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1. INTRODUCTION

1.1. The Hardware

The "hard" disk is so called because the surface that data is stored on is rigid, unlike the flexible surface of a "floppy" disk. By keeping the recording surface rigid it is possible to place data tracks very close together, resulting in much larger storage capacity than is available on floppies. To achieve the highest data density it is necessary for the read/write heads to skate on a thin cushion of air just a few millionths of an inch from the surface of the disk. Under such conditions minute dust particles become boulders which could cause the heads to "crash" into the surface of the disk, destroying both head and data in the process.

To prevent such catastrophes hard disk drives are sealed in airtight enclosures to maintain a dust-free environment. This "bubble" is then encased in a more conventional metal case with the necessary power and interfacing electronics. All of which lead us to the first rule of hard drives; keep them clean. Although the actual drive is sealed, the power supply could overheat if too much dust builds up. Most drives have a cooling fan which blows over the power supply. Air is pulled in through a filter, which should be inspected often and cleaned whenever necessary.

The second, and most important, rule of hard drives is don't rock them! Shocks can cause head crashes just as dust and dirt can. Therefore it pays to be careful in selecting the place where the hard drive is to be installed. For example, placing the drive on a desk might be a good idea, unless the desk has a drawer that might get slammed and cause vibration of the drive. Keep shocks in mind while looking for a resting place for your hard drive.

1.2. The Software

Since not all users of CP/M will use a hard disk drive CP/M is shipped without the software necessary for hard disk access. The most important piece of software required is a specialized program called a "driver." A driver's job is to communicate to the hard disk the read and write requests issued by the CP/M Basic Input/Output System (BIOS). Each driver is tailored to match the characteristics of a particular hard disk drive, so you must choose the correct one for the drive that you have. This process will be explained in the INSTALLATION section.

Once the driver has been installed the hard disk drive may be used as one or more logical disk drives under CP/M, just like you use the floppy disk drives now. In some ways, though, the hard drive must be treated differently from floppies. Since most hard drives do not have removable media there is no need for CP/M to check the directory to see if the disk has been changed. That means that you cannot get the dreaded "R/O" (Read/Only) error on a hard disk drive.

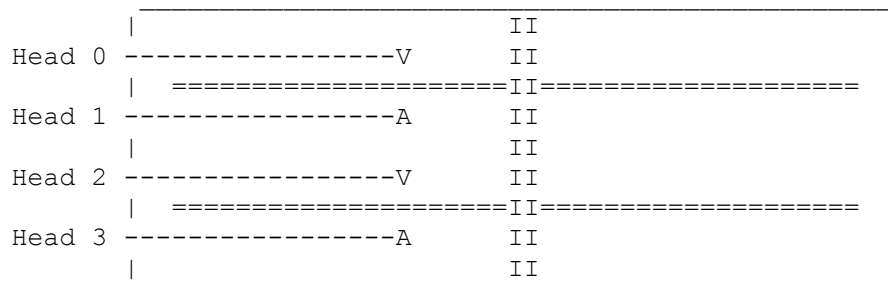
Another area of difference is in making backups. It will usually require multiple floppy diskettes to make a backup of a single hard drive, due to the much larger capacity of hard disk drives. To assist you in making backups of your hard drive we have included one or more public domain copy utilities on the Hard Disk Support diskette. Each of these programs will have an associated file with an extension of '.DOC' which describes the program and tells how to use it. This file may be viewed on your screen with the CP/M TYPE command, or printed out with the same PRINT utility that was used to print this manual.

To simplify the cumbersome backup task we offer a separate program called HARDBACK. This utility will backup a hard drive to a set of floppy diskettes all at once, rather than file by file. Even files which exceed the size of a single diskette can be backed up with ease. Both the backup and restore process operate as fast as the hardware will allow, minimizing the difficulty of doing backups on a regular basis. If you install the patches to CP/M provided with the CPMFIX utility (discussed in the INSTALLATION section) HARDBACK can also be used to make a backup of only those files which have been added or changed since the last prior backup, speeding the backup process even more. Finally HARDBACK can be used to restore a single file from the backup floppy set to any disk drive. You can have this fine utility for use on your hard drive for just \$49. To order call toll-free at (800) 527-0347. In Texas call (800) 442-1310.

2. THE INSIDE STORY

To obtain maximum benefit from your hard disk drive it is very helpful to have a clear understanding of how it is physically constructed. There are also some terms that you will need to know when installing the driver. Let's take a look inside the "bubble" of a typical hard disk drive:

Illustration 0



This particular drive has four heads, numbered from 0 to 3. Each head is positioned over or under one of the two platters on which data is stored. Information is read and written in concentric circles called "tracks", much like the grooves in a phonograph record. The number of tracks covered by each head varies from one drive to another and, along with the number of heads, determines what the capacity of a given drive will be. Notice that all heads are positioned over the same track on each surface. Since there is only one positioning mechanism within the hard drive all heads will always be positioned over the same track. The data available without repositioning the heads is called a "cylinder." In the above example one cylinder is composed of four tracks. The term "cylinder" is not generally used in the TRSDOS documentation, but is often used by other Radio Shack TRS-80 Model 4/4P operating systems.

This brings us to the first point of confusion in the use of hard disk drives. In the TRSDOS and LDOS operating systems the floppy drives are numbered starting from 0 and going up to 3. Hard drives, however, are numbered starting at 1 and go up to 4. Likewise the heads are numbered in these systems starting with 1. We have chosen to remain consistent and begin numbering drives and heads starting at 0. While this might create some confusion it will make entry of flawed track information much easier. Just remember, in CP/M everything starts counting from 0.

Unlike floppy disks hard disk drives are not certified to be error-free. Manufacturing the platters is so exacting that it is not economical to scrap those which exhibit flaws. Each drive manufacturer certifies that a drive will not have more than some set number of flaws (which varies from one manufacturer to another), and that certain tracks (usually boot tracks) will not be flawed. The drive manufacturer will also include a list of the flaws, typically attached to the drive. Flawed tracks will be listed by head (counting from 0) and track (also counting from 0). This information should be entered when the hard drive is

formatted. Our main reason for numbering everything from 0 was to simplify the entry of the flaw data provided with the drive.

While the information recorded on a hard disk is retained after the drive has been turned off, you should not be lulled into thinking it is there "forever." With prolonged use minute changes can occur in the magnetic surfaces of the platters. Flawed tracks can become good, and good tracks can become flawed. If it is necessary to repair the hard disk drive some or all of the information on it could be lost. Therefore backup of the hard disk should be considered of paramount importance! The easiest and best way to make backups is with the optional HARDBACK utility discussed in the INTRODUCTION section of this manual. This program also provides a function which allows a hard drive to be quickly checked for flaws, and which can "lock out" any flawed areas not currently in use.

All drivers made for Radio Shack drives automatically prevent use of track 1 on any head, since this track is traditionally used for diagnostic purposes. That means that track 1 may be erased if the hard disk drive is taken in for service. There is also a possibility that ALL data on the hard disk might be lost, if extensive repairs need to be made on the hard drive.

3. INSTALLATION

3.1. Getting Started

Your first order of business, after having read this far in the manual, should be to make a backup of your Montezuma Micro Hard Disk Support diskette. This disk is in Montezuma Standard SYSTEM disk format, although it does not contain a copy of the CP/M operating system. You may back it up easily using the DUP utility provided with CP/M. If you need information regarding the use of DUP please consult the manual that came with your copy of CP/M. After you have backed up your hard disk support diskette put it in a safe place and use the backup copy for installation.

***** IMPORTANT ***** IMPORTANT ***** IMPORTANT *****

The Montezuma Micro Hard Disk Support package is designed to work ONLY with Montezuma Micro CP/M 2.2, versions 2.20 and later. If you have an earlier version you MUST upgrade to use the hard disk.

***** IMPORTANT ***** IMPORTANT ***** IMPORTANT *****

Before you can install a hard disk driver you must select the driver that is designed for the particular hard disk drive that you will be using. We have included a file on your disk called DRIVER.LST, which is a list of the drivers included on the disk by manufacturer and model number. Use the CP/M TYPE command to list the file. (If you have a printer attached to your Model 4/4P you can get the listing on the printer by entering ^P before pushing ENTER after entering the TYPE command. Refer to the CP/M manual for more information.) When you find the entry for your hard disk drive in the list make note of the number of heads, the number of tracks per head, and the driver file name. This information will be used later. Should you be unable to determine which driver to use from the information in DRIVER.LST please consult the manufacturer of your hard disk drive for assistance on which driver to use. Don't call Montezuma Micro -- all of the drivers that we have are listed in the DRIVER.LST file. If you have something else you must contact the manufacturer, who must contact us about getting a driver written for it.

3.2. Hard Drive Organization

Using Montezuma Micro hard disk drivers you can have at most four hard disk drives in your CP/M system. However it is not necessary for each CP/M drive to correspond to a different physical hard disk. That means that one hard disk drive can be organized to appear as one to four logical disk drives to CP/M. (For an explanation of "logical disk drives" please refer to the DISK DRIVES and CP/M chapter in the CP/M manual.) You may also wish to divide a hard disk drive so that part of it is used by CP/M and part of it is used by TRSDOS or LDOS.

Montezuma Micro drivers partition each hard drive according to how many heads the drive has and how many logical drives it is to be divided into. Radio Shack's TRSDOS and LDOS hard disk drivers

also divide hard drives by the number of heads, so it is a fairly simple matter to partition a drive for use by both CP/M and TRSDOS/LDOS. The TRSDOS and LDOS drivers from other manufacturers may divide the hard drive by cylinders rather than by heads. Such drives will be identified in the DRIVER.LST file as using the SCSI interface. In such cases our driver will also map the drive by cylinder to maintain compatibility. This division, however, is usually made according to the number of heads that the drive has. The following tables show how the various types of hard drives are divided up for assignment to 1, 2, 3, or 4 logical drives. Whether the space is allocated by head or by cylinder the amount of space used will be the same.

Table 1 - Hard disk drives with 2 heads

Number of logical drives	1st drive heads & % used	2nd drive heads & % used	3rd drive heads & % used	4th drive heads & % used
1	0,1 - 100%			
2	0 - 50%	1 - 50%		
3	0 - 50%	*1 - 25%	*1 - 25%	
4	*0 - 25%	*0 - 25%	*1 - 25%	*1 - 25%

* indicates only half the tracks under this head are used, i.e. the head is "split" between two logical drives. Radio Shack's TRSDOS & LDOS drivers are unable to divide a head up into 2 drives.

Table 2 - Hard disk drives with 4 heads

Number of logical drives	1st drive heads & % used	2nd drive heads & % used	3rd drive heads & % used	4th drive heads & % used
1	0,1,2,3			- 100%
2	0,1 - 50%	2,3 - 50%		
3	0,1 - 50%	2 - 25%	3 - 25%	
4	0 - 25%	1 - 25%	2 - 25%	3 - 25%

Table 3 - Hard disk drives with 5 heads

Number of logical drives	1st drive heads & % used	2nd drive heads & % used	3rd drive heads & % used	4th drive heads & % used
1	0,1,2,3,4			- 100%
2	0,1,2 - 60%	3,4 - 40%		
3	0,1 - 40%	2,3 - 40%	4 - 20%	
4	0,1 - 40%	2 - 20%	3 - 20%	4 - 20%

Table 4 - Hard disk drives with 6 heads

Number of logical drives	1st drive heads & % used	2nd drive heads & % used	3rd drive heads & % used	4th drive heads & % used
1	0,1,2,3,4,5			- 100%
2	0,1,2 - 50%	3,4,5 - 50%		
3	0,1 - 33%	2,3 - 33%	4,5 - 33%	
4	0,1,2 - 50%	3 - 17%	4 - 17%	5 - 17%

Table 5 - Hard disk drives with 8 heads

Number of logical drives	1st drive heads & % used	2nd drive heads & % used	3rd drive heads & % used	4th drive heads & % used
1	0,1,2,3,4,5,6,7			- 100%
2	0,1,2,3 - 50%	4,5,6,7 - 50%		
3	0,1,2 - 38%	3,4,5 - 38%	6,7 - 25%	
4	0,1 - 25%	2,3 - 25%	4,5 - 25%	6,7 - 25%

To understand how these tables work it is helpful to look at a few examples. Suppose we have a 5 megabyte hard drive with two heads. Looking at Table 1 we can see that defining the drive as one logical drive would assign both heads and all 5 megabytes to the same logical drive. Making it two logical drives would assign the first drive to head 0 for 2.5 megabytes and the the second to head 1 for the remaining 2.5 megabytes. Things get a little strange if the drive is assigned to three logical drives. Although the first drive gets head 0 and 2.5 megabytes, the second and third each get half the tracks on head 1, and are 1.25 megabytes each. When four logical drives are used both heads are "split" and each drive gets 1.25 megabytes. Note that this head "splitting" occurs only on drives having two heads. When using such drives you should keep in mind that Radio Shack's TRSDOS and LDOS drivers require that heads be completely assigned, i.e. no splitting. Therefore only the two drive combination would work if the drive were to be partitioned between CP/M and TRSDOS/LDOS.

Using three drives on a 6 head, 15 megabyte hard drive would result in each drive getting two heads and 5 megabytes. Assigning four logical drives to the same hard disk would result in three heads and 7.5 megabytes on the first drive and 1 head with 2.5 megabytes on each of the remaining three.

If this same 6 head, 15 megabyte hard drive were mapped by cylinders the allocation would be similar. For illustration purposes let us suppose this drive has 306 cylinders. (This information can be obtained from the manufacturers documentation.) Setting it up as three logical drives would result in cylinders 0 through 101 going to the first drive, 102 through 203 to the second, and 204 to 305 to the third. Each

logical drive would then occupy 102 cylinders holding 5 megabytes.

If you need a driver configured for space allocation other than what is listed above we may be able to create a custom driver for you. Such drivers carry an additional cost, depending on how much they need to be modified. Call Montezuma Micro at (214) 339-5104 for more information.

One very important fact to keep in mind when partitioning your hard drive is that CP/M cannot deal with any disk drive that has a capacity of more than 8 megabytes. This is deeply ingrained into the basic architecture of CP/M and cannot be changed without also changing the overall structure of the DOS. If you make an assignment that would require a single logical drive to have more than the 8 megabyte limit you will simply lose the extra space. For example, assigning a 15 megabyte hard drive to one logical drive would result in having one 8 megabyte drive in the system and 7 megabytes wasted. Since you don't save anything by creating less than 4 logical hard drives it's better to partition so that all available space is used.

Before moving on a few more words need to be said about hard disk drive sizes. One megabyte should logically represent the product of 1 kilobyte times 1 kilobyte, or 1,024 times 1,024 for a total of 1,048,576. In actual practice this is not the case. A five megabyte drive, for instance, usually has 5,013,504 bytes which is 229,376 bytes short of 5 times 1,048,576. This disparity comes about due to rounding of drive sizes by the manufacturer and is the functional equivalent of "Batteries not included." If your newly formatted hard disk falls a bit short of your storage expectations please don't think we are "holding out" -- you'll get everything that's there to format!

3.3. Preparing the Boot Disk

To make the transition from a floppy-only CP/M to a combination floppy and hard drive CP/M you will need to prepare a "boot" disk. Model 4 and 4D users will need to use this disk each time this system is powered up. Model 4P users, however, may need it only once since the Model 4P is capable of booting directly from Radio Shack hard disk drives. Regardless of which kind of Model 4 you have, the process of creating the boot disk is the same.

Nothing in this world is free, and that holds true for hard disk drives. After coming up with the purchase price you will also have to sacrifice some RAM for the hard disk driver to operate in. Fortunately only 1k is required. Since the hard disk driver is an appendage to the CP/M BIOS we need to make space for it above the BIOS in RAM. In a 64k CP/M system the BIOS maps right up to the end of RAM, so we will need to make a CP/M system that is no larger than 63k. If you have configured a CP/M that is less than 64k, just substitute your normal size, less 1k, everywhere that 63 is used in the step by step instructions. Now get your backup copy of the CP/M distribution disk (you're not using the original are you?), a blank disk, and the backup copy that you

made of the Hard Disk Support disk. When you have collected these items proceed as follows:

1. Using the instructions that were supplied with it connect the hard disk drive to your Model 4/4P/4D if you have not already done so. Pay particular attention to the cables, since it is very easy to plug them in upside down. DO NOT turn on the hard disk drive at this time. When everything has been properly connected boot up CP/M from your backup copy of the distribution disk.

2. Put the blank disk in drive B: and use the DUP utility to format it in Montezuma Micro standard SYSTEM disk format. The number of tracks and/or sides is not important as long as they are compatible with the drive that will be used to boot the CP/M hard disk system.

3. Using PIP copy the utilities that you normally use to the newly formatted SYSTEM disk in drive B:. A suggested set is the following:

PIP.COM	SUBMIT.COM	XSUB.COM	STAT.COM
DUP.COM	KEYDEF.COM	DISK.FDF	CONFIG.COM

This is only a suggested list. You may want more or fewer of these programs.

4. Again using PIP copy the hard disk driver that you need (the name of which you got from the DRIVER.LST file on the Hard Drive Support disk) to the new SYSTEM disk. This file will have the name HDxxxxx.COM, where the "xxxxx" is different for each drive manufacturer and drive size. You should also copy the following utility programs to the new disk:

CPMFIX.COM

5. Use MOVCPM to create a 63k CP/M system. The command is:

MOVCPM 63 * <ENTER>

Following this use SYSGEN to place the 63k system on the new SYSTEM disk. At the prompt for SOURCE disk just push ENTER. When prompted for DESTINATION enter 'B' which is where the new SYSTEM disk is.

6. Remove the new SYSTEM disk from drive B: and place it in the drive used to boot CP/M (normally A:). Push the RESET button to perform a boot of the new system. Verify from the CP/M banner on the screen that you have a 63k system. If it does not say 63k go back to step 5.

7. Using the CONFIG utility set all of your configuration options the way that you want them. Then use KEYDEF to set up your standard key definitions. If you run KEYDEF without parameters it will set up the Montezuma Micro standard definitions. When done save the newly configured system to drive A:.

3.4. Activating the Hard Disk Driver

You should now turn on the hard disk drive. Most drives have a "ready" indicator of some type, usually a green light. Wait until this indicator is lit. At this point you are ready to activate the hard disk driver. This is accomplished by entering the driver file name (from the DRIVER.LST file) followed by a few parameters. ("Parameters" is an overworked computer term that essentially means "fill in the blank" information.) The parameters which may be used are as follows:

H#=????

This parameter is used to tell CP/M which drives are to reside on which hard disk. The '#' part of this parameter is needed only if you have more than one physical hard disk drive. Replace the '#' by the drive number (0 to 3) or leave it out altogether if you have only a single hard drive. The question marks are to be replaced by the letters A through P (for assignment of drives A: through P:), or by '*' which indicates space to be reserved for non-CP/M drives. No more than 4 drives total may be defined or reserved. Proper use of the 'H=' parameter is shown in the following examples:

H=ABCD	Drives A, B, C, & D go to Hard Drive 0.
H1=AB H0=CD	Drives A & B go to Hard Drive 1, C & D go to Hard Drive 0.
H=AB*	Put drives A & B on the first two parts of Hard Drive 0. The last part is reserved.
H=AB	Drives A & B are on Hard Drive 0.
H=A*B*	Drives A & B are on 1st & 3rd parts of Hard Drive 0. 2nd & 4th parts reserved.

To see how the space on a hard drive is divided up refer back to Tables 1 through 5. Note that at least one hard drive must be defined, and that no logical drive ('A' through 'P') may be assigned to more than 1 hard drive. You may not assign drive M: to a hard drive since this drive is used for the memory disk drive on systems with the 128k memory option. Note that drives may be specified in any order after the 'H=', i.e. 'H=DCBA' is just as valid as 'H=ABCD'. Space is assigned, however, according to Tables 1 through 5 and the order that drives are defined in.

When assigning space on a hard drive with only two heads pay special attention to those entries in Table 1 that are marked with a '*'. These entries identify a head that is "split", i.e. regarded by CP/M as two different drives. Radio Shack's TRSDOS and LDOS drivers can assign space only in whole head multiples. Therefore some care must be taken when partitioning a two-headed drive. For example, 'H=AB*' would not work since head 1 would be split between CP/M and TRSDOS/LDOS. You could use 'H=AB**', since this would split head 0 for drives A: and B:, while reserving all of head 1. In any case the hard disk driver software will not detect illegal assignments. That is your responsibility.

F=????

The 'F=' parameter must appear once and only once on the hard disk driver command line. It defines the logical drives that are to be used for floppy disks. These assignments will define the drives which were defined as A:, B:, C:, and D: when the driver was activated. It is not necessary to define all four floppy drives, but any drives not defined in this parameter will not be accessible to the system once the hard disk driver is active.

F=ABCD	Keeps floppy assignments the same.
F=EFGH	Floppies are E:, F:, G:, & H:.
F=A	Only drive A: is floppy.

Keep in mind that drive A: MUST be defined either as a floppy or as a hard disk. Any drive that appears on an 'F=' parameter may not also appear on an 'H=' parameter and vice-versa. No more than 4 floppy drives may be defined. Even if you don't need all four of the floppy drives you should assign them since there is no savings of space to be gained by leaving drives unassigned.

INIT

The 'INIT' parameter is optional and will probably be used very seldom. On hard disk drives using the SCSI interface this parameter has two forms, which are discussed later. Such drives are identified in the DRIVER.LST file. The purpose of the INIT parameter is to request that all defined hard disk drives be formatted. The formatting process completely initializes the drive and destroys any data that may be on it. You will be asked to confirm the format request, so that drives cannot be formatted by accident. Drive space which is reserved but not used by CP/M ('*' in 'H=' parameter) will NOT be formatted. This characteristic can be used if you find it necessary to format one drive without disturbing the others. Suppose you normally have your hard disk partitioned as three drives, A:, B:, and C:. If you want to format drive B: ONLY you could load the driver using the following:

```
HDxxxxxx H=*B* F=ACDE INIT
```

This would allow drive B: to be formatted. Then you would reset and load the driver again, this time using:

```
HDxxxxxx H=ABC F=DEFG
```

If your hard disk drive uses the SCSI interface (identified in the DRIVER.LST file) the INIT parameter has two forms. When specified as 'INIT' the logical drives will be formatted using a "soft" format procedure which is identical in function to the type of format that was previously discussed. This "soft" format, however, is not a true format in that it only writes a preset data pattern to the specified drives. None of the control or timing information traditionally associated with a format is written, and the drive must, in fact, have been fully formatted in the traditional way prior to using the INIT option.

To do a full format of a drive using the SCSI interface the parameter must be specified as 'INITF'. USE EXTREME CAUTION when doing this, however, since the entire physical drive will be formatted and all data on it will be lost. This includes any areas reserved for use by other operating systems. If you have just installed your hard disk drive you will need to use the INITF parameter at least once before it will be usable.

Examples

Now that all the parameters have been identified it's time to look at some complete examples. Background information will be provided for each example so that you can see where the parameter values came from.

Example 1

Hard Drive 0 is a Radio Shack 5 Megabyte drive (Cat. #26-1130). The computer is a Model 4P with two floppies. We want to use LDOS on head 3 of the hard disk drive, and we want 3 CP/M hard drives.

HDRS5M H=ABC* F=DEFG INIT (See Illustration 1)

We got the name 'HDRS5M' from the DRIVER.LST file on the Montezuma Micro Hard Drive Support disk. Since this drive has 4 heads we used the information in Table 2 to determine head usage. In this case head 0 will go to drive A:, head 1 to drive B:, head 2 to drive C:, and head 3 is reserved. Floppy disk drives will be accessed as D:, E:, F:, and G:. Since 'INIT' was specified drives A:, B:, and C: will be formatted, but the LDOS drive on head 3 will not be touched. Since the computer is a Model 4P and drive A: is the first hard drive this configuration will be bootable directly from the hard disk. Refer to Illustration 1 below to see how this drive is set up.

Illustration 1

		II	
Head 0	-----V	II	CP/M A: 1.25Mb
		II	
Head 1	-----A	II	CP/M B: 1.25Mb
		II	
Head 2	-----V	II	CP/M C: 1.25Mb
		II	
Head 3	-----A	II	LDOS 1.25Mb
		II	

Example 2

A Radio Shack 15 Megabyte drive (Cat. #26-4155) is the hard disk drive. The first three heads are to be reserved for TRSDOS and the last three are available for CP/M.

HDRS15M H=*A F=BCDE

(See Illustration 2A)

or

HDRS15M H=*ABC F=DEFG

(See Illustration 2B)

Two possible configurations are available to give us the first 3 heads for TRSDOS. Referring to Table 3 you can see that the first 3 heads are assigned to the first drive when there are either two or four hard drives. In the first form drive A: would have a capacity of 7.5 megabytes, while the second would give drives A:, B:, and C: 2.5 megabytes each. Since INIT was not specified none of the hard drives will be formatted. Illustrations of the two possible configurations are shown below. Note that the hard drive cannot be used to boot CP/M if the computer is a 4P, since drive A: is not the first logical drive on Hard Drive 0.

Illustration 2A

Head 0	-----V	II	TRSDOS	2.5Mb	<---+ 7
Head 1	-----A	II	TRSDOS	2.5Mb	<---+ 5
Head 2	-----V	II	TRSDOS	2.5Mb	<---+ b
Head 3	-----A	II	CP/M A:	2.5Mb	<---+ 7
Head 4	-----V	II	CP/M A:	2.5Mb	<---+ 5
Head 5	-----A	II	CP/M A:	2.5Mb	<---+ b

Illustration 2B

Head 0	-----V	II	TRSDOS	2.5Mb	<---+ 7
Head 1	-----A	II	TRSDOS	2.5Mb	<---+ 5
Head 2	-----V	II	TRSDOS	2.5Mb	<---+ b
Head 3	-----A	II	CP/M A:	2.5Mb	
Head 4	-----V	II	CP/M B:	2.5Mb	
Head 5	-----A	II	CP/M C:	2.5Mb	

Example 3

Having just gotten a Brother-in-law deal on hard disk drives we find ourselves the proud owners of three 10 megabyte Zippy Hard Drives. Each drive has 4 heads. We want to divide the available space equally between CP/M and LDOS. Looking in the DRIVER.LST file we notice that these drives use the SCSI interface and are mapped by cylinder rather than by head.

HDZIP10 H0=A* H1=B* H2=C* F=GHIJ INITF (See Illustration 3)

Notice the Hard Drive numbers after each 'H'. If these numbers were omitted all drives would be assumed to be on drive 0. Each CP/M drive will receive the first half of the cylinders on its associated hard drive (from Table 2), and the last half of the cylinders will be reserved for LDOS. Notice that drives D:, E:, and F: are undefined. This is perfectly legal, if not terribly logical. All CP/M drives will be formatted and, due to the INITF parameter, so will the space reserved for LDOS.

Illustration 3

Hard Drive 0

Head 0	-----V	CP/M	II	LDOS
	=====II=====			
Head 1	-----A	Drive A:	II	Drive 0
	II			
Head 2	-----V	5 Mb on	II	5 Mb on
	=====II=====			
Head 3	-----A	1/2 cyls.	II	1/2 cylinders
	II			

Hard Drive 1

Head 0	-----V	CP/M	II	LDOS
	=====II=====			
Head 1	-----A	Drive B:	II	Drive 1
	II			
Head 2	-----V	5 Mb on	II	5 Mb on
	=====II=====			
Head 3	-----A	1/2 cyls.	II	1/2 cylinders
	II			

Hard Drive 2

Head 0	-----V	CP/M	II	LDOS
Head 1	-----A	Drive C:	II	Drive 2
Head 2	-----V	5 Mb on	II	5 Mb on
Head 3	-----A	1/2 cyls.	II	1/2 cylinders

3.5. Formatting Hard Disk Drives

As previously mentioned the INIT (or INITF) parameter causes hard drives to be formatted. In this section we will elaborate on that process.

After displaying a banner announcing the format the hard disk driver will ask for you to confirm by typing 'Y'. Any other response will cause an immediate exit back to the CP/M configuration as booted from floppies. The driver will NOT be initialized and the hard drive will NOT be changed in any way. This check was built in for your protection. Once a format has started there is no way to stop it other than a system reset, so be very sure what you are doing before you push the 'Y' key.

After you have confirmed that you do indeed wish to format the hard disk the driver will prompt for the addresses of known flaws on the hard disk drive. These entries are made one line at a time, with each line containing the drive number (0-3), the head number (0-7), and the track number, all separated by commas. No validation is performed, other than to make sure the drive and head numbers are within the maximum allowable range. Note that these entries are taken from the flaw list provided with your hard disk drive, and the values entered will be the same as they are written, with the possible exception of sector information which we do not use. The drive number will normally be 0 unless you have more than 1 hard disk drive.

Examples of Flawed Track Entries

0,3,35	Hard drive 0, head 3, track 35
0,5,176	Hard drive 0, head 5, track 176
1,0,4	Hard drive 1, head 0, track 4

Following entry of the known flaws the drive will be formatted. A display of the current drive and track will be shown. Once the drive is formatted it will be verified. During this phase any bad tracks (either entered by you or detected through verify) will be mapped into a file call BADTRACK.TBL. This file will be set up with the SYS attribute (making it invisible), Read Only, in USER area 15. This will make it very difficult to delete accidentally, which would allow bad tracks to be used for data storage. This file will normally be present on any Radio Shack drive which uses more than 1 head, since track 1, on every head but the first one, is always locked out for diagnostic purposes.

When the verification has completed a check is made to see if any errors were found in tracks that could not be locked out from use. If so a message is made to that effect, and you are using the hard drive at your own risk. The only areas affected in this way are those allocated to the CP/M disk directory. A drive with errors in the directory area still might be usable, but could be a time bomb that could lose files. If this happens change your drive allocation around and use another area of the hard drive for CP/M. The only other alternative would be to change the "bubble" inside the hard drive which would be a very expensive proposition.

3.6. Initialization of Drive A:

The last phase of driver installation involves the setting up of drive A:, the CP/M system drive. If drive A: is a floppy then no action is necessary. For maximum efficiency, though, most users will want drive A: to be on a hard disk. There are no special instructions necessary to do this, other than to specify 'A' as one of the drives in the 'H=' parameter.

When the hard disk driver determines that drive A: will be on a hard disk it copies the CP/M operating system from RAM to the reserved tracks of hard disk A:. A boot program is also placed there, although it can be used only by a Model 4P, and only if drive A: is the first drive defined on Hard Drive 0. (Unless the hard disk drive is made by Radio Shack it still will not boot, since it will not be compatible with the code in the Model 4P boot ROM.) If the driver was invoked by a SUBMIT file (see the discussion which follow) then the \$\$\$\$.SUB file is copied from the original (floppy) drive A: to the new (hard) drive A:. This procedure makes it possible to construct a floppy boot disk that uses a SUB file to invoke the hard disk driver and start an application without any operator intervention.

4. UTILITIES

4.1. Creating a SUBMIT file - the BUILD utility

The SUBMIT program is one of the more useful of the CP/M utilities. Its function is to cause CP/M to temporarily take its commands from a disk file. This makes it possible to prepare a "script" of commonly-used commands which may be invoked by a single command line. Normally a SUBMIT file is built using a text editor. If you have a word processor such as WordStar you can easily use it (in the Non-document mode) to prepare the file. Should you have only ED.COM, the somewhat lame editor that is provided free with CP/M, you may wish to use something else.

Toward that end we have included a simple utility on your disk called BUILD.COM. This utility allows you to build .SUB files easily. To use it just type:

```
BUILD filename <ENTER>
```

The filename may be any legal CP/M file name. If no extension is provided then .SUB will be assumed. BUILD will prompt you to type in command lines one at a time. You may use the backspace and CLEAR keys as needed to edit each line. Once you push ENTER, though, the line is included in the disk file and it cannot be changed. When all command lines have been entered just push ENTER by itself to indicate the end of the file.

Here is an example of using BUILD to create a hard disk boot file for a 5 megabyte Radio Shack hard disk:

```
BUILD HDBOOT <ENTER>
EXBIOS <ENTER>
CPMFIK <ENTER>
HDRS5M H=ABCD F=EFGH <ENTER>
<ENTER>
```

After building the file above, or a similar one using your own hard disk driver name, you would run CONFIG. There you would choose item 'H' to save the configuration to disk. When asked for a command to be run when CP/M is booted you would enter:

```
SUBMIT HDBOOT <ENTER>
```

CP/M would then proceed to save the system to your boot disk. From then on when you push the RESET button with the boot disk in drive 0 it would load CP/M and SUBMIT the HDBOOT.SUB file for processing. This file would load EXBIOS, add the CPMFIK patches, and finally install your hard disk driver. You could, of course, add other commands after that to perform functions of your own.

4.2. Parking the head - HDPARK utility

On your Hard Disk Support diskette you will find a file called HDPARK.COM. The purpose of this utility is to allow you to "park" the heads of your hard disk drive prior to powering

down your system. One reason for doing this is to minimize the risk of damage to an area of the hard disk due to electrical transients generated by powering down the system. Another might be to position the head over an "unimportant" spot prior to moving the hard drive to another location.

When HDPARK is run it parks the heads of each hard disk drive in the system on the cylinder designated in the HDPARK command. If no cylinder is specified HDPARK will use the last cylinder on the drive. As each drive's heads are parked a message will be displayed in confirmation. If a hard drive is partitioned into multiple logical drives this message will reflect only the FIRST logical drive. After all heads are parked you will be advised to either power down, or to push BREAK (^C). The BREAK option is included in case you change your mind, and if you choose it you can no longer depend on the heads being parked as you directed.

HDPARK may be run in two ways. The first is like this:

```
HDPARK <ENTER>
```

This form will park the heads on the LAST cylinder of the hard drive. By using this form you can specify the cylinder:

```
HDPARK cylinder <ENTER>
```

For example:

```
HDPARK 1 <ENTER>           parks the heads on cylinder 1
HDPARK 104 <ENTER>        parks the heads on cylinder 104
HDPARK 0 <ENTER>          parks the heads on cylinder 0
```

If an invalid choice is made for cylinder number the last one on the drive will be used.

The drivers for Radio Shack hard disk drives all reserve cylinder 1 for diagnostic purposes. CP/M will never use this cylinder, except for storage of the operating system on drive A:. In that case it is formatted prior to use. Therefore cylinder 1 might be a good choice as a "parking place" for the drive heads.

It is important to note that HDPARK is not an infallible guarantee of where the heads of the hard drive will wind up. Some hard disk drives have internal circuits which park the heads automatically when power is removed from the drive. We cannot tell you which drives do this, so please do not call for that information.

5. Error Messages

Most of the time the hard disk driver goes about its job with no displays. Occasionally, however, you might get one of the following error messages. Each message is followed by a brief explanation and suggestions for avoiding it.

Insufficient memory for Hard Disk Driver!

There is less than 1k of RAM between the end of the BIOS and the 64k top of memory address. You are probably trying to load the driver in a 64k CP/M system. The maximum allowable size is 63k. Use MOVCPM to construct a 63k system, or a system 1k smaller than the size you normally use.

Hard Disk Driver already initialized!

You are trying to load the hard disk driver when it has already been loaded. If you want to change the hard drive assignments you will have to reboot CP/M from a floppy disk first. To stop CP/M from automatically loading the driver in a SUBMIT command hold down the CTRL and CLEAR keys until you get the 'A>' prompt. This key sequence generates the DEL character, which CP/M checks for whenever it is "between programs" in the execution of a SUB file. If CP/M gets a DEL character from the keyboard it will stop the SUB process immediately. On the Model 4P the system will always boot from a Radio Shack hard drive if it is initialized, powered up, and ready. To override this and boot from a floppy you must push the F2 key after pushing RESET.

Illegal drive assignment!

You have tried to assign the same logical drive to more than one physical drive, or you have tried to assign drive M: on a system with 128k. Check your parameters and try again.

Parameter missing or in error!

Either the 'H=' or 'F=' parameters were missing or in error, or you have something else on the command line that the driver cannot recognize. Correct your parameters and try again.

Drive A: has not been defined!

Oops! You forgot to include 'A' on an 'H=' or 'F=' parameter. CP/M insists on having a drive A:, so the driver won't initialize without it. Fix up your parameters and have another go at it.

The hard disk drive is not ready!

All your parameters checked out, but nobody seems to be home at the Hard Drive. Is it plugged in? Turned on? Correctly cabled to the Model 4/4P/4D? Ready light on? Did you specify the correct unit number in your 'H' parameter? Turn everything off, take a deep breath, count to ten, and go over everything step by step. The problem may be nothing more serious than a cable plugged in upside down (yes, it does matter!).

The hard disk drive is write-protected -- INIT aborted!

This message speaks for itself. You cannot INIT a hard disk if it is write protected. Turn off write protect and try again.

Error during disk format -- INIT aborted!
This could be a malfunction of the hard disk drive, but you should also check your cabling very carefully to be sure everything is correct. If you can't get by this message then take your hard disk in for a checkup.

Unable to initialize system areas of hard disk drive A:--

Returning to original configuration.

You requested that drive A: be configured as a hard drive, but the driver was unable to write the CP/M operating system on it. Since CP/M cannot run without the system on drive A: the driver returns to the floppy-based system without installing itself. Try putting drive A: in a different part of the hard disk drive. If you can't resolve the problem take the hard drive in for service.

Unrecoverable error on drive x: or

Disk error on x: C

This error is not issued by the disk driver software, but by the CP/M BIOS. If the drive specified in the message is defined as a hard disk then the last attempt to read or write to that drive was unsuccessful. Typing anything but ^C will cause the operation to be retried. However, due to the extensive error handling logic present in most hard disk controllers, most errors that are serious enough to warrant this message will be persistent. That's what the "Unrecoverable" in the message means.

6. CP/M EXTRAS

6.1. Removing the Warts

While implementing the hard disk under CP/M 2.2 we discovered a few blemishes that made operation much more difficult. Fortunately these were relatively easy to correct with some patches to the Console Command Processor (CCP) and the Basic Disk Operating System (BDOS). Although we strongly recommend that you install these patches, they are a departure from "pure" CP/M and there may be some who do not wish to use them. Therefore we have packaged them in an installation program called CPMFIX.COM. In this way you are free to use them, or not, as you see fit.

In the following subsections we will discuss each of the problems and how we have attempted to fix (or at least deal with) it. This is not to imply that you can choose which patches to apply. You cannot. It is an all or nothing deal. Furthermore the patches are made only to the copies of the CCP and BDOS that are currently in RAM when CPMFIX is run. Since the hard disk driver programs all copy the CCP, BDOS, and BIOS from memory to the hard disk (when drive A: is a hard disk) these patches will be propagated to hard drive A: if CPMFIX is run IMMEDIATELY prior to activating the hard disk driver. Unless you are using a Model 4P and a can boot from the hard disk, this procedure is best automated using a SUBMIT file. An example of such a file:

```
CPMFIX
HDxxxxxx H=ABC F=DEFG
YOURSTUFF
```

In this example the 'xxxxxx' would be replaced by the name of your hard disk driver (from the DRIVER.LST file). 'YOURSTUFF' is, well, whatever "stuff" you want to run after setting up shop on the hard disk. Please note, however, that the patches will be in effect ONLY if drive A: is a hard disk. There is no way to permanently install these patches on a floppy disk. Already some of the "die-hard" floppy addicts are screaming from the balcony -- just try it and you'll see. Putting drive A: on the hard disk makes CP/M easier, faster, and better!

6.2. Making the USER Concept Work

With the large capacities of hard disk drives it is very easy to fill directories to the point where they no longer fit on one screen. Trying to find a specific file becomes a troublesome task since there are so many others cluttering up the screen. Very soon it becomes obvious that you need some way to categorize what you have into smaller, more workable collections of files.

The CP/M USER command was created for this purpose. (Read the manuals that came with your copy of CP/M for a full discussion of the USER concept.) By setting the USER number to a value you limit the files that you can access to only those created under that same USER number. At first glance this seems like a pretty

good idea. Use it for a little while, though, and the warts begin to sprout.

The first problem is determining just which USER number you are in, since CP/M does not choose to display this information. Panic sets in quickly when you accidentally change USER numbers, do a DIR and get "NO FILES." All of a sudden it's not fun anymore.

Another rodent in the proverbial kindling supply arises from the inability to access files under any other USER area except through an option in PIP. (How do you get PIP into another USER area? Read the gory details in your big CP/M book!) Every USER area suddenly needs its own copies of all the standard utilities, as well as application programs, etc. All of a sudden the vast space of our hard disk is being gobbled up by the horde of clones of all our favorite software. This is progress?

About twenty minutes after we finished developing the first hard disk driver we decided that the USER concept as implemented in CP/M was worthless. That was when we wrote the first patch in the CPMFIX set. This one modifies the CCP to make two small changes in the way USER is handled. First the USER number is displayed immediately after the drive number in the '>' prompt. USER 3 on drive B:, for example, is prompted as 'B3>' instead of 'B>'. This solves the problem of knowing what USER area you are in.

Secondly we changed how CP/M locates files. Whenever the BDOS is requested to open a file it checks the current USER area first. If the file is found it is opened and processed just as it normally would be. The difference comes in what happens if the file is NOT found in the current USER area. Instead of returning an error to the calling program the patched BDOS searches USER area 0 for the file. If found it is opened and processed. Thus when the CCP searches for a program it will find it if it is in either the current USER area OR USER 0. Otherwise the familiar 'Huh?' response is given.

The second patch means that any file in USER 0 is available no matter what USER number is currently active. Please note that this patch is effective for files whose name is specified completely and WILL NOT have any effect at all on wild card (* or ?) file names. Note also that you will not be able to use DIR to see programs in a different USER area from the one you are in. Even though you can always run programs from USER 0, you won't be able to see them in a DIR display unless you are actually in USER 0.

6.3. Sour Cream and Archives

File names in CP/M are composed of ASCII characters, which use only 7 bits. That means that the eight character file name and the three character file type of each CP/M file each have one bit left over not doing anything. CP/M has designated these bits as "attributes", which is a complicated way of saying that they serve as 11 ON/OFF (YES/NO) switches for each file. Some of these attributes are reserved for future use, while others are

functional now. For example, if bit 7 of the first byte of the file type is set to 1 then the file is marked as Read Only and can not be written to or erased.

Referring to our mammoth "sees all, knows all" volume of CP/M lore we learned that the most significant bit of the third byte of the file type is the "archive" attribute, and that it is set to 0 whenever the allocation of the file is changed in any way. We liked this, and built our entire backup system around it. Then Mr. Murphy got to us, and we discovered that the CP/M "Good Book" was in error. The archive attribute is available in MP/M, but NOT in CP/M 2.2.

We thought the idea was so good that it ought to be implemented. One of the patches in CPMFIX changes the BDOS to honor the archive attribute. With this patch whenever a file is closed, after having been written to, the archive bit is reset to 0. This takes care of new files, and updates to old files.

There are, however, some sneaky programs (like PIP) which copy to a scratch file and rename it when they are finished. This rename "clones" the attribute bit from the old file to the new file, possibly masking the fact that it is a new file. The patch changes the rename process so that the new file name always has the same archive status as the renamed file.

If you plan to use our HARDBACK hard disk backup utility we strongly recommend that you install CPMFIX just for this archive bit patch. By using the archive bit to backup only files which have changed since the last backup you can save a great deal of time.

6.4. CONFIG and CPMFIX

As mentioned earlier, if CPMFIX is run just before activating a hard disk drive A: then the patch will be stored permanently in the system area of drive A: and will be available until the next boot from a floppy disk. This is also true if CONFIG is used to save the configuration to a hard disk drive A:. However the CPMFIX patches will be removed when the configuration is saved on a floppy since there is not sufficient space for them in the system tracks.

7. QUESTIONS AND ANSWERS

We have tried to include in this manual everything that you need to know to use a hard disk drive under Montezuma Micro CP/M 2.2. No matter how much we put in, though, there always seems to be one last thing that doesn't make it. In this section we offer the questions that have come up, along with the answers to them.

I just used PIP to copy a 2k file from a floppy disk to my hard disk drive. The hard disk version takes 4k. Why did the file double in size just moving it from floppy to hard disk?

Disk space in CP/M is assigned to files in "allocation blocks." An allocation block is a "chunk" of disk space which may vary from 1k to 16k in size. Determining the optimum size of an allocation block requires the same kind of educated guesswork as weather prediction and other non-exact sciences. There is no correct answer and everything involves trade-offs. If the block size is too big then there will be few of them on the disk and it will fill quickly. But if the block size is too small files will be fragmented into small pieces all over the disk.

In determining the proper allocation block size for a hard disk drive we had one additional consideration. To keep the overall RAM used by the driver at 1k we had to make sure that no one drive had more than 1,024 allocation blocks. Therefore hard drive block sizes will range from 2k to 16k, with larger block sizes going to larger drives.

When you are copying small files to the hard drive it is inevitable that some space will be wasted. This is one of the prices that one must pay for the large amount of storage on a hard disk drive. Generally this is not a problem unless you have a large number of small files. In such cases you should divide your hard disk drive into as many logical drives as possible, so as to force each drive to have less space and therefore use a smaller allocation block size.

I have a (name brand) hard disk attached to my Model 4P. It works great when I boot from a floppy, and I have no problems setting up drive A: as a hard drive. My problem comes when I try to boot from the hard disk. No matter what I do the 4P won't boot the hard drive. Why not?

Hard disk drives are available from a number of sources for the Model 4/4P. Many of them use totally different methods for access than the ones designed by Radio Shack for the 4/4P. While these drives are perfectly acceptable when used with one of our driver programs, they may be incompatible with the software in the Model 4P ROM, and thus will not boot up on a 4P. The only drives which can absolutely be counted on to boot on the 4P are those made by Radio Shack. Others may, or may not, depending on how they are addressed by the computer.

Whenever I use HARDBACK to make an archival backup it seems to skip some of the files that I know have changed. Is something wrong with HARDBACK?

No, the problem is not with HARDBACK, but rather with CP/M not clearing the archive bit when a file is changed. You didn't install our patches for this by running CPMFIX prior to activating the hard disk driver. If you chose not to use the patches, well you'll just have to live with the problem.

When I bought my hard drive from the Zippy company they assured me that you had a CP/M driver for it. The DRIVER.LST file doesn't have any entry for the controller that is in my drive. Do I need an updated driver or what?

Hard drive manufacturing companies may change the boards that they use from time to time. Often this is done without regard to the fact that we don't have a driver for the new board. Since we don't know when they have changed, let alone to what board, we are unable to provide the correct driver. If you find yourself in this unfortunate fix you must contact the hard drive manufacturer for assistance. If we had the driver that you need it would have been on your disk and in the DRIVER.LST file.

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