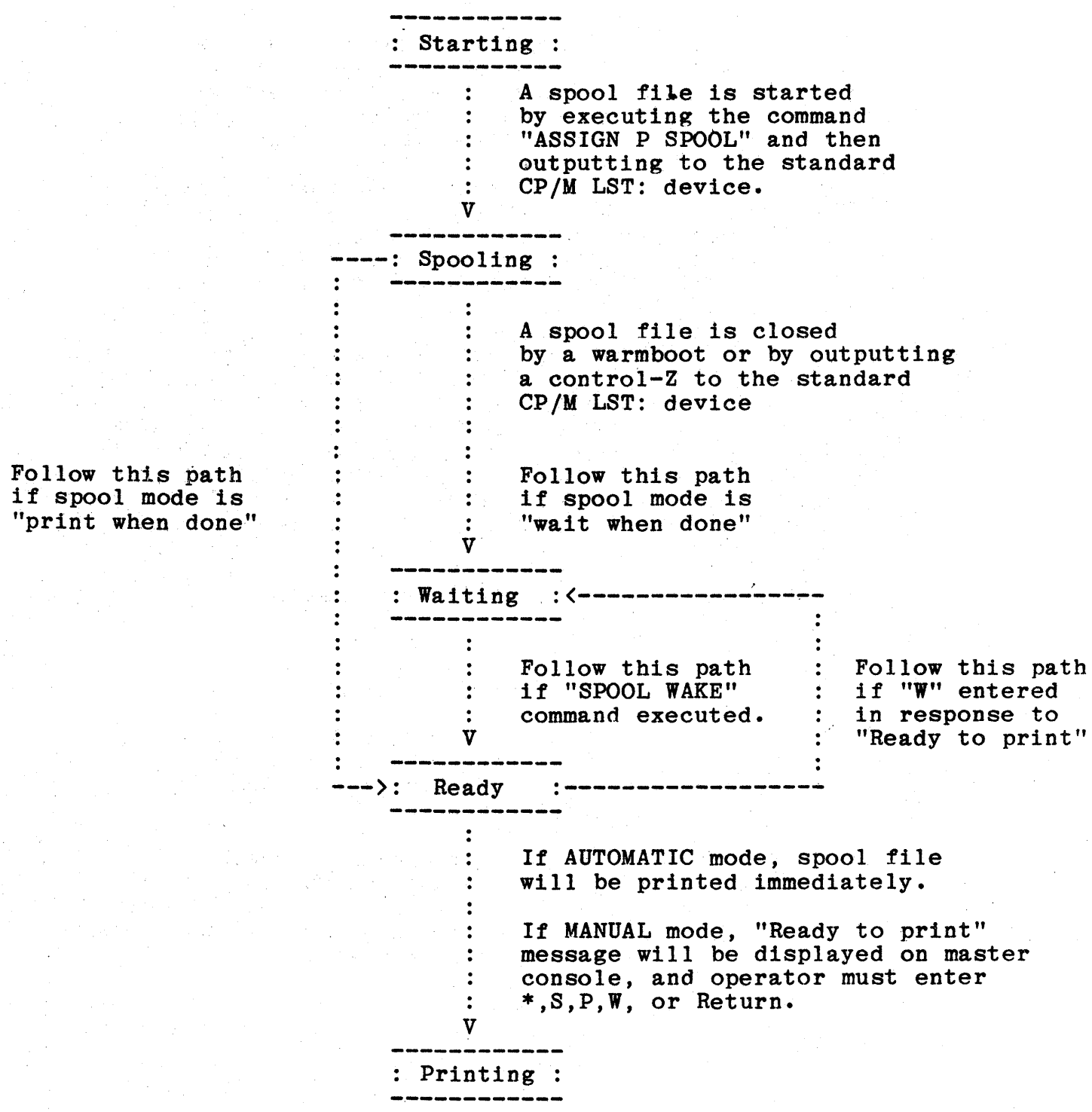
Printing - The spool file is being printed.

Finished - The spool file has finished printing, and will be erased momentarily.

Waiting - The spool file is in the waiting queue. The "SPOOL WAKE" command must be used to wake all files in the waiting queue. Otherwise, they will remain in the waiting queue forever (even after the system is powered down and booted up again).

Summary of Spool Modes

As one can plainly see from the above discussion, the HiNet spooler allows for many different printing options. The following diagram summarizes the chain of events that take place during the life of a spool file.



4.9 Mimic Option

An automatic on-line continuous backup capability is available under HiNet. If a second HiNet Master is initiated, it will automatically detect that another Master is already controlling the network. It will then ask the user whether the second system should mimic all network disk writes. If the user answers in the affirmative, then each network disk write will be duplicated on the mimicker's disk. This feature allows one to maintain a continuous network master backup. If the main system fails, the mimicking system can be brought on-line, and thus take over the role of the network master, with minimal loss of data. The mimicking system cannot be used for any other purpose during the time that it is mimicking. This feature is most useful for those applications which absolutely require continuous system availability.

5. DSC-3 and DSC-4 CPU Board Operations

5.1 Overview

A block diagram showing the major components of the DSC-3 and DSC-4 is supplied on the following page. The major support chips used are the Zilog DMA, SIO, PIO, and CTC chips, and the NEC765 floppy controller chip.

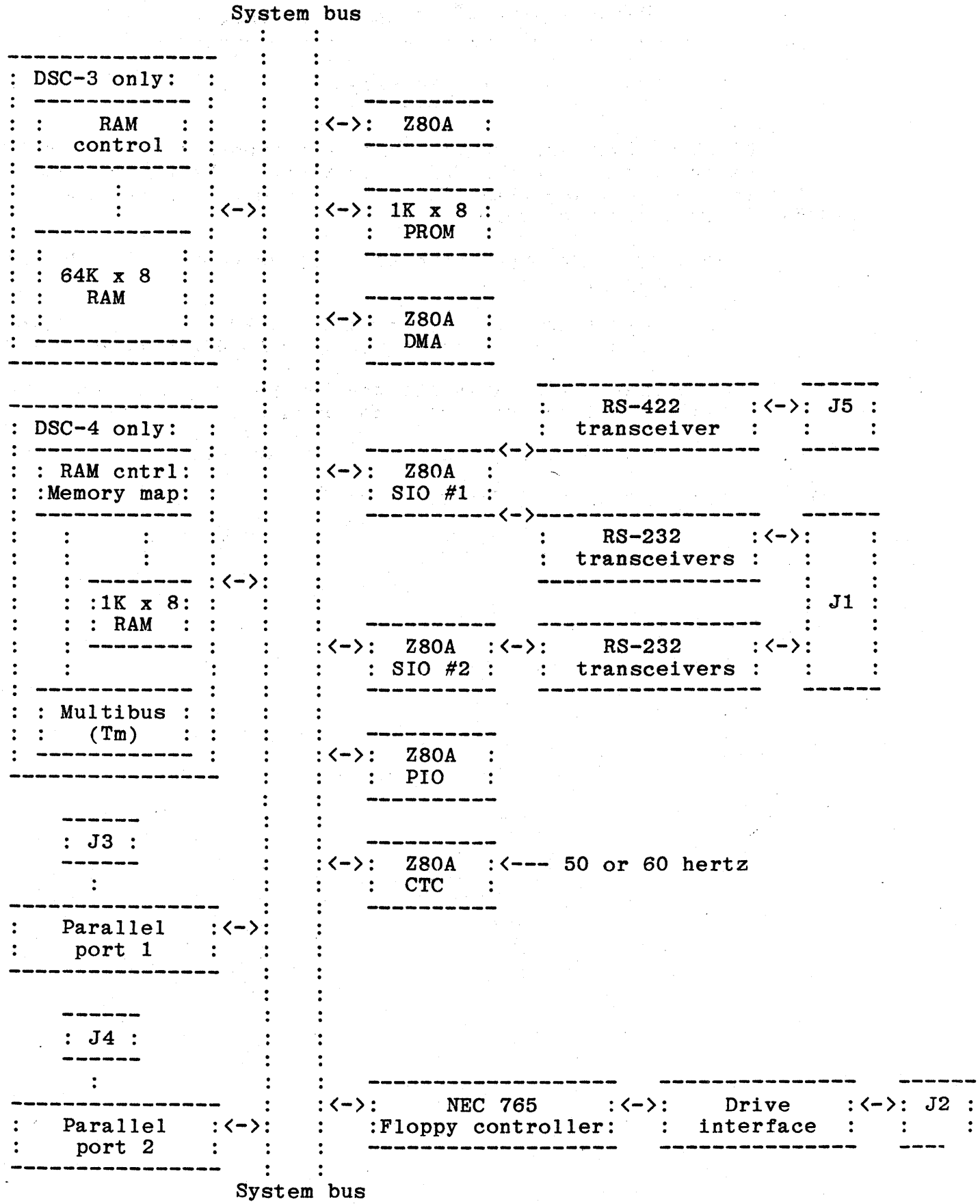
DMA — Performs high speed data transfer between an I/O device and memory.

SIO — Each SIO chip controls up to 2 RS-232 ports. Also, channel B of SIO #1 can control an RS-422 port.

CTC — Generates baud rates for the I/O ports, and generates real-time interrupts at line frequency.

PIO — Provides control signals for I/O devices.

NEC765 — Controls up to 4 floppy disks.



5.2 PROM Monitor

When the computer is powered on or when the RESET switch is pressed, the computer will begin executing a 1K PROM monitor program. If one of the auto-boot jumper options has been selected (see section 6.2), the PROM will immediately attempt to bootup from a floppy, a harddisk, or the network. Otherwise, the message "PROM Monitor 1.09" will be displayed, and the command prompt ":" will also be displayed. This indicates that the monitor program is ready to accept a command. Valid commands are:

<CR>	Dump memory at 9000H
S addr	Set memory locations beginning at addr.
D [addr1 [addr2]]	Dump memory locations from addr1 to addr2.
F addr1 addr1 byte	Fill memory locations from addr1 to addr2 with byte.
G addr	Jump to addr.
I port	Input a byte from a Z-80 port.
O port byte	Output a byte to a Z-80 port.
M register mapbyte	Set a memory map register (applicable to the DSC-4 only).
T addr1 addr2	Test memory locations from addr1 to addr2.
BF	Boot from a floppy on unit 0
BN	Boot from the network
BH	Boot from the harddisk
BT addr	Test the floppy controller - send the command string beginning at addr to the controller. The string should be terminated by 0FFH. The result string will be placed in memory beginning at 9380H.
B1	Boot from a floppy on unit 1

The 'M' command can be used to set a memory map register on the DSC-4. The register to be set (0,1,2,...F) is given by 'register'. The value to be placed in the memory map register is given by 'mapbyte'. The high order bit of mapbyte determines whether the selected page is mapped into local memory or external memory. The remaining 7 bits select an external memory page; however, the high-order 3 of the 7 bits are low-true. Thus, the command 'M2 F3' will map logical addresses 2000-2FFFH to external physical addresses 3000-3FFFH. To activate the memory map, the command 'I 0' must be executed.

The 'T' command can be used to test a range of memory locations. When used in conjunction with 'M' commands, the 'T' command can be used to test the entire external memory on the DSC-4. However, on the DSC-3, it is only possible to test locations from 4000 to 93EF or 9400 to FFFF. Addresses from 0 to 3FFF are not accessible while the PROM is active; addresses from 93F0 to 93FF contain the stack for the PROM monitor. More exhaustive testing requires using the MEMTEST program.

5.3 Memory Management

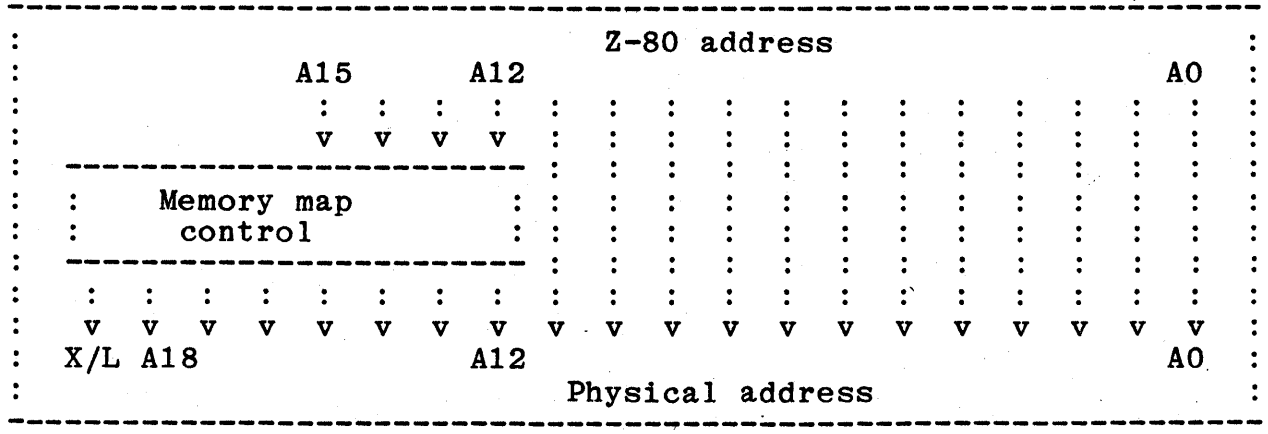
DSC-3 memory management

The DSC-3 has a 1K PROM and 64 Kbytes of dynamic RAM. When the computer is powered on or reset, the 1K PROM and the upper 48K of RAM are accessible. To 'replace' the 1K PROM with the lower 16K of RAM, an 'IN 2' instruction must be executed. Normally, this is done as part of the bootstrap procedure and is totally transparent to the user. Once the PROM has been 'mapped out', it cannot be re-enabled until the machine is powered off or the reset switch is pressed.

DSC-4 memory management

The DSC-4 has a 1K PROM and a 1K static RAM on the CPU board. Each memory board has 128 Kbytes of RAM. When the computer is powered on or reset, only the 1K PROM and the 1K RAM are accessible. All 'even' memory pages (0xxx, 2xxx, ...) map to the PROM, while all 'odd' pages (1xxx, 3xxx, 5xxx, ...) map to external memory.

Since the Z-80 allows only 16-bit addresses, a mapping scheme is required to access more than 64 Kbytes. The DSC-4 has 16 8-bit memory map registers. The upper 4 bits of each 16-bit Z-80 address select one of the 16 memory map registers. This scheme is illustrated below:



The X/L bit determines whether the physical address is in 'local' or 'external' memory. To set a memory map register, the Z-80 OUTP instruction must be used. This instruction outputs a byte to the port given by register C. The upper 4 bits of the B register select the map register to be set. For example, B = 60H selects register 6. The C register should equal 3. The output byte is written into the selected register.

Each memory map register contains 8 bits. The high bit (i.e., X/L) equals 0 to select local memory, and 1 to select external memory. The next 7 bits are placed on the address bus. However, the top 3 of the 7 bits are high-true. Thus, to map Z-80 addresses 2000-2FFFH to physical addresses 3000-3FFFH, use:

```
     LXI  B,2003H    ; B = register number x 10H, <= port 3
     MVI  A,0F3H     ; A selects physical addresses 3000-3FFFH
     OUTP A
```

To set all the memory map registers at once, use the following Z-80 code:

```
     LXI  H,MEMMAP   ; point to base of map
     LXI  B,0003H
LOOP:OUTI            ; put B-1 on address bus
     MVI  A,11H
     ADD  B
     MOV  B,A        ; load next map reg no. into B
     JNZ  LOOP
     .
     .
     .
MAP: .BYTE 0FFH, 0F0H, 0F1H, 0F2H ; page F gets set first
     .BYTE 0F3H, 0F4H, 0F5H, 0F6H
     .BYTE 0F7H, 0F8H, 0F9H, 0FAH
     .BYTE 0FBH, 0FCH, 0FDH, 0FEH
```

To activate the memory map, execute an 'IN 0' instruction. After the map has been activated, the local memory can still be accessed by using the X/L bit.

5.4 System clock and timer

All timing on the DSC-3 and DSC-4 is derived from one of two sources: a 16 MHz crystal controlled oscillator and a line frequency synchronized square wave.

The 16MHz oscillator is a standard crystal controlled circuit using two 74S04 inverters biased into their active region. This oscillator output is buffered and divided by successive powers of two to develop all binary frequencies from 16 MHz to 500 KHz.

The 4 MHz clock in all the Z80 family devices is developed using discrete transistors to provide the rapid rise and fall times, and levels sufficiently close to the supply voltages (0V and +5V) required by Z80 specifications. Particularly important is pulse width low and high (110 nsec), and high level (Vcc -.6V min).

Serial baud rates are derived using a Zilog CTC chip dividing a 2 MHz input by a software selected division.

A real time clock is implemented from a line frequency signal developed in the power supply from the main voltage. This signal is squared using a Schmidt trigger (7414) and is fed to the counter timer chip to provide interrupts.

5.5 SIO#1 and SIO#2 - Serial I/O ports

The DSC-3 and DSC-4 have 3 RS-232 ports, and a fourth port which can be jumper-selected to be either RS-232 or RS-422 (see section 6.2 for jumper connections). There are 2 SIO chips connected to the internal bus and to edge connectors via EIA RS232 signal receivers and drivers.

Each SIO chip controls two ports. SIO #1 controls ports 0 and 1; SIO #2 controls ports 2 and 3. Port 1 can be either RS-232 or RS-422. Port 0 is usually attached to the main system console. Port 2 is usually attached to a printer, while port 3 is available for another CRT, printer, or modem. Each port can be programmed separately by using the following Z-80 port numbers:

Serial I/O port	Z-80 data port	Z-80 command port	Standard Use
0	28H	2AH	console
1	29H	2BH	network
2	20H	22H	list
3	21H	23H	reader/punch

The SIO chips are described in detail in the Appendix. For example, the following code is used in the PROM monitor to setup port 0 as an RS-232 port:

```
     LXI  H,RS232
     LXI  B,092AH
     OUTIR
     .
RS232:
     .BYTE  18H                ; channel reset
     .BYTE  14H,01001100B      ; 2 stop bits, no parity
     .BYTE  03H,11000001B      ; receiver enable
     .BYTE  05H,11101010B      ; transmitter enable
     .BYTE  11H,00000000B      ; no interrupts
```

To read from port 0, the following code is then used:

```
RWAIT:
     IN   2AH          ; get port status
     BIT  0,A          ; wait until receiver is ready
     JZ   RWAIT
     IN   28H          ; get character from port
```

To write to the port, the following code is used:

```
WWAIT:
     IN   2AH          ; get port status
     BIT  2,A          ; wait until transmitter is ready
     JZ   WWAIT
     MOV  A,C          ; move output char to accumulator
     OUT  28H          ; output the character to the port
```

5.6 PP#1 and PP#2 - Parallel I/O ports

Two 8-bit parallel ports are provided on the DSC-3 and DSC-4. They can be accessed by using IN and OUT instructions on Z80 ports 1 and 2. Two control bits are also provided for each parallel port. These control bits are accessible by reading bits 3,4,5, and 6 of channel A of the PIO chip. They can be used for handshaking with auxiliary I/O devices.

In the standard CP/M BIOS as supplied by DMS, port 1 is used to interface with the hard disk, while port 2 is used as a Centronics compatible printer interface.

Note: The parallel ports should not be confused with the PIO chip. The PIO chip is used to provide miscellaneous control signals for different devices within the DSC-3 and DSC-4. It cannot be used as an interface with an auxiliary I/O device.

5.7 CTC - Baud rates

In normal operation, each of the 4 serial I/O ports is initialized as follows:

Port 0 - RS-232, 31-character type-ahead, 9600 baud

Port 1 - RS-422, 500 Khz if the network option is selected
RS-232, 9600 baud otherwise

Port 2 - RS-232, 9600 baud

Port 3 - RS-232, 9600 baud

Port 0 is initialized in the PROM monitor, while ports 1, 2, and 3 are initialized in the cold-boot portion of the BIOS. Each port can run at a different baud rate, except ports 2 and 3, which must run at the same baud rate. To change the baud rate of a serial I/O port, it is necessary to reprogram the appropriate channel of the CTC chip. This is done by outputting a string of bytes to a Z-80 port corresponding to the serial I/O port.

Serial I/O port	Z-80 port	Baud rate	Command bytes
0	30H	9600	45H,0DH
1	31H	4800	45H,1AH
2	32H	2400	45H,34H
3	32H	1800	45H,45H
		1200	45H,68H
		600	45H,D0H
		300	05H,34H
		110	05H,8EH

For example, to set port 1 to 300 baud, execute the following Z-80 instructions:

```
MVI  A,05H
OUT  31H
MVI  A,34H
OUT  31H
```


5.8 NEC765 - Floppy disk controller

The NEC765 floppy controller chip is used to control up to 4 floppy disk drives. The Z-80 communicates with the controller via its status port (10H) and data port (11H). The status port is used to determine whether the controller is ready to receive a command byte or to send a result byte. The status port must be consulted before a byte may be read or written into the data port.

The floppy controller has three basic phases: (1) a command phase; (2) an execution phase; and (3) a result phase. During the command phase, a command string is sent, byte by byte, to the controller. The controller then executes the command. At command completion, the CPU must read all result bytes from the controller before the next command can be issued. The NEC765 controller chip is more completely described in the Appendix.

Data is transferred between memory and the FDC by DMA. The PIO chip is used to provide several control signals for the floppy controller. The following signals are supplied by the PIO, channel B:

bits <0,1> - Drive select

bit < 2 > - Head load

If this is high, then the head on the selected drive is loaded. Depending on which type of drive is used the CPU must then delay before attempting to read or write from the drive.

bit < 4 > - Small/large precompensation

This should be high if between tracks 22 and 59 in double density.

bit < 5 > - Select precompensation

This should be high if above track 22 in double density.

5.9 DMA - Direct memory access

The DMA chip can be used to transfer data between an I/O device and memory, or from memory to memory. The DMA chip can only be used by one device at one time. The device is selected by bits 0, 1, and 2 of channel A of the PIO chip.

PIO channel A bits 2, 1, 0	Device Selected	Z80 port for selected device
0 0 0	NEC765 floppy controller	18h
0 0 1	SIO1 channel B (i.e., RS-422 network)	29h
0 1 0	SIO2 channel A (i.e., RS-232 port 2)	20h
0 1 1	SIO2 channel B (i.e., RS-232 port 3)	21h
1 0 0	Parallel port 1, input	01h
1 0 1	Parallel port 1, output	01h
1 1 0	Parallel port 2, input	02h
1 1 1	Parallel port 2, output	02h

In the standard BIOS provided by DMS, the DMA chip is used for floppy disk accesses and network accesses. The DMA chip is described more completely in Appendix B.

5.10 PIO - Control bits

The PIO chip provides miscellaneous control bits used for various different purposes. Some of these bits are input bits, while others are output bits. The PIO has two independent 8 bit channels, thus a total of 16 controls bits are provided. The PIO is programmed by sending command bytes to Z-80 port 0Ah for channel A, or port 0Bh for channel B. The data bytes are accessible though Z-80 port 08h for channel A, or 09h for channel B.

5.11 Interrupts

Interrupts on the DSC-3 and DSC-4 can be generated by the following chips:

DMA (highest priority)
SIO #1
SIO #2
PIO
CTC (lowest priority)

The DMA chip has the highest priority. This means that an interrupt request from a lower priority device will not be serviced until the DMA interrupt has been processed. Thus, for example, the CTC chip cannot interrupt the DMA interrupt handler, even if interrupts are enabled.

Each of the above chips is capable of generating an interrupt on a wide variety of conditions. The operating system in the DSC-3 and DSC-4 uses only a small number of these choices. Other operating systems may need to use different types of interrupts, depending upon their requirements.

Digital Microsystems uses the following interrupts:

(1) DMA transfer complete

The DMA chip issues an interrupt when it has finished transferring data to or from the floppy disk or the network.

(2) SIO1 channel A character received

To allow console type-ahead on port 0, the SIO1 channel A is programmed to interrupt when a character is received.

(3) Network first and last character received

When the first character or the last character of a network block is received, SIO1 channel B issues an interrupt.

(4) PIO channel A, bit 7 (front panel / halt)

When the front panel switch is pressed, or when a halt instruction is executed, bit 7 of PIO channel A goes high and causes an interrupt to occur.

(5) CTC channel 3 (60 hertz clock)

A 60 hertz signal is connected to CTC channel 3. The CTC is programmed to interrupt every 1/60th of a second, so that the time of day can be maintained in locations 40h to 46h.

To handle interrupts, the Z-80 interrupt mode 2 is used. When an interrupt occurs, the upper 8 bits of the address of the interrupt vector are supplied by the I register while the lower 8 bits are provided by the chip which is causing the interrupt.

For example, the following code is used to process an interrupt every 1/60th of a second:

```
;
; Program the CTC chip, channel 3
CTC3 =    33h
CTC0 =    30h
     mvi  A,0C5h     ; set the CTC counter
     out  CTC3
     mvi  A,1        ; initial value of counter
     out  CTC3
     mvi  A,CTCvect&0FFh
     out  CTC0       ; setup vector address
        .
        .
CTCvect:
     .word CTCint    ; interrupt vector
        .
        .
CTCint:
     ei         ; interrupts must be re-enabled
     <save user registers>
     <process interrupt>
     <restore registers>
     reti       ; end of interrupt handler
```

It is usually a good idea to keep interrupts enabled all the time, except for timing sensitive code and critical sections of the operating system. Each interrupt handler must be terminated by an RETI instruction. This instruction returns the CPU to the program that was executing before the interrupt occurred. It also allows the interrupting chip and lower priority chips to cause new interrupts. However, it is not desirable to use a RETI instruction when the DMA chip is programmatically reset (by sending 0C3h to port 38h). When the DMA chip is reset, it automatically allows other chips to start interrupting. However, interrupts are not re-enabled until an EI instruction is executed.

5.12 Multibus interface

BCLOCK/: The DSC-4 provides an 8 MHz buffered bus clock signal to the system bus though JP201. This signal is necessary for the ZSBC-4 board to use bus slaves, for example, the 128K byte memory card. If the BCLOCK/ signal is to be supplied by another bus master the shorting block at JP201 must be removed and the default circuit trace on the back of the board must be carefully cut. This signal must have only one source.

BPRN/: Bus access conflicts in a Multibus system may be resolved by a daisy-chain priority resolution scheme, as in the DSC-4 motherboard, or by some other scheme. When such conflicts over bus use arise, access to the bus is granted to the highest priority bus master by bringing its BPRN/ input low. If the ZSBC-4 CPU card is to be the only bus master pins 1 and 2 of JP206 may be left connected either by the default circuit trace or by a connecting jumper block, or the card may be left in the highest priority slot in the motherboard (furthest to the left). If another bus master is to have higher priority than the ZSBC-4 CPU, pins 2 and 3 of JP206 must be connected with a jumper block and the default trace between pins 1 and 2 must be cut. In this case the higher priority master must occupy the leftmost slot in the motherboard and the ZSBC-4 CPU card must be in the next slot to the right. If the other bus master responds to a CBRQ/ bus request from the ZSBC-4 card both will be able to use the bus, interleaving their accesses to bus slaves. The ZSBC-4 card will likewise respond to a CBRQ/ bus request from a lower priority bus master by granting it the bus after completing its current bus cycle. If no other master asserts CBRQ/ the ZSBC-4 will retain control of the bus resulting in quicker memory accesses.

If the user wishes the ZSBC-4 to relinquish and re-acquire the bus for every bus access (if used with a bus master that did not assert CBRQ/, for example) the default trace between pins 2 and 3 of JP202 may be cut, jumper pins installed and a jumper block used to connect pins 1 and 2. If the user wishes the ZSBC-4 not to interfere with a higher priority bus master, the default trace at JP203 may be cut so that the ZSBC-4 will not assert CBRQ/ and will wait until the higher priority master has given up control of the bus.

Interrupts: The ZSBC-4 board can accept two distinct interrupt signals from other devices on the bus or from the front panel interrupt switch. These inputs may each be connected to any of the eight Multibus bus interrupt lines INT0/ (highest priority) to INT7/ (lowest priority). The bus interrupt lines are available at JP205 in order of priority with INT7/ (lowest priority) on pin 1 (leftmost pin). INT7/ is usually connected to pin 1 (leftmost pin) of JP204. A low logic level on this pin or execution of a HALT instruction will generate a vectored interrupt through the PIO integrated circuit if I/O pin A7 has been programmed to do so (and the Z80 interrupts have been enabled). In the DSC-4 INT7 on the bus is connected to the front panel interrupt switch through a debouncing RS latch.

In addition to the interrupt inputs described above the ZSBC-4 will respond to interrupts from its counter-timer if supplied with a 60 Hz zener-clipped input TTL level signal on pin 77 of the bus. This pin is currently listed as reserved in Intel's specification of the Multibus but is used on some motherboards as -10 volts. If a ZSBC-4 circuit board is used in another Multibus system which does not provide a 60 Hz TTL signal on bus pin 77 the default trace at JP10 must be cut. Software which uses the real time clock, including Digital Microsystem's versions of CP/M and OASIS, will not operate without a 50/60 Hz input to the counter-timer integrated circuit.

The ZSBC-4 can interrupt another bus master by connecting any of the bus interrupt pins of JP205 to pin 2 of JP204. The interrupt is generated by setting I/O pin B3 of the PIO to a high logic state.

5.13 The 128K Byte RAM Board

The memory board used in the DSC-4 contains 128K bytes of MOS dynamic memory and may occupy any of the eight 128K blocks of address space allowed by the Multibus. The address block is selected by connecting one of the eight pairs of jumper pins located between U12 and U13. Typical access time from a read command is 330 ns or better. Worst case access time is 750 ns and is only encountered when a read request occurs immediately after a refresh cycle is started. To increase the speed of processors such as the Z80 which can terminate wait cycles before requiring data to be valid the 128K memory board is normally configured to provide XACK/ typically 325 ns after a read request just as the data becomes valid. A Multibus- conforming XACK/, which typically goes low 410 ns after a read request, is available by connecting the upper two pins of the jumper between U9 and U10 and cutting the default trace between the lower two pins. The memory board does not require data to be valid at the beginning of a write command so that a write can be initiated before valid data is available. Although this does not conform to Multibus specifications, it results in shorter write cycles with some bus masters.

The 128K byte memory board uses 4 16K bit dynamic memory chips with address multiplexing, RAS/ and CAS/ timing and Multibus slave response timing generated by Intel's 8202 dynamic RAM controller operating with a 25 MHz clock. The board supports both 8 bit and 16 bit operation conforming to Multibus standard operation:

ADR0/	BHEN/	Active data lines	Operation
high	high	DAT0/ thru DAT7/	8 bit read or write to even address
low	high	DAT0/ thru DAT7/ (also DAT8/ thru DATF/)	8 bit read or write to odd address
high	low	DAT0/ thru DATF/	16 bit read or write must be even address
low	low	DAT8/ thru DATF/	8 bit read or write to odd address w/ 16 bit master

(Last operation is not a normal Multibus operation but is supported by the 128K byte RAM board.)

The parallel operation of upper and lower halves of the data bus is achieved by dividing the 128K bytes of memory into two 64K byte blocks each with its own data-in buffer (U23 and U18), data-out latch (U22 and U17), separate write line and separate parity checking circuitry and associated parity memory. Data at even addresses is stored in the block near the right edge of the board and data at odd addresses is stored in the block closer to the left edge of the board. When an 8 bit master reads or writes to an odd address, bi-directional transceivers, U20 and U21, transfer data in the appropriate direction between DAT0/ thru DAT7/ and the memory block occupying the odd addresses.

During a write operation to either block of memory the data-out line of the parity memory is floating and is pulled high by a pullup resistor. Parity generator/checkers, U19 and U24, then generate parity bits for each block which are written into the corresponding parity memory. Since the data stored in the parity memory is random before a write operation, reading from an address before writing into both that address and the same address with the lowest bit complimented may result in a parity error.

A memory read operation combines the results of parity checks of both blocks from U19 and U24 and latches an error at the end of either CAS/ or MRD/ if one exists. This generates an interrupt on INT0/, pin 41 of the Multibus, the highest priority interrupt. Once a parity error is latched it will only be cleared by a read from any address in the range of either 60000H to 7FFFFH or C0000H to DFFFFH. The choice of address range used to clear the parity error condition is made by connecting the center jumper pin located between U6 and U7 to one of the adjacent pins. The center pin is connected to the upper pin by a default trace, configuring the board to respond in the lower address range. The trace must be cut if the other connection is made. The read which clears the parity error will lower XACK/ and one of the lower 8 data lines selected by the jumpers between U21 and U22. Error recovery software can use this information to tell which memory board detected the error if each board lowers the data line associated with its location in the Multibus address space. Because of this method of determining the offending memory board, system memory cannot occupy the address block which other boards use to respond to a parity error read. If this address block is required for system memory, none of the jumpers between U21 and U22 should be connected (cut the default trace) and pin 11 of U9 should be lifted. Memory boards will generate an interrupt on a parity error but other methods must be used to determine the offending memory board.

6.0 DSC-3 and DSC-4 hardware connections

6.1 Cable connections

The cables listed below should be in place and securely installed with the correct polarization. The A.C. and D.C. power cables are keyed to prevent improper connection.

1. A.C. power--2 or 3 wires (AWG 18) twisted together	
115 V.A.C.	230 V.A.C.
Power from AC line to the switch	
red/white stripe: live white/red stripe: neutral green: chassis ground	red/white stripe: live white/red stripe: live green: chassis ground
Power from the switch to equipment	
red: live conductor white: neutral conductor green: chassis ground	red: live conductor white: live conductor green: chassis ground
Unit type:	Cable part number:
DSC-3, DSC-3/101,/102	83-3010
DSC-3/4004,/4008	83-0093
DSC-4, DSC-4/101,/102, /4004,/4008	83-4057
HDO 4004, 4008	83-0049
STD-20, SO-STD	83-3010
SA 850 drive motor adaptor	83-0104

This cable carries current from the input line filter through the fuse and power switch to the fan, disk drives, courtesy outlet and the D.C. power supply. Connections to the drives and power supply transformer are made with 3-pin connectors. Other connections in the circuit are soldered. The chassis ground wire (green) connects the chassis ground of each disk drive and the ground of the DSC-3, including the logic ground connections of all connectors, to the grounding wire in the line cord.

2. D.C. power to drives--five separate wires (AWG 16) held together with cable ties:

green	ground (two wires)
blue	+5 volts
yellow	-12 volts
brown	+24 volts

This cable connects the disk drives to the D.C. power supply P.C. board. Connections are made with keyed six-pin Molex connectors.

Unit type:	Cable part number:
DSC-3	83-3011 or 83-4058
DSC-3/101,/102	83-4058
DSC-3/101,/102 with STD-20 streamer tape unit	83-3211
DSC-3/4004,/4008	83-0094
DSC-4, DSC-4/101,/102, /4004,/4008	83-4058
HDO 4004, 4008 power cable	83-0091
STD-20	83-3212

3. D.C. power to CPU (DSC-3) or to motherboard (DSC-4) and to optional HDC--six separate wires (AWG 16) held together with cable ties

green	pins 2 and 7	ground (two wires)
blue	pin 1	+5 volts
red	pin 3	+12 volts
yellow	pin 4	-12 volts
white	pin 8	zener-clipped 60/50 Hz (time base for CPU)

Connections from the power supply P.C. board to the HDC (Hard Disk Controller), if installed, and to the CPU (DSC-3) or motherboard (DSC-4) are made with eight pin Molex connectors keyed by removal of one pin.

Unit type:	Cable part number:
DSC-3	83-0090
DSC-3/101,/102, SO-STD	83-0096
DSC-3/4004,/4008	83-0097
DSC-3/A25	83-3023
DSC-4, DSC-4/4004,/4008	83-0101
DSC-4/101,/102	83-4104
HDO 4004, 4008	83-0089

4. Reset and front panel interrupt switches to CPU (DSC-3) or motherboard (DSC-4)--four separate wires twisted together

green	ground
white	reset (switched to ground--normally open)
black	interrupt (switched to ground--normally open)
blue	interrupt (switched to ground--normally closed)

DSC-3: This cable connects to the CPU with a small six pin Molex connector. The connector is not mechanically keyed and must be attached with the green wire closest to the center of the CPU board.

DSC-4: Connections to the motherboard are made with a small four pin molex connector. The connector must be attached with the green wire toward the back of the cabinet.

Unit type:	Cable part number:
DSC-3/A25 Hinet station with CRT	83-6102
DSC-3/B HiNet station with no CRT	83-3501
DSC-3 all other units	83-3059
DSC-4 all units	83-4059

5. CPU to RS 232 I/O board--twenty-six conductor ribbon cable

This cable connects J1 on the CPU to J5 on the RS 232 I/O board. Twenty-six pin hooded headers are used on the CPU and the RS 232 I/O board with pin 1 marks on both headers and on the connectors attached to the ribbon cable. The user's CRT is normally connected to the uppermost DB 25 connector on the I/O board. See section 2.3 for jumper configurations for the serial ports on the CPU board. See section 2.5 for jumper configurations for the I/O board for various I/O devices.

Unit type:	Cable part number:
DSC-3, DSC-3/101,/102	83-0011
DSC-3/4004,/4008	83-0041
DSC-3/A25	83-6103
DSC-4 all	83-4056
external chassis to CRT	83-0012

6. CPU to floppy disk drive(s)--fifty pin ribbon cable

This cable connects J2 on the CPU to the fifty pin edge connectors on the floppy disk drives. Pin 1 is on the left side of both drives and the CPU board (viewed from he front of the cabinet) and is marked on all connectors. The drive which has terminating resistors installed (section 2.4) must be attached to the connector furthest from the CPU on the cable.

Unit type:	Cable number:
DSC-3 2 FD drives or /4004,/4008	83-0005
DSC-3/101,/102	83-3102
DSC-3 with 4 FD in one cabinet	83-3024
DSC-3 with 4 FD in two cabinets	83-0003
DSC-4	83-0114
DSC-4/101,/102,/4004,/4008	83-4101

7. CPU RS-422 HiNet connection (optional)--nine conductor ribbon cable or ten conductor twisted-pair ribbon cable.

The nine pin network connector is connected to J5 on the CPU with this cable. Pin 1 is on the left side on the CPU and of the nine pin connector (viewed from front of cabinet) and is marked J5. See section 2.3 for jumper configuration for HiNet use.

unit type:	Cable part number:
DSC-3, DSC-3/101,/102	83-3020
DSC-3/A25,/B HiNet station	83-3025
DSC-3/4004,/4008	83-3021
DSC-4 all	83-3022

8. CPU parallel port to HDC (optional)--twenty-six conductor ribbon cable

The CPU is interfaced to the HDC with a cable connecting J3 on the CPU (I/O port 01H) to P1h on the HDC. Pin 1 is on the left side on the CPU and on the right side on the HDC. The cables and connectors are marked.

Unit type:	Cable part number:
DSC-3/101,/102,/4004, /4008, SO-STD	83-3101
DSC-4/101,/102 ZSBC to HDC	83-4103
DSC-4/4004,/4008	83-4060
HDO 4004, 4008	83-6060
external chassis to chassis	83-0048

9. CPU J4 to tape interface P.C. board

This cable connects J2 on the tape drive interface connector block to J4 on the CPU board. 26 pin hooded header connectors are used on the CPU and the streamer tape drive. Pin 1 is marked on both headers and on the connectors attached to the ribon cables.

Unit type:	Cable part number:
DSC-3/101,/102,/4004,/4008	83-3213
SO-STD	83-0011
DSC-4/101,/102,/4004,/4008	83-3213
STD-20	83-3213
external chassis to chassis	83-3214

10. HDC to hard disk (optional)--fifty pin ribbon cable

When a hard disk is installed it is connected to the HDC at P1d. Pin 1 is marked on all connectors.

Unit type:	Cable part number:
DSC-3/101,/102, SO-STD	83-3210
DSC-3/4004,/4008	83-4102
DSC-4/101,/102	83-4102
HDO 4004, 4008	83-3103

11. CPU parallel port to Centronics printer connector (optional)--twenty-six conductor ribbon cable.

    A Centronics-type interface is provided through J4 on the CPU (I/O port 02H). Assigning the twenty-six pins of J4 to the thirty-six pins of the Centronics connector on the back panel is done within the hood of the Centronics connector. Pin 1 of J4 is on the left and is marked and the Centronics connector is polarized.

Unit type:	Cable part number:
Parallel port to rear panel	
Centronics style connector	83-4050
External chassis to printer	83-4550

6.2 CPU board jumper connections

The ZSBC-3 and ZSBC-4 PC boards may be configured for various options by making connections between jumper pins with removable shorting blocks. Their functions are described below. When shorting blocks are not being used to make connections they may be kept on one of the jumper pins.

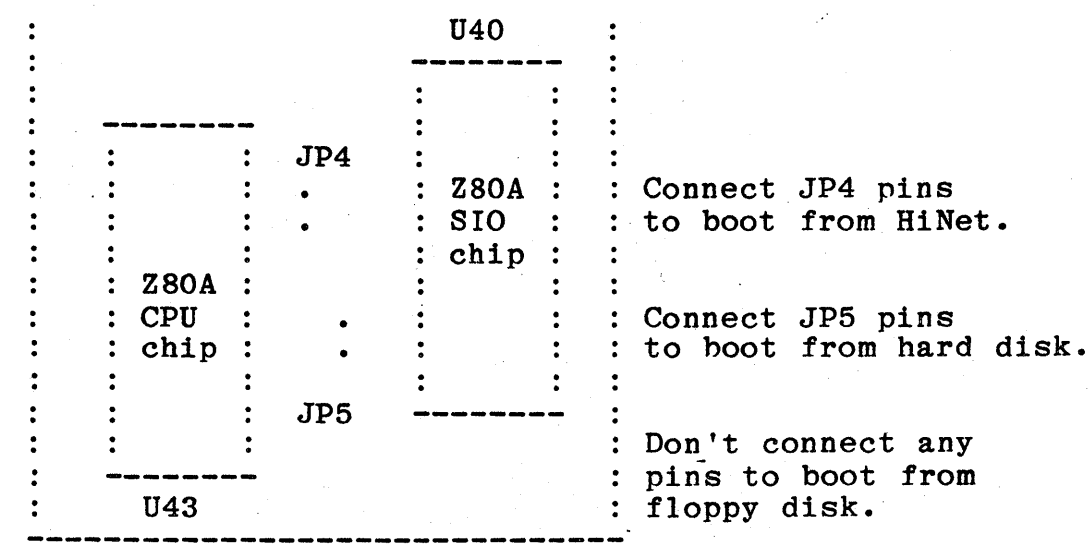
Auto bootup jumper options

Start-up options: Following a reset or when power is applied the CPU will start in one of four ways depending on the state of jumpers JP4, JP5, and the front panel interrupt switch (This applies to PROM version 1.09 only).

To enter PROM Monitor:		Depress interrupt switch, then press and release reset switch.
To boot automatically:		
JP4 open	JP5 open	Boot from floppy disk A
JP4 connected	JP5 open	Boot from HiNet
JP4 open	JP5 connected	Boot from hard disk

JP5 should not be connected when the ZSBC-3 board is used inside a terminal and there is a wire connecting the top pin of JP5 to TP105.

Blowup of upper-left of CPU board

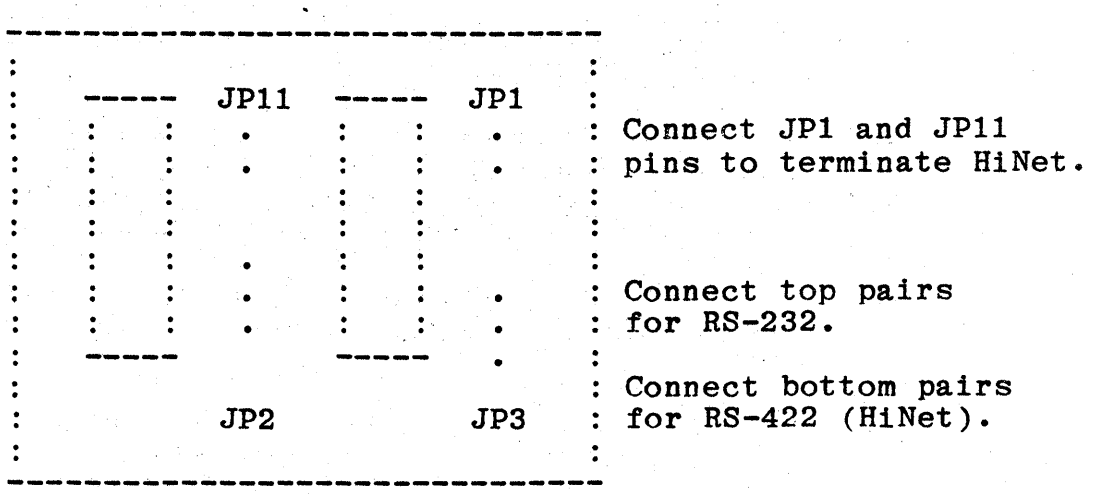


Port 1 - RS-232 and RS-422 options

Serial port 1 may be configured as an RS-232 asynchronous serial port for connection to a printer, modem, or CRT by installing shorting blocks at JP2 and JP3 to connect the two pins at each location that are closest to the top of the PC board (pins 1 and 2 at both JP2 and JP3).

The interface to the HiNet network requires serial port 1 to be configured as an RS-422 synchronous serial port. This is accomplished by installing shorting blocks at JP2 and JP3 to connect the two pins at each location that are closest to the bottom of the board (pins 2 and 3 at JP2 and JP3). No shorting blocks are required if the default traces on the back of the board have never been cut. Shorting blocks are to be installed at JP1 and JP11 only if the system is at either end of the HiNet network cable. They enable on-chip resistor terminators.

Blowup of top-center of CPU board



Other jumper options

Parallel port 02H (Centronics): When the parallel port connection at J4 is used as an output port only, a shorting block is installed at JP9 to permanently enable the data outputs. A shoring block is not required with an 83-4050 Centronics cable or in the DSC-3/B.

Shorting blocks at JP6, JP7 and JP8 must be left as installed by Digital Microsystems. JP6 selects one of two patterns stored in the floppy disk interface phase-locked loop PROM. JP7 and JP8 allow the use of a 2716 type EPROM.

Special jumpers on the DSC-4 only

Several jumpers are found only on the DSC-4. They may be left as shipped from Digital Microsystems unless other bus masters (e.g. other CPU cards or DMA cards) are added to the system. These jumpers are described in section 5.12.

6.3 128K RAM board jumper connections

The 128 Kbyte RAM board has four sets of jumper posts which may be used with shorting blocks to select various options. All post locations have default circuit traces which, unless cut and jumpered otherwise, configure the board to operate as board 0 (lowest 128K bytes of the 1 Mbyte address space of the Multibus in a DSC-4. If the board is to be used with other bus master Multibus boards or in a DSC-4 with more than one memory card the default traces may need to be cut and connecting shorting blocks installed.

The eight sets of two posts, located between U12 and U13 at the lower left corner of the PC board, select which of the eight 128K byte blocks of memory space is occupied by the board. The upper two posts are connected by a default trace which must be cut if the board does not occupy the lowest 128K bytes. The pairs of posts are in order so that the board can be made to occupy the nth block of memory space by connecting the nth pair of posts from the top.

The timing of the Z80 CPU used in the ZSBC-4 is such that one CPU wait state may be avoided if the transfer acknowledge (XACK/) from slave boards is brought low slightly before valid data is present on the data bus. When used in the DSC-4 the 128K RAM board normally provides this early version of XACK/ thru the default trace between the lower two posts of the three between U9 and U10. If another bus master is to be used with the 128K RAM board this trace may be carefully cut and the upper two posts connected with a shorting block to provide a Multibus-conforming XACK/. This will cause the DSC-4 to run approximately 20% slower and may interfere with timing dependent software and is therefore not recommended unless necessary.

When the 128K RAM board detects a parity error it generates an interrupt on INT0/, the highest priority interrupt line on the Multibus. The board also latches the error condition so that software may determine which memory board in the system generated the error. This is accomplished by the first memory read operation to any address in either block 3 (60000H to 7FFFFH) or block 6 (C0000H to DFFFFH) of the Multibus address space. A default trace connecting the upper two pins of the set between U6 and U7, selects a parity error response from block 3. If a parity error response from block 6 is desired the default trace must be cut and the lower two pins connected.

A memory board which has latched a parity error responds to a block 3 or block 6 read by pulling low one of the lower eight Multibus data lines. The data line to be lowered is selected by the eight pairs of jumper pins located between U21 and U22 and should correspond to the address block occupied by the board. A default trace configures the board to lower DAT0/. The pairs of pins are arranged in the following order, from bottom to top:

pair 1 (lowest)	DAT7/
pair 2	DAT5/
pair 3	DAT4/
pair 4	DAT6/
pair 5	DAT3/
pair 6	DAT2/
pair 7 (default)	DAT0/
pair 8 (highest)	DAT1/

Since a memory board configured to respond to a parity error read of block 3 or block 6 will lower XACK/ in response to such a read even if no parity error has occured, no system memory should occupy the address block which boards use to give error responses.

7. Printer, CRT, and HiNet connections

7.1 RS-232 I/O board jumper connections

The following chart shows the correspondence between pins on the I/O board (i.e., DB-25 board) connectors, the I/O board jumper blocks, and the ZSBC board for each of the four serial I/O ports. This information can be used to construct a cable and/or jumper block to connect a CRT or printer to the DSC-3 or DSC-4.

Note: On I/O board pullups connect through pin 19 to +12 volts. Use 4.7K ohm resistors on I/O board.

CRT

Serial port 0 (I/O board connector J1)

	I/O board DB25S (J1)	I/O Board jumper block	J5 on I/O brd J1 on ZSBC3/4	ZSBC 3/4 serial ports
	pin 1	no jumper blk		chassis ground
TxD :>	pin 2	for port 0	pin 3	U2 pin 4 RxD
RxD :<	pin 3		pin 5	U1 pin 6 TxD
RTS :>	pin 4		pin 1	no connect (CTS)
CTS :<	pin 5		pin 10	pullup (RTS)
DSR:<	pin 6		pin 6	pullup (DTR)
	pin 7	signal ground	pin 13	logic ground
DCD:<	pin 8		pullup	
DTR:>	pin 20		pin 2	no connect (DSR)

ASYNC/HiNet Serial port 1 (I/O board connector J2)

(JP2&3) (p.6-8)

I/O board DB25S (J2)	I/O Board jumper block	J5 on I/O brd J1 on ZSBC3/4	ZSBC 3/4 serial ports
pin 1	(for CRT)		chassis ground
pin 2	pin 1-pin 16	pin 9	U2 pin 1 RxD
pin 3	pin 2-pin 15	pin 8	U1 pin 3 TxD
pin 4	pin 3-pin 14	pin 7	no connect (CTS)
pin 5	pin 4-pin 13	pin 14	pullup (RTS)
pin 6	pin 5-pin 12	pin 16	pullup (DTR)
pin 7	signal ground	pin 13	logic ground
pin 8	pin 7-pin 10	pullup	
pin 11	pin 8		
pin 14	pin 9		
pin 20	pin 6-pin 11	pin 4	no connect (DSR)

PRINTER

Serial port 2 (I/O board connector J3)

	I/O board DB25S (J3)	I/O Board jumper block	J5 on I/O brd J1 on ZSBC3/4	ZSBC 3/4 serial ports
	pin 1	(for CRT)		chassis ground
TxD >	pin 2	pin 1-pin 16	pin 17	U2 pin 13 RxD
RxD <	pin 3	pin 2-pin 15	pin 24	U1 pin 8 TxD
RTS >	pin 4	pin 3-pin 14	pin 12	U4 pin 4 CTS
CTS <	pin 5	pin 4-pin 13	pin 18	U3 pin 3 RTS
DSR <	pin 6	pin 5-pin 12	pin 15	U1 pin 11 DTR
	pin 7	signal ground	pin 13	logic ground
DCD <	pin 8	pin 7-pin 10	pullup	
	pin 11	pin 8		
	pin 14	pin 9		
DTR >	pin 20	pin 6-pin 11	pin 11	U4 pin 13 DCD

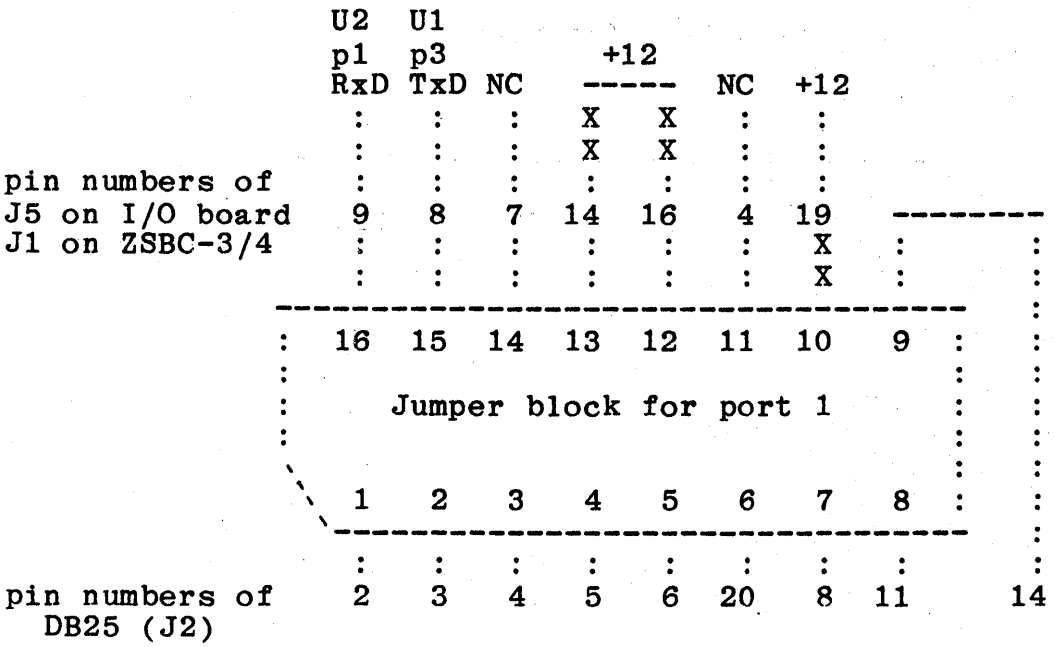
Serial port 3 (I/O board connector J4)

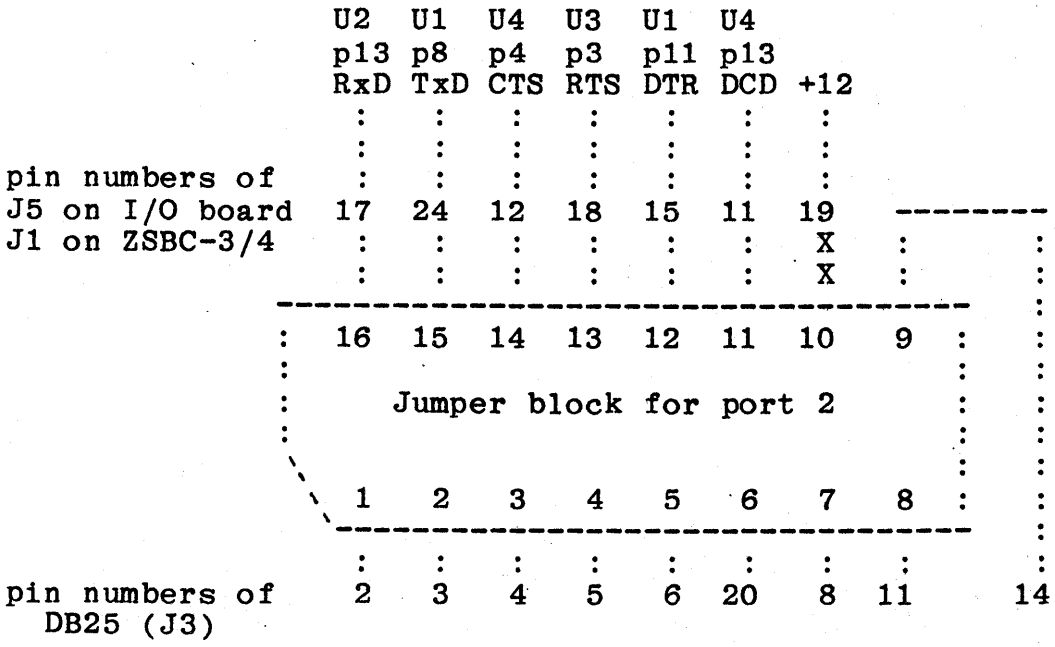
I/O board DB25S (J4)	I/O Board jumper block	J5 on I/O brd J1 on ZSBC3/4	ZSBC 3/4 serial ports
pin 1	(for CRT)		chassis ground
pin 2	pin 1-pin 16	pin 21	U2 pin 10 RxD
pin 3	pin 2-pin 15	pin 25	U3 pin 8 TxD
pin 4	pin 3-pin 14	pin 20	U4 pin 1 CTS
pin 5	pin 4-pin 13	pin 26	U3 pin 11 RTS
pin 6	pin 5-pin 12	pin 23	U3 pin 6 DTR
pin 7	signal ground	pin 13	logic ground
pin 8	pin 7-pin 10	pullup	
pin 11	pin 8		
pin 14	pin 9		
pin 20	pin 6-pin 11	pin 22	U4 pin 10 DCD

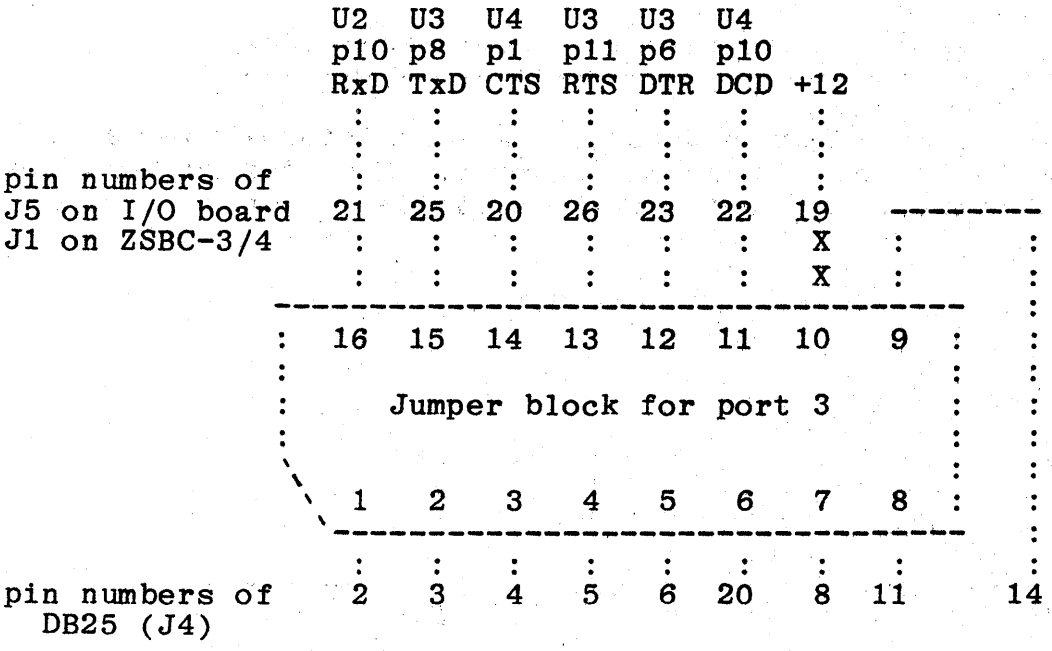
Hardwired connections to jumper block pins

The following diagrams present the same information as the tables on the previous pages; however, the information is presently pictorially, so it may be a little easier to understand.

Note: X represents a 4.7K ohm resistor.
X

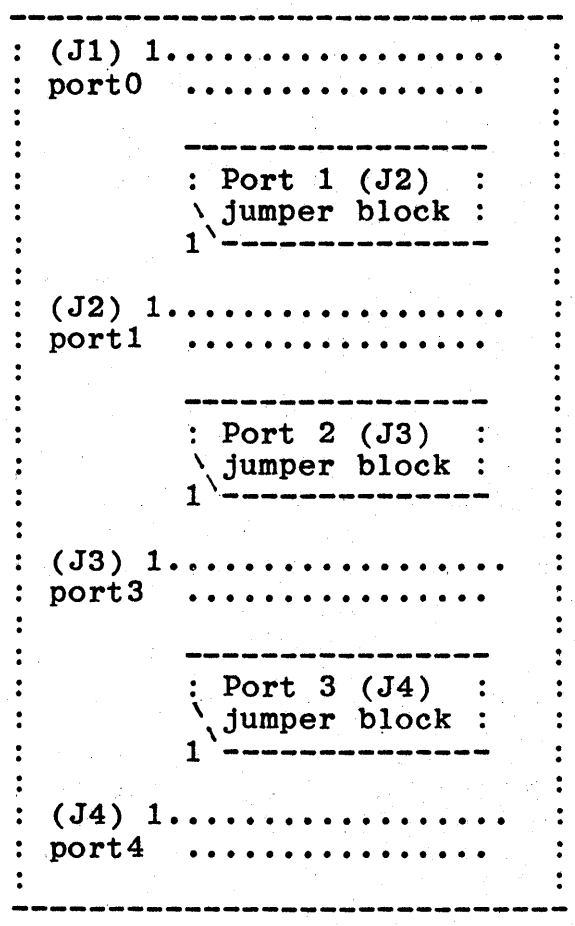





U2 p10 RxD
U3 p8 TxD
U4 p1 CTS
U3 p11 RTS
U3 p6 DTR
U4 p10 DCD
+12
pin numbers of J5 on I/O board
J1 on ZSBC-3/4
21 25 20 26 23 22 19
X
X
16 15 14 13 12 11 10 9
Jumper block for port 3
1 2 3 4 5 6 7 8
pin numbers of DB25 (J4)
2 3 4 5 6 20 8 11 14

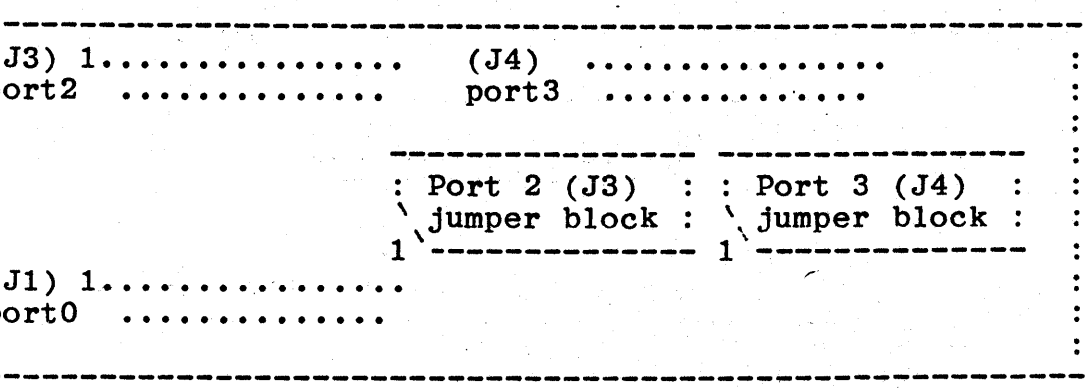
Inside view of RS-232 I/O board on DSC-3 or DSC-4

This board is located on the back of the cabinet, on the lower lefthand side.



Inside view of RS-232 I/O and power supply board on DSC-3/B

This board is located on the back of the DSC-3/B HiNet basic user station cabinet. Serial port 1 cannot be used under HiNet.

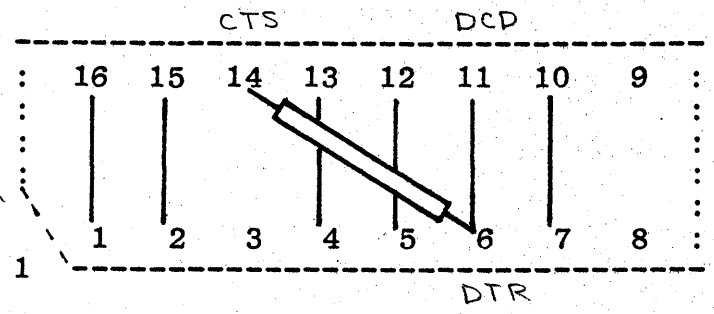


Examples of Jumper Blocks

Jumper Block for a Texas Instruments 810 printer

The TI 810 printer has an onboard buffer. When the buffer is full, the printer sends a busy signal to the DSC-3/4 by lowering DTR on RS-232 pin 20. The serial I/O port on the ZSBC 3/4 will stop transmission automatically if this signal is connected to its CTS input. This is accomplished by connecting pin 14 to pin 6 instead of pin 3 on the corresponding jumper block.

Implies: BIOS uses both DCD and CTS to handshake with printer



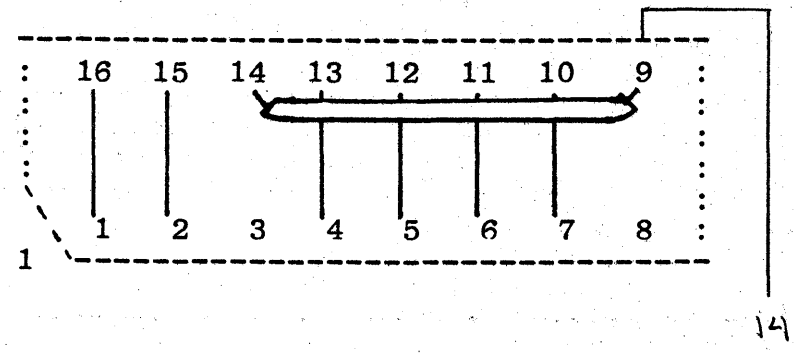
The DNB option on the TI 810 must be enabled by setting the panel switches to:

1	2	3	4	5	6	7
low	high	high	low	low	high	high

Remove the processor board of the printer (green card ejectors) and jumper E5 to E6 instead of E4. Verify that the resistor network near the printer's RS-232 connector has not been pulled loose before replacing the card cage enclosure.

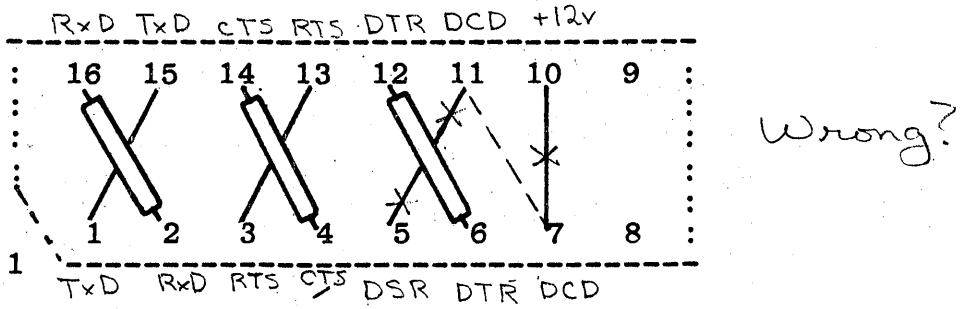
Jumper block for a Teletype model 40 printer

The teletype model 40 uses RS-232 pin 14 to tell the computer that it is busy and no more characters can be sent to it. This signal may be connected to CTS on the proper serial I/O port of the DSC-3/4 by connecting pin 14 to pin 9 instead of pin 3 on the corresponding jumper block on the I/O board.



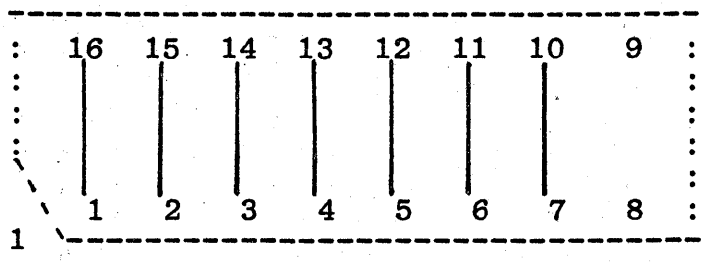
Jumper block for a standard modem

Most modems require the following pairs of signals to be interchanged (compared to their arrangement for a CRT): RxD and TxD, CTS and RTS, and DCD and DTR.



Jumper block for a standard CRT terminal

The jumper block connections which are used with a CRT terminal are listed in the table above.



7.2 Parallel printer cable

The following table lists the pin connections required to connect a DSC-3 or DSC-4 with a printer using a parallel interface.

Z80 port 2	ZSBC-3 or 4 Connector	Printer Connector	Centronics Signal Name	In or Out of Printer
DB0	Pin 2	Pin 2	DATA 1	Input
DB1	Pin 3	Pin 3	DATA 2	Input
DB2	Pin 4	Pin 4	DATA 3	Input
DB3	Pin 5	Pin 5	DATA 4	Input
DB4	Pin 6	Pin 6	DATA 5	Input
DB5	Pin 7	Pin 7	DATA 6	Input
DB6	Pin 8	Pin 8	DATA 7	Input
DB7	Pin 9	Pin 9	DATA 8	Input
STAT2B	Pin 17	Pin 11	BUSY	Output
IN 00/	Pin 21	Pin 1	DATA STROBE/	Input
GROUND	Pin 1	Pin 19	DATA STROBE	Ground
GROUND	Pin 10	Pin 20	DATA 1	Ground
GROUND	Pin 12	Pin 21	DATA 2	Ground
GROUND	Pin 14	Pin 22	DATA 3	Ground
GROUND	Pin 16	Pin 23	DATA 4	Ground
GROUND	Pin 18	Pin 24	DATA 5	Ground
GROUND	Pin 20	Pin 25	DATA 6	Ground
GROUND	Pin 22	Pin 26	DATA 7	Ground
GROUND	Pin 24	Pin 29	BUSY	Ground

J9 Note that Pin 11 on J4 of the ZSBC-3 or 4 must be grounded in the cable to enable the port outputs. Also, Pin 36 on the printer connector must be grounded when using an EPSON printer.

The following pins of J4 on the ZSBC-3 or 4 are not connected to the printer and should be cut when leaving the computer cabinet: 13, 15, 19, 23, 25. The following pins of the printer connector are not connected and should not be attached in the cable: 9, 10, 12, 14 thru 18, 27, 28, 30 thru 35.

Note that J4 and the printer connector are numbered differently:

J4 Connector	Printer Connector
2 4 6 ...	1 2 3 4 5 ...
1 3 5 ...	19 20 21 22 23 ...
(top view)	(face view of male connector)

Check that pin 36 of the printer connector is grounded to allow the use of EPSON printers.

Early versions of CP/M, HiNet, and MP/M used a slightly different parallel printer interface. The following versions ARE compatible with the interface described on the previous page: CP/M 1.437, CP/M 2.237, HiNet 1.437, HiNet 2.237, MP/M 1.104A, MP/M 1.104B, MP/M 1.104C, MP/M 1.104D. In earlier versions, the most significant data bit was used as a DATA STROBE/ by resetting and setting it in software. The new interface allows a full 8 bits to be transmitted to the printer. The former interface differed in the following ways:

Pin 9 on J4 was connected to pin 1 of the printer connector. Now, it must be disconnected from pin 1 and connected to pin 9 of the printer connector.

Pin 21 on J4 was not connected. Now, it must be connected to pin 1 on the printer connector.

7.3 HiNet cable installation

For basic systems, the DMS HiNet uses RS-422 receivers and drivers operating at 500K baud over distances of up to 325 meters.

Each network device transmits a separate data and clock signal when it has authority to talk on the network. All other stations will disable their transmitters and listen for packets addressed to themselves. Since RS-422 uses a differential signal, data and clock each require 2 wires. There should also be at least one ground wire in the network cable to protect the receivers and drivers from large common mode voltages. If the building power distribution system develops large differences in ground potential some form of isolating connection system must be used.

The minimum network cable therefore consists of 5 conductors, 2 differential signals, plus ground. The connectors used in the HiNet are 9 pin "D" connectors, similar to the 25 pin version used for RS-232. Each instrument will be fitted with a female connector and the network cable itself will have male connectors daisy chained past all stations in the system.

For physically short networks, (up to 100 meters) the most rapidly installed and economical network cable is made from flat cable with mass terminated 9 pin "D" connectors. Standard twisted pair communication cable can also be used with soldered connections to the 9 pin "D" connectors. If flat cable is used, the minimum number of conductors is 6 to span the 2 differential signals, separated by 2 grounds.

Network Cable Connections

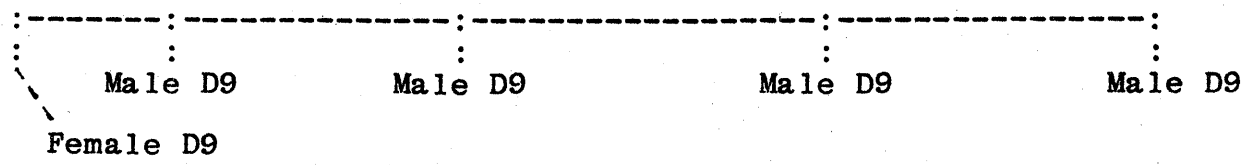
J5 connections on ZSBC-3/4				9 Pin "D" connector	
Pin				Pin	
1	-->	GROUND	<--	1	
2	-->	GROUND	<--	6	
3	-->	+ CLOCK	<--	2	
4	-->	- CLOCK	<--	7	
5	-->	GROUND	<--	3	min. required
6	-->	GROUND	<--	8	
7	-->	+ DATA	<--	4	
8	-->	- DATA	<--	9	
9	-->	GROUND	<--	5	
10	-->	GROUND	<--	no connection	

For reliable operation over long distances the network cable should be properly terminated at both ends. This termination consists of 180 ohm resistors across the differential pair for both data and clock. These resistors can be inserted by installing jumpers JP1 and JP11 on the ZSBC-3/4 CPU board of the station physically closest to each end of the cable. Note that all other stations must not have these jumpers installed. If the last station is not near the end of the cable, or if it may be necessary to disconnect this station while the network is operational, one should terminate the cable with resistor-capacitor networks. These consist of 100 to 220 ohm resistors in series with .01 mfd capacitors soldered across the data and clock pins of a 9 pin female "D" connector. The capacitors are optional and their use should be evaluated experimentally. Plug the connector in at the end of the network cable.

HiNet cable products

To facilitate the installation of demonstration systems and simple networks, the following parts and materials may be ordered from DMS:

1. Network Demonstration Cable 1 (DMS part number CBL-N/1). This is a 30 meter flat cable with 4 male DB9 connectors, spaced approximately every 10 meters, with a female D9 connector at one end to allow more than one cable to be connected together.



2. Male D9 connector for mass termination. (DMS part number CBL-N/CONM)

3. Male D9 connector for solder termination. (DMS part number CBL-N/CONSM)

4. Female D9 connector for mass termination. (DMS part number CBL-N/CONF)

5. Female D9 connector for solder termination. (DMS part number CBL-N/CONSF)

6. 150 meter spool of Belden type 8725 communication cable containing 2 twisted, shielded pairs plus ground. (DMS part number CBL-N/500) This cable is for use with soldered connectors.

As with all electrical installations, safety should be a primary consideration. Installations should be performed by technically competent individuals and all applicable building and electrical codes must be observed.

8.0 Floppy disk hardware

8.1 Jumper Options

Two types of floppy disk drives are currently used in DSC-3 and DSC-4 systems: Floppy disk SA800R single sided 8 inch and the Floppy disk SA850R double sided 8 inch. Each of these drives has numerous options in its electronics which are enabled or disabled by various jumper connections on its PC board. In order to accommodate the NEC765 LSI floppy disk controller chip, many of these options must be jumpered differently from their state as shipped by Shugart (and also differently from the requirements of the DSC-2).

The following tables show the jumper requirements of the DSC-3/4 when using the SA800R and SA850R as the A or B drive.

Floppy disk SA800R

Jumpers installed as shipped: 800, X, T1, HL, A

All drives:	install	T2, DC, Wirewrap #1 (*)
	remove	Z, B, 18
A drive only:	install	DS1, C
B drive only:	install	DS2, Wirewrap #2

For all 800 drives and systems, jumpers T3,T4,T5, and T6 must be installed on the drive furthest from the controller on the signal cable.

Floppy disk SA850R

All drives:	install	2S, DC, 850, IW, S2, RS, M Wirewrap #3
	cut	B, Z (both on Jumper Block at F4)
A drive only:	install	DS1, C-HI
B drive only:	install	DS2, C-D

For all 850 drives and systems, the resistor pack should be installed at E5 on the drive furthest from the controller on the signal cable.

(*) See drive sketches in Appendix D.

8.2 Care and Handling of Diskettes

DO keep your diskettes in storage envelopes. This protects them from becoming damaged by dust, dirt, and other messy things.

DO allow the diskette and the computer system to come to an equilibrium temperature before use.

DO provide adequate backups of all your programs and data. Organized, frequent backups are essential to protect against hardware, software, and human failures.

DO use high quality diskettes to reduce disk drive wear and to reduce the likelihood of read/write errors.

DO NOT handle the disk surface or attempt to remove the diskette from its jacket. A fingerprint on the surface of a diskette may render it completely unusable.

DO NOT turn the computer on or off when a diskette is in a drive.

DO NOT store the diskettes near heat, sunlight, or a magnetic field.

Write Protect Feature

The drives used in the DSC-3 and DSC-4 are equipped with a sensor to detect individual diskette write-protect. Diskettes with this option have a notch removed from the end opposite the label. The notch must be covered in order to write on the diskette. Use the small silver tabs provided by most diskette manufacturers.

9. Hard disk hardware

9.1 Jumper options

This section describes jumper options for these drives:

SHUGART 4000 14 inch drives, 4004 single platter 14 megabyte
4008 double platter 28 megabyte

FUJITSU 2300 8 inch drives, 2001 double platter 11 megabyte
2002 quad platter 23 megabyte

Drives are jumpered to determine sector length and other hard disk controller parameters. Jumper settings are alike for models 4004 and 4008, and likewise for models 2001 and 2002.

Shugart 4000 14 inch drives

Jumper configuration on control PCB version 26058 is shown below (this is the board that the 50 pin signal cable plugs into from the hard disk controller):

Pins shorted: 1X, RY, ST, DS4 (marked by rectangle), SL, C
T, E, SC, S2, LSB, 2, 3, 4, 5, 7, 8, 9, 10, 12, GR

Fujitsu 2300 8 inch drives

Jumper pins shorted: S1, 2-3 S2, 2-3 S3, 2-3

DIP switches:

SW4:

1	2	3	4	5	6	7	8	
								on
								off

SW3:

1	2	3	4	5	6	7	8	
								on
								off

SW2:

1	2	3	4	5	6	7	8	
								on
								off

SW1:

1	2	3	4	5	6	7	8	
								on
								off

9.2 Care and handling of hard disks

Shugart 4000 14 inch drives

1. During shipping or when the disk is moved, the read/write heads must be positioned at an inner track and the damper pin inserted before powering off. When the disk stops rotating, insert the locking screw in the spindle. Note: the spindle must only be turned in a clockwise direction to prevent damage to the media.

2. The locking screw which prevents the spindle from turning must be removed before energizing the A.C. motor.

3. The damper pin must be removed while the drive is spinning (i.e., AC energized) to allow free movement of the read/write heads.

4. Before attempting to use the hard disk, allow 1 1/2 minutes warmup after powering on for the drive to become ready.

Fujitsu 2300 8 inch drives

1. During shipping or when the disk is moved, the read/write heads must be positioned at track 0 (this can be done by resetting the system). This will allow the locking arm to be moved to the right, thereby locking the drive.

2. Do not pick up or move the drive during power up or power down. Do not turn the drive upside down at any time. When handling the disk be very careful of the P.C. board attached to the bottom; do not disturb any of the components connected to it.

3. Allow at least 30 seconds for the drive to become ready after powering on the system.

9.3 Hard disk organization

The Winchester 8" and 14" hard disks currently available with the DSC 3/4 have 10 to 28 megabytes of storage.

The absolute file addressing limit for CP/M 1.4 is 4 Megabytes and for CP/M 2.2 is 8 Megabytes. Therefore the hard disk must be partitioned into smaller logical partitions for use with CP/M. Operations that cause frequent directory searches will run more efficiently in small partitions as the number of CP/M sectors read and processed for each directory search will be smaller than for large partitions.

Physically, each of the hard disks has a different number of heads (4 or 8), tracks (202 or 242) and sectors per track (11 or 17). Each physical sector is 1024 bytes. CP/M works with logical sectors of 128 bytes, up to 128 sectors per track and up to 256 tracks. The firmware executing in the hard disk controller treats each disk as a linear array of 1024 byte blocks. Blocks are numbered from 0 on up to the maximum available. When a CP/M request for partition, track, and sector (128 bytes) is received, it is mapped onto this array. The physical sector is read, and the appropriate 128 bytes are extracted and returned to CP/M. For simplicity, CP/M is told that all hard disk logical partitions have 128 sectors per track and as many tracks as appropriate for that logical partition's size.

Each of the hard disks available can be divided into at most 64 partitions (also called "units"). Each partition must be one of the following sizes:

1 - 256K bytes
2 - 512K bytes
3 - 1024K bytes
4 - 2048K bytes
5 - 4096K bytes
6 - 8192K bytes (CP/M 2.2 only)

The sum of the sizes of all the partitions must obviously be less than the total disk space available. After making allowance for spare sectors for defective sector mapping, total available disk space is as follows:

Winchester 101B	10,560K bytes
Winchester 102B	21,120K bytes
Winchester 4004	13,600K bytes
Winchester 4008	27,200K bytes

The first disk partition (numbered 0) is reserved for use by the operating system and controller. It is not a CP/M structured disk and contains at specifically assigned locations information such as:

Disk controller firmware
Disk allocation table
CP/M and BIOS for HiNet master
CP/M and BIOS for HiNet stations
CP/M and BIOS for single user system

The size of this partition should be 1 (256K bytes). Because this partition does not have a CP/M directory structure, information that must be put on it during system installation (or after a hard disk format) must be done so directly. A program is provided to transfer CP/M files (usually from a floppy) to the system partition and is called WRUNO (WRite UNit 0). WRUNO assumes partition (i.e., unit) 0 contains 16 tracks with 128 sectors, each of 128 bytes. This maps to blocks 0 through 255 of any hard disk. WRUNO must be told explicitly the logical track and sector to be written.

Before any high level software can communicate with the hard disk (this includes WRUNO), the firmware must be loaded onto blocks 0 and 1. This is accomplished with a program called HARDHELP. When executed, HARDHELP will ask the user for the size of the hard disk so the firmware will know the physical parameters to use.

In order to inform the controller firmware of the location and size of all partitions, and to inform CP/M of their size, a disk allocation table is maintained on partition 0 (Block 15). This table contains one entry for each of 64 partitions, with the following information:

(Position in table implies partition number, 0 first)

1 byte - size	0 = not assigned
8 bytes - name	alphanumeric characters
6 bytes - password	password (optional)
1 byte - control information	(currently not used)

The entries in this table directly control the size and physical location of the partitions and should be changed with care. Each partition physically starts after the number of blocks required for all lower numbered partitions. Changing the size of any partition will displace all higher numbered partitions and therefore should only be done after a backup and format.

The construction or modification of the disk partition table is accomplished by a program named ALLOC. For demonstration purposes a default partition table is available in a file named ALLOC.TAB and may be directly written onto the hard disk using the WRUNO utility, as shown here: A>WRUNO ALLOC.TAB 0 79

Contents of Partition 0 of a Hard disk

Logical Address	Contents
track 0, sectors 01-1F	Controller program
track 0, sectors 79-80	Disk Allocation Table Up to 64 16-byte entries: 1 byte : size (0-6) 8 bytes: partition name 6 bytes: password 1 byte : -- reserved --
track 1, sectors 01-08	Bad Sector Table Up to 64, 128, or 256 3-byte entries: 1 byte: track 1 byte: head 1 byte: sector
track 1, sectors 09-80	Single user CP/M (sectors 35-80 for CP/M 1.437) (sectors 21-80 for CP/M 2.437)
track 2, sectors 01-02	Single User CP/M or HiNet cold-boot
track 2, sectors 03-80	HiNet Station CP/M (sectors 23-80 for HiNet 1.437) (sectors 0F-80 for HiNet 2.437)
track 3, sectors 01-10	HiNet User Name Table Up to 128 16-byte entries: 8 bytes: user name 6 bytes: password 2 bytes: -- reserved --
track 3, sectors 11-80	-- reserved --
track 4	HiNet User Configuration Table Up to 128 128-byte entries 8 bytes: default A drive 8 bytes: default B drive 8 bytes: default C drive 8 bytes: default D drive 1 byte : default IOBYTE 1 byte : length of typeahead 31 bytes: typeahead buffer 63 bytes: -- reserved --
tracks 5,6	HiNet Master CP/M (track 5 and track 6, sectors 7D-80 for HiNet 1.437) (track 5 and track 6, sectors 69-80 for HiNet 2.437)

10. Streamer tape hardware

10.1 Overview

Digital Microsystems provides a choice of two backup options for its Winchester hard disks. A special utility program HARDBACK allows one to quickly backup hard disk partitions onto floppy diskettes. The primary disadvantage of HARDBACK is that a substantial number of diskettes are usually required to backup an entire hard disk. DMS provides a alternate solution to the backup problem - a streaming cartridge tape. A standard cartridge tape (quad density TC8450 or equivalent) is used to record data at 8000 bits per inch, 30 inches per second. The net data transfer between tape and disk is about 30K bytes per second; thus a 10 Mbyte disk can be backed up or restored in about 6 minutes. A special utility program CARTBACK is provided to transfer partitions between hard disk and cartridge tape.

The primary differences between using floppy diskettes and cartridges for backup are summarized in the following table.

			Requirements for 10M bytes Backup:			
Program Used	Media	Capacity	Diskettes/ Cartridges	Time	Convenience	Cost
PIP	floppy	500K	20	1-2 hrs	low	medium
HARDBACK	floppy	600K	16	12 mins	medium	medium
HARDBACK	floppy(ds)	1200K	8	12 mins	medium	medium
CARTBACK	cartridge	20M	1	6 mins	high	high

The cartridge tape drive and controller are produced by Archive Corp. The interface between the controller and the DSC-3/4 is produced by DMS. This interface uses one parallel port on a standard DSC-3/4. Since the tape drive is usually active only for a short period of time each day, an optional switch can be installed to disable the tape and allow some other device to use the parallel port. This is especially useful if a parallel printer is to be used, since the hard disk will use the other available parallel port.

The backup and restoration procedure used by CARTBACK is partition oriented. The contents of any partition on the hard disk can be backed up or restored either to its original partition or any other partition of the same size. The allocation table and bad sector table can also be stored on the tape. This allows one to restore an entire disk from scratch. The backup and restore functions can also be used to move partitions from one hard disk to another, thus allowing easy transportation of programs between DMS computers.

10.2 Hardware description

The Archive streaming tape drive is mounted in a DSC-3 cabinet with its own power supply or in a DSC-3/4 cabinet with an eight inch Winchester drive. A small PC board interfacing the tape drive to the ZSBC 3 or 4 parallel port is mounted on the rear of the tape drive frame below the tape controller PC board. Connector J2 on the interface board connects to J4 on the ZSBC-3 or 4 via a short 26 conductor cable with female header connectors if the tape is in the same cabinet as the CPU or via a 25 conductor female to female DB25 cable (4 feet maximum length) with short male DB25 to female header cables in each chassis if the tape drive has its own chassis.

The tape interface PC board requires a 2 MHz clock on J2 pin 25. The following modifications to the CPU board of the host are required:

ZSBC-3.1x*: Jumper U34 pin 13 to U13 pins 12 & 13
Jumper U13 pin 11 to J4 pin 25

ZSBC-4.1,4.1B: Cut traces on solder side of the CPU board leading to U35 pins 1 & 2.

Jumper U34 pin 13 to U35 pin 1
Jumper U35 pin 2 to J4 pin 25

ZSBC-4.1C: No modification required

*The modifications described for the ZSBC-4 should be used on the ZSBC-3.1B if the modifications for OASIS are also to be installed.

The tape interface can be disabled and the same parallel port used for another purpose (such as driving a parallel printer) by connecting the two pins of J4 on the tape interface PC board. These pins will normally be connected to a toggle switch mounted on the rear panel. When the pins of J4 are connected, connectors J5 and J1 on the tape interface PC board provide a buffered interface to the CPU's parallel port. J1 on the tape interface has the same pinout as J4 on the CPU. J5 on the tape interface has the pinout of the Centronics-type parallel printer interface except for pins 14 through 18 and 32 through 36 which are not connected. These pins may be left open in most cases except for pin 36 which must be grounded to enable some printers to operate. If a parallel printer interface is ordered J5 will be connected to a Centronics-type female connector (Amp 552931-1 or equivalent) mounted on the back panel and a switch will be installed to change the interface from tape to printer. When a parallel printer is used the two pins of JP 9 on the CPU board must be connected to enable the parallel port data outputs.

The tape interface accomplishes the multiplexing of command and status lines with bidirectional data lines by allowing the host to switch the interface to command/status mode using an IN 00 instruction. After one transfer (either an IN or an OUT) to port 02 the interface switches back to data mode. In command/status mode an IN 02 gives the host the status of the DIRC/, READY/, EXCEPTION/ and ONLINE/ lines from the tape drive controller in bits 0 through 3 respectively. An OUT 02 in command/status mode sets the control lines, RESET/, REQUEST/ and ONLINE/, on the tape drive controller connector from bits 0, 1 and 2 respectively. In addition, bit 3 must be output low to enable the interface to send the XFER/ handshake signal to the tape drive and STAT2B signal to the host CPU. Bit 4 must also be output low and then high (each time in command/status mode) before writing data to the tape controller to initialize the XFER/-ACK/ handshake logic. The direction of transfer on the data lines between the tape interface and controller is determined by the DIRC/ signal from the tape controller. DIRC/ low means data is being sent to the tape. DIRC/ also controls whether XFER/ or ACK/ is returned to the host as STAT2B.

10.3 The CARTBACK program

CARTBACK can perform the following functions:

1. Backup one or more partitions onto the tape.
2. Load one or more partitions from the tape.
3. Rewind, Retension, or Erase a tape.

Before CARTBACK can be run, the tape enable switch on the DSC-3/4 must be set to TAPE. This switch is located on the back of the cabinet. If the system does not have this switch, then the two pins on the tape interface board must not be shorted together. The pins should be shorted together if it is desired to use the parallel port for a device other than the tape drive.

Data Format on Tape

Each tape contains one or more "cartridge files". A cartridge file is NOT the same as a CP/M file. A cartridge file holds the contents of an entire hard disk partition. The first file on a tape is always the CARTBACK program. Thus, it is possible to boot from a cartridge when a system does not contain a floppy disk. However, a special PROM is needed for a cartridge boot (version 1.09C). The CARTBACK program also contains its own version of HARDHELP and DDT; these can be used when booting from a cartridge. The second file on a tape is always partition 0. This partition contains the basic system software.

Each partition on the tape is written as one cartridge file with a 1 block header, then data, and finally a file mark. The header contains the following information:

```
:       Date: XX/XX/XX (optional date of backup)                  :
:       Time: XX:XX    (optional time of backup)                  :
:       Name: XXXXXXXX (name of source partition or *ALLOC)       :
:       Type/Size: X   (size of partition (1-6) or A for alloc)   :
```

The header information is written as one ASCII string (with trailing zeroes) so that it can be printed easily. After the header, the actual data on the disk is written as a continuous string of blocks. The bad sector table which currently resides on the disk is used when backing up and restoring, thus it is not necessary to backup the replacement sectors separately. At the end of the entire tape, a file mark is written instead of a header.

Backup disk onto Tape

Run the CARTBACK program. It will tell you the size of the harddisk. Note that the controller firmware, the allocation table, and the bad sector table must be valid before CARTBACK can be used. CARTBACK will offer the following choices:

```
Hard disk to TAPE backup program
CARTBACK ver X.XX

     A = Back up all the disk partitions onto the TAPE
     B = Backup disk partitions (you select which ones)
     L = Load the Hard Disk from the TAPE

Enter choice:
```

Answer 'B' to backup single partitions, 'A' to backup all partitions, or 'L' to load a partition (see next section). CARTBACK will tell you to insert a tape, and ask you if you want to rewind, retension or erase the tape. Normally, one only needs to rewind the tape before writing to it, but if too many read/write errors occur on the tape one should retension or erase it. One cannot append files to the end of a tape once it is removed or rewound. CARTBACK will ask for the current date and time. This information is needed only for identification, and will appear on the header of each file on the tape. You are now ready to backup partitions on the tape.

CARTBACK will automatically write the CARTBACK program (*CART) and the system partition (*PART0) at the beginning of the tape. If the 'A' option was selected, the program will proceed to write the CARTBACK program, the system partition, and all other partitions in the allocation table to the tape cartridge. If the 'B' option was specified, CARTBACK will ask for the name of the partition to be copied to tape. Valid entries are:

name	backup the single partition 'name'
*END	write final file mark (i.e. mark end of tape)
*LIST	list out the hard disk allocation table

After your reply, CARTBACK will print the header for the partition and then write the partition onto the tape. If a single partition was copied, then CARTBACK will ask for the name of the next partition to be backed up. AN END-OF-TAPE MARK MUST BE WRITTEN AT THE END OF THE TAPE SO THAT THE TAPE CAN BE RE-READ WHEN RESTORING. When an end-of-tape is written, CARTBACK will automatically rewind the tape so that one can remove it without damaging the middle of the tape. To exit the program properly, enter a control-C only when the 'BACKUP or LOAD' (the initial question) is asked.

Restoring from tape to disk

Run the CARTBACK program, check for proper disk size, insert a tape, and rewind or retension it. DO NOT ERASE THE TAPE! At this point CARTBACK will ask you where you want to position the tape. There are 7 possible answers:

name	Position to next occurrence of named partition.
*ALL	Load rest of tape partitions onto the hard disk.
*END	Exit the load phase and rewind the tape.
*LIST	List the hard disk allocation table.
*PART0	Position to partition 0.
*REWIND	Rewind the tape and resume the load phase.
*NEXT	Position to next partition.

Note that the *CART file is automatically skipped. Note also that CARTBACK will not rewind itself to look for partitions. After CARTBACK finds the appropriate partition, the header for that partition is printed. CARTBACK will ask you if you want to load this particular partition onto the disk. Valid answers are:

Y	Yes, load this partition.
N	No, skip this partition.

If the 'Y' option is selected, CARTBACK will overlay the name disk partition with data from the tape partition.

When one loads *PART0 (the system partition), CARTBACK will ask whether the bad sector table and the allocation table on the disk should be overwritten with the tables on the tape. If no overwriting is specified, CARTBACK will first read the bad sector and allocation tables, then write all of partition 0 to disk, and finally write back the bad sector and allocation tables. Care should be taken when loading partition 0, since if CARTBACK terminates prematurely (fatal tape error or hard reset), the bad sector and allocation tables on the disk will be those on the tape, not the ones originally on the disk.

Continuation Tapes

Some disks may contain more data than will fit on one tape. If this is the case then CARTBACK will automatically ask that another tape be mounted. This new tape will have a size of '-'. Note that *CART and *PART0 will not be the first files on these continuation tapes. Writing or reading will continue from this point.

Internal Organization of the CARTBACK program

The CARTBACK program has four parts:

1. CARTBACK - Cartridge backup and restore program.
2. HARDHELP - Hard disk format and diagnostic program.
3. CARTMON - A small 1K monitor used to select which program should be executed.
4. DDT,BIOS - A simple operating system under which CARTBACK is always executed.

The BIOS only provides the features needed by CARTBACK, HARDHELP, and DDT. This BIOS is not used to run normal user programs. The normal operating system must be reloaded after CARTBACK is executed. The memory organization for CARTBACK is as follows:

```
    0h  -  0FFh    : reserved for CP/M
  100h  - 24FFh    : CARTBACK
 2500h  - 48FFh    : HARDHELP
 4900h  - 4CFFh    : CARTMON
 4D00h  - 4DFFh    : a copy of 0h-0FFh
 4E00h  - 79FFh    : a copy of DDT,BDOS,BIOS
 D400h  - FFFFh    : DDT,BDOS,BIOS
```

The file CARTBACK.COM can be created from scratch by following this procedure:

```
A>ddt
DDT 1.4
-mD400,FFFE,4E00     ; get a copy of DDT,BDOS,BIOS
-m0,FF,4D00          ; get a copy of 0h-0FFh
-a6B03
6B03  jmp 4900       ; jump to monitor on warm boot
-ihardhelp.com
-r2400               ; load HARDHELP
-icartmon.hex
-r                   ; load CARTMON
-icartback.hex
-r                   ; load CARTBACK
-^C
A>save 123 cartback.com
```

If a modification has been made to just the CARTBACK source file, then this shorter procedure should be followed:

```
A>ddt cartback.com       ;load in complete cartback program
DDT 1.4
-icartback.hex           ;overlay new hex code
-r
-^C
A>save 123 cartback.com  ; save as new cartback program.
```

10.4 Booting from a cartridge

If a floppy disk is available, one can run the CARTBACK program by booting a single user system from the floppy, and then typing "CARTBACK". If a floppy disk is included with the hard disk system, one can load CARTBACK by booting directly from the cartridge. This option is available only under PROM version 1.09C. Place the cartridge tape in the drive and enter the PROM Monitor (press and release the RESET switch while pressing the INT switch). Type "BC". The cartridge should rewind, and the CARTBACK program should be loaded from the cartridge into memory. The CARTBACK monitor should then print the following message:

```
:                    D - DDT debugger                          :
:                    H - HARDHELP program                      :
:                    T - Tape backup/restore program           :
:                                                              :
:          Enter choice:                                       :
```

The HARDHELP and DDT programs are included within CARTBACK so that one can conveniently format and test a hard disk system from a cartridge when a floppy is not available. To exit HARDHELP, DDT, or CARTBACK and re-enter the CARTBACK monitor, type control-C at any time. The monitor should redisplay the above menu, and a new choice may be made.

10.5 Care and handling of cartridge tapes

Very important: NEVER DROP THE TAPE!

Since the tapes are recorded at very high densities, one must be very careful when handling them. A tape that has been dropped or otherwise subjected to mechanical stress should be retensioned (twice is recommended) using the retensioning command, "T", provided in CARTBACK. However, the tape may be permanently damaged if dropped.

A new tape must be retensioned at least twice before use. Since new tapes may deposit relatively large amounts of material on the read-write heads and on the integral tape cleaning bar (immediately to the right of the head assembly), the heads and cleaning bar must be cleaned after this operation. See cleaning instructions below.

Always make sure that the tape is rewound before it is removed from the drive. This will protect the portions of the tape that actually contain data.

Each tape has a write-protect key on it so that once a tape is written it has some hard protection. To write-protect a tape turn the protect key to 'safe'. To write on a tape the protect key must point away from 'safe'.

Always store tapes in their case and away from any magnetic sources and heat. Care must be taken to protect the tapes from dust. Never allow any dirt or foreign objects to enter the tape cartridge case.

Cleaning instructions

Cleaning operations should be performed after every eight hours of tape operation or after a new tape has been retensioned twice prior to its first use. Turn the AC power switch off when cleaning the tape drive to prevent injury or damage. Tape wear or other conditions may dictate more frequent cleaning. The read-write head assembly and integral tape cleaning bar (a small vertical bar with a longitudinal groove immediately to the right of the head assembly) should be cleaned with a cotton swab and an approved head cleaning solution and then wiped dry with another swab. Swabs should be at least six inches long to easily reach the head and cleaning bar assembly.

Archive recommends that only the following tape cleaning solutions be used:

IBM tape head cleaner or QM 116 tape and head cleaner*

*available from:

Nortronics Company, Inc., Recorder Care Division
8101 Tenth Avenue North, Minneapolis, MN 55427
telephone: (612) 545-0401 telex: 290304