

STUDY MATERIALS ON HARDWARE INSTALLATION AND MAINTENANCE

(As per the curriculum of fifth semester BSc
Electronics of M. G. University)

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MODULE III HARD DISK DRIVE INSTALLATION AND UPGRADING

Introduction:

Hard Disk Drive is used as a secondary memory for storing data or programs permanently. They are organized in the form of metal platters stacked one on top of another. Each side of each platter is divided into concentric tracks. Each track is further subdivided into sectors; HDD divide each track into 17/26/43/52/63 or more sectors. Both HDD and FDD stores 512 bytes on a sector. The number of tracks, surfaces and sectors per track vary between different models and manufactures. 64 sectors are collectively called as one cluster. The collection of a number of tracks on all surfaces is called a cylinder.

Types of recording: **Zone Bit Recording / Write Pre-compensation Technique.**

HARD DISK DRIVE INSTALLATION

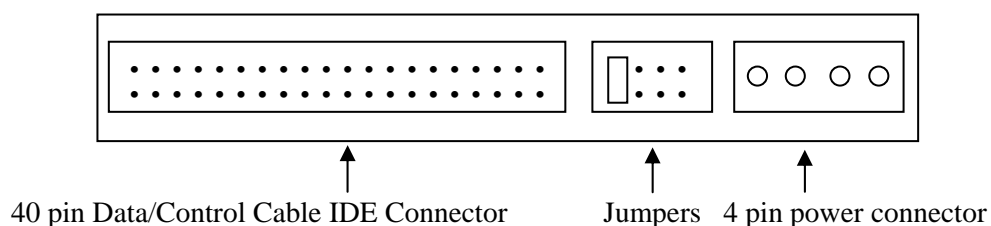


Fig: Back side view of a typical IDE HDD

The main steps involved in the installation of a hard disk are

1. Collect all the parts required for installing the drive like Drive with controller, Data Cable, jumpers, screws & screw driver.
2. Turn off the power and remove the power cable from the socket. Remove the system unit cover
3. Check the master/slave jumper settings on the drive. Layout of jumper settings and HDD parameters are given on the HDD itself (Study the layout from the lab manual)
4. Attach the data/control cable to the drive. Make sure that the alignment of the cable is correct.

5. Attach the power supply cable properly
6. Place the HDD in the bay and insert and tighten the mounting screws.
7. Power up the system.
8. Watch out the booting procedure displayed on the monitor and check whether the HDD is detected properly
9. Boot from floppy disk/CD and **Partition** the hard disk using FDISK or DM utility
10. **Format** the disk and transfer operating system files

Steps followed for preparing a Hard Disk Drive:

1. **Low Level Formatting**
2. **Partitioning**
3. **High Level Formatting**

1. LOW LEVEL FORMATTING: where tracks and sectors are physically created in the factory itself.

2. PARTITIONING: Divides the disk into logical sub-drives that are assigned different drive letters such as C, D, E and can be separately addressed.

Objectives of Partitioning:

- (i) Helps to keep the files organized and failure of FAT of one drive will not make the complete data on the hard disk corrupt.
- (ii) Loads multiple operating systems in the same disk such as windows 98 and Linux with each operating system in its own partition.
- (iii) Support multiple file system such as NTFS and FAT 32 on the same disk drive.
- (iv) Separates data files from application on different partition to speed data backup.
- (iv) Improves disk efficiency.

File System:

Each cluster is assigned a number. FDD/early HDD used a 12 bit no. – FAT 12 i.e. 2^{12} clusters
HDD's typically use a 16 bit no. – FAT 16 i.e. 2^{16} clusters

One file requires a minimum one cluster. If the drive is 120 MB; each cluster = $120 \text{ MB}/65536 = 1.8 \text{ KB} \cong 2 \text{ KB}$. If the drive is 540 MB; each cluster = $540 \text{ MB}/65536 \cong 8 \text{ KB}$. If the size of a file is very less than the size of the cluster, then the remaining space is wasted which is called **Slack Space**. So we go for advanced file systems viz. FAT 32 etc.

Under FAT 16, the maximum size of a cluster is 32 KB. Therefore the max. size of a partition is $32 \text{ KB} * 65536 = 2.1 \text{ GB}$. Therefore if the physical size of a drive is larger than 2.1 GB, then we must create logical partition to utilize the additional space.

But why we partition a HDD < 2.1 GB? - In order to reduce the slack space, we have to create a large no. of small logical partitions – doing this result in smaller clusters and create more drive letters.

MS DOS-PC DOS : after 3.3 and before 4.0 – 32 MB / partition

DOS & Windows 95 – 2.1 GB /partition

WIN NT – 4.2 GB / partition

WIN 95, OS2 & WIN 98 uses FAT 32- 2 TB/partition

Note: Partitioning requires even if we are putting all of the space into a single volume. Partitioning size and type will have an imported impact on both the performance and disk space efficiency.

A hard disk can be divided into two types of partition

- i) **Primary Partition:** A Primary partition is created to hold an operating system typically the p[artition used to boot the PC. A hard disk can be divided into as many as 4 partitions but only one primary partition (set as boot partition) can be active at a time.
- ii) **Extended Partition:** An extended partition can be divided into as many as 23 logical sub-partitions. Each logical partition can be assigned its own drive identity, such as D:, E:, F: etc. and used for many purpose.

FDISK is the DOS utility program that is used to partition a HDD. It creates the Master Boot Record (MBR) in the first physical sector of the Hard Disk. i.e. Cylinder 0, Head 0, Sector 1. FDISK program can be used for the following:-

- i) Creating a Primary DOS partition
- ii) Creating an Extended DOS partition
- iii) Creating Logical Drives in Extended DOS partition
- iv) Setting a partition to Active (Bootable)
- v) Deleting a partition
- vi) Displaying partition data
- vii) Selecting a Hard Disk Drive for partitioning when more than one hard disk drive is installed.

Refer “Modern All About HDD” : 272-276 and 283 (including both pages)

To start the FDISK utility at the DOS prompt, type FDISK and press ‘Enter’ key.[For this the file FDISK.EXE must be available in the boot disk].

A PC with a hard disk drive larger than 512 MB will display a dialog box message as shown. This box contains a message advising that ‘You can enable large disk support’ and warning you of the consequences of doing so. Press the ‘Enter’ key to accept the default value of ‘Yes’ (Y), which accepts large disk support or ‘Enter’ N and press the ‘Enter’ Key.

“Your computer has a disk larger than 512 MB. This version of Windows includes improved support for large disks, resulting in more efficient use of disk space on large drives, and allowing disks over 2GB to be formatted as a single drives.

Important: *If you enable larger disk support and create any new drives on this disk, you will not be able to access the new drive (s) using other operating systems, including some version of Windows 95 and Windows NT, as well as earlier versions of Windows and MS-DOS. In addition, disk utilities that were not designed explicitly for the FAT 32 file system will not be able to work with this disk. If you need to access this disk with other operating systems or other disk utilities, do not enable large drive support.*

Do you wish to enable large disk support (Y/N)? (Y)”

Once you press the enter key, the main menu of the FDISK program will appear on the screen. This is shown in the figure.

To create a partition on the newly low-level formatted hard disk drive you need to select the option number 1 i.e. **“Create DOS Partition or Logical DOS Drive”** and press Enter Key.

Next the second menu i.e. the **“Create DOS Partition or Logical DOS Drive”** menu as shown in the figure will appear on the screen.

This menu has three options: **Create Primary DOS Partition, Create Extended DOS Partition and Create Logical DOS Drives(s) in Extended DOS Partition.**

If you are partitioning a new drive then you must choose the option 1 i.e., Create Primary DOS partition. If a DOS partition already exists, then FDISK will show an error message that Primary DOS partition already exists.

After choosing the option 1, FDISK will ask for the size of the primary DOS partition. You can have maximum 2 GB or 2000 MB size for a partition under the DOS 6.x. Once the primary DOS partition is created, if you have some more area on the hard disk drive then you can go back to the **“Create DOS Partition or Logical DOS Drive”** menu and create extended DOS partition and logical DOS drive in the remaining area of the hard disk.

The primary DOS partition is the main, bootable partition of the hard disk. Only one primary DOS partition is created for a drive.

```
MS-DOS Version 6.2
Fixed Disk Setup Program
(C) Copyright Microsoft Corp. 1983-1993
FDISK Options

Current fixed disk drive :1
1. Create DOS partition or Logical DOS Drive.
2. Set active partition
3. Delete partition or Logical DOS Drive
4. Display partition information

Enter Choice: [1]

Press Esc to exit FDISK
```

```
Create DOS Partition or Logical DOS Drive

Current fixed disk drive: 1

Choose one of the following:
1. Create Primary DOS Partition.
2. Create Extended DOS Partition.
3. Create Logical DOS Drive(s) in the Extended DOS Partition.

Enter choice: [1]

Press Esc to return to FDISK Options
```

Set Active partition

Current fixed disk drive : 1`

Partition	Status	Type	Volume Label	Mbytes	System	Usage
C: 1	A	PRI DOS	ARUN	493	FAT 16	98%
D: 2		PRI DOS	NAIR	11	FAT 12	2%

Total disk space is 584 Mbytes (1 Mbyte = 1848576 bytes)

Enter the number of the partition you want to make active [-]

Press Esc to return to FDISK options

Delete DOS partition or logical DOS drive

Current fixed disk drive: 1

Choose one of the following:

1. Delete primary DOS Partition
2. Delete Extended DOS partition
3. Delete Logical DOS Drive (s) in the extended DOS partition
4. Delete Non – DOS Partition

Enter Choice: []

Press Esc to return to FDISK Options

Display Partition Information

Current fixed disk drive : 1

Partition	Status	Type	Volume Label	Mbytes	System	Usage
C: 1	A	PRI DOS	ARUN	493	FAT 16	98%
D: 2		PRI DOS	NAIR	11	FAT 12	2%

Total disk space is 504 Mbytes (1 Mbyte = 1048576 bytes)

Press Esc to continue

The drive created in the extended partition is called logical drives because they act as independent disk drives but they are not physically separate object.

Once defining of Primary DOS partition, Extended DOS partition and logical drives in the extended DOS partition is over, we should restart the machine with a boot floppy (floppy with DOS) in A: drive.

Once the machine restarts and DOS is loaded from the floppy disk, we can start the final process of preparing the hard disk drive for use, this process is high – level formatting of all the partition defined using the FDISK command.

3. HIGH LEVEL FORMATTING: Allows the drive to store files that are suitable to the operating system (transfer of file system). i. e. High Level Formatting is used to prepare the disk partitions to receive the operating system and to store data files. The high level format prepares the disk partitions by creating DBR, two copies of FAT and empty Root Directory. The FAT is used to record the locations and relationships of files and directories on the disk. When we format a hard disk that contains data files, the FAT is reconstructed, removing all references of the existing files.

Two choices to format an HDD on most PC's are the following.

- a) Use the DOS **FORMAT** command from the DOS command line prompt. The command used should be ; **FORMAT X:** where X: should be replaced by the Drive letter of the partition we wish to format. The active primary is usually C: drive. After giving the above command, when you press <Enter>, the drive will begin to Format. If the HDD is already high level formatted, then a warning message will be displayed on the screen as shown.

WARNING, ALL DATA ON NON-REMOVABLE DISK DRIVE X: WILL BE LOST; Proceed with Format (Y/N) ?.

You can type “Y” and press <Enter> to begin formatting.

FORMAT C:/S – to copy the system files (IO.SYS, MS DOS.SYS and COMMAND.COM) while formatting.

FORMAT C:/U – To conduct an Unconditional Format.

Formatting scans and verifies all the tracks and sectors in that partition. If it encounters any bad area, it performs up to 5 retries to read these tracks or sectors. Even it is unreadable; the DOS FORMAT program notes that area as bad cluster in the FATable and moves to the next track or sector. At the end of formatting process DOS will display the information about the space on the HDD, with the cluster/allocation unit size and the no. of clusters /allocation available.

Note: The storage capacity of formatted disk is slightly less than the storage capacity of an unformatted disk.

- b). Use the Windows Explorer to format an existing partition for reuse by the following steps:

Right click the Drive letter in the left pane of the Windows Explorer window of the drive you wish to format to display a short cut menu. Choose Format from the short cut menu. The formatting dialog box will display.

Note: Windows will not allow you to format the C: drive from the Windows Explorer.

LOGICAL STRUCTURE OF A HARD DISK DRIVE

The area created by the FDISK is Master Boot Record (MBR) and FORMAT command creates DOS Boot Record (DBR), FAT area, Root Directory area and the empty data area (see the figure)

MBR, DBR, FAT, ROOT DIRECTORY & DATA AREA

Master Boot Record (MBR): It contains a small program to load and start the active / bootable partition from the HDD. Also contains information about other primary partitions (if there – max. is 4), their starting sector, ending sector, size etc. in a partition table record. Also includes the configuration information like number of cylinders, heads, sectors and bad area. The master partition table is always located at the cylinder 0, head 0, sector 1 and the extended partition boot sector is located at the beginning of each extended partition volume.

Physical sector 1	Logical sector 1 on Drive C:					Logical sector 1 on Drive D:				
	Partition 1 (Drive C:)					Partition 2 (Drive D:)				
Master Boot Record	Dos Boot Record	FAT 1	FAT 2	Root Directory	Data Area	Dos Boot Record	FAT 1	FAT 2	Root Directory	Data Area

DOS Boot Record (DBR)

Function of DBR is to load the operating system from the HDD into the computer’s main memory and gives the system’s control to the loaded program. For this purpose the DBR contains a small program, which is executed by the MBR program. The DBR program looks for two program files namely IO.SYS and MSDOS.SYS on the root directory of the partition (These hidden program files are not displayed when DIR command is used to see the directory) . If the above two programs are not available in the directory, then this MBR program displays the error message ‘**Non-System Disk Error**’. DBR also contains the information about the number of Bytes/cluster, Sector/cluster, number of FATs, maximum number of root directory entries etc. This data area is called Media Parameter Block / Disk Parameter Block / BIOS Parameter Block (BPB). The BPB helps the DOS to find the location of FAT.

The DBR is created by running the DOS FORMAT program. DBR resides in the logical sector 1 of the particular partition for the DOS. This DBR is usually located at the physical location: Cylinder 0, Head 1, sector 1.

File Allocation Table (FAT)

FAT is a kind of index used by DOS to keep track of the information stored on the HDD. FAT keeps a map of the complete surface of the disk drive, which area is free, which area is bad, which area is taken by which file etc. DOS keeps two copies of the FAT, but it uses the second copy, only when there are some bad sectors on the first FAT area. There are different types of FAT namely FAT 12, FAT 16 etc. The type of FAT to be used is decided by the FDISK program during the partition of the HDD.

Root Directory (RD)

This is a table of contents like things of information stored on the HDD. The number of files that can be stored on the HDD depends on the type of FAT being used. i. e. 128 entries for FAT 12 and 512 entries for FAT 16. This does not mean that with 16-bit FAT, one can store only 512 files on HDD. One can use sub-directories to store any number of files, limited only by the size of the drive. If the drive is a MSDOS bootable HDD, then the first 2 entries in the directory will be IO.SYS and MSDOS.SYS. The directory area keeps the information about the file name, date & time of creation, file attribute, file size and starting cluster number (total 32 byte information). Directory entry is linked with the FAT entry based on the first cluster value. Once the DOS has the starting cluster value of any file from the directory, then the DOS can find out the complete file using the FAT.

Data Area

Data area contains the actual data stored on the disk surface. DOS uses the cluster number 2 or the first sector of the data area. (Cluster numbering starts from 2). When formatting a hard disk drive, the FORMAT command does not destroy or overwrite the data on the data area. It only removes the directory entry and the FAT entries, but it does not touch the actual data area. This makes the recovery of accidentally formatted HDD possible, which is not possible in case of accidentally formatted floppy disk.

HARD DISK DRIVE TROUBLE SHOOTING

Basically two types of problems:

1. Hard Problems (related to Drive or Controller)

Symptom: generates a lot of noise

If the problem is inside the sealed hard disk assembly – nothing to do

If with the outside logic board of the drive or the drive controller card – replace it with new part.

2. Soft Problems (related to software, DOS, BIOS etc)

Symptom: normal working sound will be heard from the drive.

SOFT PROBLEMS (SOFT ERRORS) AND ITS SOLUTION

- Un-Erasing a File:-** FAT and Directory together are used by DOS/Windows to keep track of the information stored on the HDD. Any problem in the FAT or the directory structure will make the data on the disk partially or completely unusable.

For example: Directory entry of a file named TEST.TXT: (Before deletion)

File Name	Date	Time	Attr.	Starting Cluster	Size
TEST.TXT	9/27/93	6:20a	Arc.	10	5 cluster

FAT Entry (Before deletion)

Entry #	Value
8	0 (Available)
9	0 (Available)
10	11
11	12
12	13
13	14
14	FFFF(EOF)
15	0 (Available)
16	0 (Available)

When a file is erased, DOS replaces the first character of the file name by the lower case **sigma** whose ASCII code is 229. After this the DOS goes to the FATable and fills the chain of clusters taken up by the file with zeros to make these clusters available for storing any data in the future.

Directory entry of a file named TEST.TXT: (After deletion)

File Name	Date	Time	Attr.	Starting Cluster	Size
σEST.TXT	9/27/93	6:20a	Arc.	10	5 cluster

FAT Entry (After deletion)

Entry #	Value
8	0 (Available)
9	0 (Available)
10	0 (Available)
11	0 (Available)
12	0 (Available)
13	0 (Available)
14	0 (Available)
15	0 (Available)
16	0 (Available)

So, one can recover the deleted data by renaming the first letter of the file and rebuilding the FAT chain. Best time is immediately after erasing – using DOS command **UNERASE** or **UNDELETE**.

Points to be remembered:

1. Directory entry could be overwritten while trying to undelete a file after some more files are written on the disk.
2. It is difficult to rebuild the FAT chain if the file is fragmented. Run the Defragmenter program once in a week to make the clusters of a file arranged in a contiguous area.
3. Take the daily backup of the FAT of the drive to reduce the guesswork.

One can also manually unerase the file by using the **DISKEDIT** program provided with the Norton Utilities. For this load the DISKEDIT program, go to the directory of the drive and in the text or hexadecimal mode change the sigma character to T. Next go to the FATable of the drive and in the FAT view mode, type the FAT chain of the file. Type 'E' to replace the zero with the EOF. Write the changes made to the disk.

2. Unformatting Hard Disk:

While formatting, DOS removes the complete root directory entry and makes all the FAT entries '0' or available. The subdirectory entries and the complete data is still in the drive, but because the FAT chain linking them is removed, it is difficult to undelete these files or unformat the complete drive.

DOS formats the disk in two different ways:

- a) **Without /U option:** Here, only the FATable and the Directory entry of the disk is blanked out and the data on the disk is not erased. Here the FAT, Directory structure and the DBR are stored on some other part of the disk as a **mirror file**, with a pointer to this mirror file on the last cluster of the disk. The **UNFORMAT** operation (of DOS or Norton Utilities) can read this mirror file and make 100% recovery of the accidentally formatted drives.
- b) **With /U option i.e. Unconditional Format:** It works in a different manner based on whether the disk formatted is a floppy or hard disk. On a floppy disk, **FORMAT /U** clears the FAT, Directory structure & the complete data without a mirror file. On a Hard Disk Drive, **FORMAT /U** clears the FAT & Directory structure without a mirror file, **but data is not erased**. Without the mirror file, only the data in the sub-directories can be recovered by the UNFORMAT program. The data in the root directory need to be manually recovered by scanning the available clusters for the required data using some text search utility.

3 Backing up and Restoring MBR

MBR can be backed up by using

- i) MIRROR command of DOS 5.0
- ii) DISKEDIT of Norton Utility
- iii) DEBUG command of DOS with a small assembly language programming (incase above two utilities are not available)

4. CHKDSK /SCANDISK Errors OR Errors detected by CHKDSK/SCANDISK

The programs CHKDSK and SCANDISK basically do the following things.

- They check the Directory entries – check the size of the file and verify that the number of clusters allocated in FAT is enough to save the file.

- They check the directory structure to verify that the sub-directory entries are in correct format.
- It checks the FAT chains to look for any lost clusters, cross-linked clusters etc.
- It also totals the used clusters, available clusters and bad clusters as specified in the FAT and displays this information on the screen.

SCANDISK program can also check the physical surface of the drive to find the defects. Some of the common errors (logical errors) displayed by these programs are:-

- Lost Clusters
- Invalid Sub-Directory Errors
- Allocation Error
- File has Invalid Cluster
- Cross-Linked Clusters

□ ***Lost Clusters / Allocation Unit***

Most common error message by CHKDSK program.

Meaning:- Some clusters/allocation unit in the FAT are shown as allocated, but these FAT chain do not have any corresponding entry in the directory.

Directory Entry

File Name	Date	Time	Attr.	Starting Cluster	Size

Here no reference to the entry no. 10 in the Directory Entry.

- Reasons:-**
- 1) may be result of some error prone softwares
 - 2) due to power loss when the system is writing the FATable
 - 3) user switching off/resetting in the middle of some disk write operation
 - 4) some programs tries to bypass the DOS and handle the FAT & directory themselves – any error in this type of programs may be another reason.

FAT Entry

Entry #	Value
8	0 (Available)
9	0 (Available)
10	11
11	12
12	13
13	14
14	FFFF(EOF)
15	0 (Available)
16	0 (Available)

Solution:-

- ✓ **Using DISKEDIT** create a dummy entry in the directory and make that entry, point to the first location of the FAT chain (starting cluster). Now quit to DOS and check the contents of the newly created temporary file. If the contents are found to be useless, then delete that file and make the space available OR if we find any useful data in them, then we can rename the file and use it.
- ✓ **Use CHKDSK** command with /F option to correct this problem.

❑ **Invalid Subdirectory Errors**

Meaning:- The first two entries in the listing of files must be **.** and **..**. The cluster number for the single dot entry, points to the same cluster where the subdirectory is located and the cluster number for the double dot entry, points to the cluster number of the directory on which this particular directory is located. If this directory is located in the root directory, then the **..** entry will contain 0 as the cluster number. When CHKDSK program cannot find these entries (**.** and **..**) it displays the error message “Invalid Sub Directory Entry”.

Solution:-

- ✓ **CHKDSK /F option:-** Now it will ask the question “ Convert directory to File (Y/N)?”. Never reply ‘Y’ to this prompt.- you will lose the complete directory and the data in it.
- ✓ **Norton Disk Doctor:** Here also the first two entries will be overwritten
Correct manually – **Load DISKEDIT** – Go to the concerned subdirectory by pressing Alt + O for the Object and pressing R for Directory (Note that DISKEDIT should not be in read only mode). Now select the first two entries and copy them to clipboard. Then paste these files in the first ‘Unused Entry’ in the directory. Now edit the first two entries to make this sub directory a valid sub directory.

❑ **Allocation Error Message**

Meaning:- The size allocated to a file in the directory entry does not match with the number of clusters occupied by the same file in the cluster chain.

Directory Entry

File Name	Date	Time	Attr.	Starting Cluster	Size
TEST.TXT	9/27/93	6:20 a	Arc.	10	3 cluster

FAT Entry

Entry #	Value
8	0 (Available)
9	0 (Available)
10	11
11	12
12	13
13	14
14	FFFF(EOF)
15	0 (Available)
16	0 (Available)

Solution:

- ✓ Manually **use DISKEDIT**. Calculate the actual file size based on the no. of clusters allocated to the file in the FAT chain. This length you can type as the file length by editing the Directory entry of the drive.
- ✓ If the directory entry is the correct entry, then put EOF in the FAT entry and mark 0 (available) in the remaining entries.

❑ **File has Invalid Allocation Unit**

Meaning: If FAT chain for the specified file contains available clusters marker (0) or Bad marker (BAD), then the above message is displayed.

Directory Entry

File Name	Date	Time	Attr.	Starting Cluster	Size
TEST.TXT	9/27/93	6:20 a	Arc.	10	5 cluster
TEMP.TXT	9/25/93	6:45 a	Arc.	20	5 cluster

- Solution:-** 1) Reduce the file size up to the bad cluster entry
 2) Correct the FAT chain in the Disk Editor screen

FAT Entry of the file TEST.TXT

Entry #	Value
8	0 (Available)
9	0 (Available)
10	11
11	FFF7(BAD)
12	13
13	14
14	FFFF(EOF)
15	0 (Available)
16	0 (Available)

FAT Entry of the file TEMP.TXT

Entry #	Value
18	0 (Available)
19	0 (Available)
20	21
21	22
22	0 (Available)
23	24
24	FFFF(EOF)
25	0 (Available)
26	0 (Available)

Solution:

Use **DISKEDIT** – get the size – get the no. of cluster. Now change the entries accordingly.

❑ **Cross-Linked Clusters / Allocation Unit**

Meaning: FAT chains of two files are cross linked

Directory Entry

File Name	Date	Time	Attr.	Starting Cluster	Size
TEST.TXT	9/27/93	6:20 a	Arc.	10	5 cluster
TEMP.TXT	9/25/93	6:45 a	Arc.	12	3 cluster

Entry #	Value
8	0 (Available)
9	0 (Available)
10	11
11	12
12	13
13	14
14	FFFF(EOF)
15	0 (Available)
16	0 (Available)

Solution:

- ✓ **Using SCANDISK (detects & corrects this error)**
- ✓ **Manual correction** – Copy both files one by one to some other name, delete old files and then rename the new files as old files

HARD PROBLEMS AND ITS SOLUTION

I. HARDWARE FAILURES

Most common hardware failures are

- i) Data / Control cable fault
- ii) Problems with the Controller, Drive motor
- iii) Read / Write head getting stuck etc.

Most of these problems generate some type of error message / error beep when the system is switched ON, during the POST. These errors could be

- “Invalid Configuration – Press F1 to continue” message is displayed.
- “Invalid configuration – Run SETUP” or “Configuration Lost – Run SETUP” message is displayed
- “0 Hard Disk(s) found” message is displayed
- 1701, 1780, 1790 etc. error code is displayed
- “Drive Failure” or “Hard Disk Failure” message is displayed

These problems can be corrected by

✓ **Check SETUP information**

- Mistakes done in CMOS SETUP information.
- Weak CMOS battery / Jumper setting of the battery must be in the charge position and not in the discharge position.
- Wrong parameters of the drive may be given while installation

✓ **Drive’s Working Temperature**

- If the working temperature is very cold / very hot, keep the machine ON for some time and then reboot.

HDD that use stepper motor to move the R/W head is low level formatted. These heads move in a fixed increment with every step pulse and write the cylinder/ sector information on the disk surface. After some time when this drive is used in a different environment where it was formatted, the hard disk platter (made of metal) may expand or contract with change in temperature. The R/W Head will not able to find the required cylinder/ sector address and will display some read error such as “**Sector Not Found**” etc. This problem does not occur with Voice Coil based HDD. Here R/W head does not move in fixed increments, instead when you give a command to find the 10th cylinder, the head moves to the location of the 10th cylinder based on the servo address written on the disk surface..

- All the magnetic information gets erased at high temperature.

✓ **Check Drive Cable**

Most common reason behind the drive failure

- Remove and reseal the data/control/power cable
- Also check the output voltage using multimeter
- Check that the data/ control cable’s wire number 1 is connected to the pin number 1 of the connector on the drive and on the drive controller.

✓ **Check Drive is spinning**

A drive has two motors. i) stepper motor to move the R/W head to the proper cylinder located at one side of the drive. ii) Platter spinning motor –to rotate the disc platter located at the center of the HDD.

- Check whether the second motor is spinning or not.
- Check the voltage to the motor.

✓ **Stiction (Static Friction)**

R/W Head gets stuck to the drive platter

- Occurs if the drive is not in use for more than one week
- Also because of high temperature conditions – excessive heat softens the lubricant coating on the disk surface. Later when the system is switched off, the lubricant cools and contract around the R/W Head.
- Stiction problem can be corrected by rotating the drive in the platter's plane very forcibly to loosen and clear the head from the platter. A drive with more no. of platters is more likely to get stiction problem.

✓ **Spindle Motor brake problem**

Spindle motor brake is used in many of the HDD's to stop the drive immediately when the power supply to the drive is switched off. This help to reduce the R/W head movement on the disk surface during the power-off position. (Although the head is in contact with the surface in power on condition) Normally this brake is removed from the spindle drum by a solenoid. Because of some problem with the solenoid, even in the power on condition, the brake is continuously applied to the spindle drum without allowing the spindle to rotate.

- This problem can be corrected by removing the spindle drum brake and allow the drum to spin freely.

✓ **Voice Coil Drive Un-Parking Problem**

Just like spindle assembly, a small plastic catch is used in most of the voice coil based HDD to hold the R/W head when the head is parked. This catch also works with solenoid. During the power on condition, the latched is released by the action of this solenoid. Any problem with this solenoid makes the R/W head to be parked position even after the power is switched on.

- Open the sealed assembly of the drive and release the head from the catch.
- Give a short blow to the drive by hand or some other soft object.

✓ **Check stepper motor**

Check whether the stepper motor is moving or not.

- Open the sealed cover: requires clean room facility. If the drive starts to work, then take the backup and discard the drive as the drive may fail at any time.

✓ **Check the controller**

Most of the symptoms given above could be also due to some faults in the hard disk controller. For example, a failed controller may not rotate the spindle motor, or may not move the R/W head. So if the

above systems are not solved even after trying the given methods, then try to exchange the drive controller with a working controller of the same type from some other machine.

II. DISK MEDIA ERRORS

DOS gives the error message “**Sector Not Found**” or “**Data Error Reading Drive X**”, when finds some kind of physical error with the disk surface. “Sector Not Found” error message arise because the DOS cannot find the sector ID placed by FORMAT program because of fading loss or corruption of this information. “Data Error Reading Drive X” error message arises because DOS finds that, the data read from the drive doesn’t match the ECC (Error Correction Code) stored on the disk surface.

Solved by:-

- Check for any virus
- Check that , drive is not very hot or cold
- Make sure that all the device drivers required to access the drive are loaded with proper parameters.

Even then if the area is still not readable, then you have disk media error i.e. some area on the disk has developed a hard error.

Solution: Use DOS SCANDISK or NDD from Norton Utility to do the surface scan of the drive. These programs will find and report the cluster no. of the area that cannot be read. Then we manually change the FAT chain of the file that contains the cluster no. of the bad area. If we do not know the file name, which uses the cluster number use the DISKEDIT program. (Choose the required cluster by pressing Alt+O, for Object and select cluster by pressing C. In the window type the required cluster no. and press enter)

Once we got the cluster no. and file name of the area with error, we have two options

- i) Edit the FAT chain of the problem file to skip that area
- ii) Try to recover as much as data as possible from the problem area

i) Editing FAT chain of the problem file to skip that area:-

Change the FAT link to skip the cluster 27 as shown:-

Entry #	Value (before correction)	Value (after correction)
20	00 (Available)	00 (Available)
21	00 (Available)	00 (Available)
22	00 (Available)	00 (Available)
23	24	24
24	25	25
25	26	26
26	27	28
27	28 (BAD)	28 (BAD)
28	29	29
29	30	30
30	EOF	EOF
31	00 (Available)	00 (Available)

We must also change the file size in the directory, because, skipping of one cluster has reduced the file size by one cluster (If not, error occurs – “Allocations error, Size Adjusted “) So edit the directory of the file and reduce the file size. For that calculate the no. of bytes / cluster by seeing the information about the no. of bytes / cluster and no. of bytes / sector from ‘Info’ Option of DISKEDIT/’Drive Info’. This method is usable only when the file is some type of text file (word processors etc)

ii) Copying file with bad area

We have got two good FAT chains and a bad cluster. Copy these two good FAT chains and the bad cluster in separate files using the DISKEDIT program. Now try to recover the data in the bad area.

Procedure for solution: Use DISKEDIT, select ‘Object’ menu and select Cluster. We will get another screen. Give the starting cluster (23) and ending cluster (25) that we want to copy to another file. Now select the ‘Tool’ menu and select ‘Write Object To’. We will get another window, which asks for ‘Where the selected object should be written?’. Select the option as ‘To a File’ and press ‘Enter’. Also type the File name in the new Window as File1.txt.

Similarly copy the contents of other good chain (i.e 28 to 30) into a file named File2.txt

Now try to recover as much data as possible from the bad cluster (i. e 27) by reading the bad area using the DISKEDIT program. Save this data into another file named Badclust.txt

Now copy these three files using COPY command in DOS

```
C:\>COPY / B File1.txt + Badclust.txt + File2.txt File.txt
```

Badclust.txt will contain some junk area – correct it using DISKEDIT or FILEFIX. Now the file size may be reduced. So change it to the size of the original file size using DISKEDIT.

Precautions/ Procedure for using drive with Bad Media

If there is any bad area then recover this data as we explained above. If the drive is an old one and the number of bad areas reported by the drive is going on increasing, then the best method is to do a low level format of the drive after backing up the complete data, do partition, high level format and then try to use the drive.

Some of the important areas of the drive that should not go bad are:-

1. **Cylinder 0, Head 0**, - area containing MBR - whole drive becomes useless even if the rest of the drive is in very good condition.
2. **DOS partition’s initial area** – containing DBR, FAT, and the Directory. DOS require FAT and Directory to be contiguous without any bad sector in between.

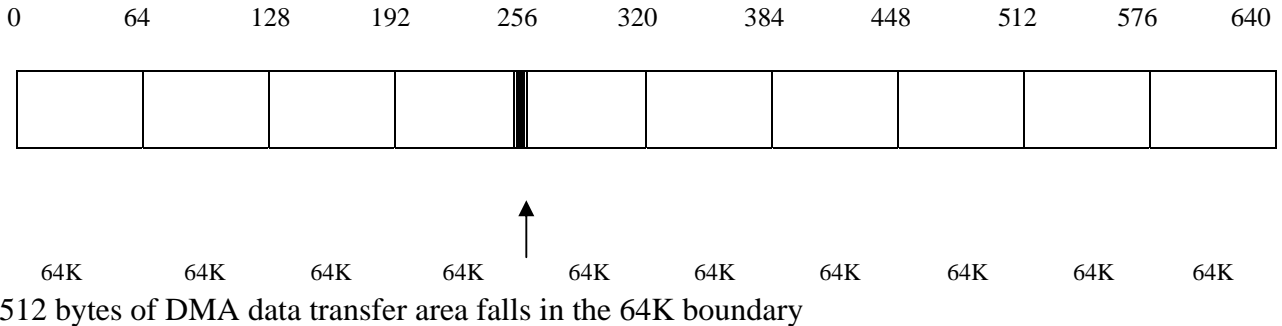
Also FDISK require DOS partition to be the first partition on a hard disk drive. (so the initial 8-10 cylinders taken up by MBR, DBR, two FATs and the directory must be in good condition for a drive to be useful). But there is no rule that it must start immediately after the MBR. So if any of the initial cylinders of a drive contain bad area, then there is a way for us to start the DOS partition away from this bad area .

Method:-Using FDISK, create a small DOS partition which will contain the bad area. Using DISKEDIT, change this partition from DOS to Non-DOS type. Again run FDISK - create DOS partition. Now FDISK will create the DOS partition from the end of the previous Non-DOS partition. This method will start the DOS partition away from the bad area. Now high-level format the drive using DOS FORMAT and the drive will become usable. Only the cylinders which are in the Non-DOS partition will not be accessible.

III CYLINDER 0 BAD / FORMAT FAILURE

Two reasons for getting the error message: Cylinder 0 Bad / Format Failure are

- (i) the MBR, cylinder 0, head 0, sector 1 of the drive is bad and the drive cannot be used for any data storage.
- (ii) Some times the FORMAT program gives this error message because of the problem known as 64K DMA Boundary Bug. This problem is as shown in figure.



As we can see in the figure, the DMA (Direct Memory Access) operations which bypass the CPU and allow the HDD controller to directly read /write memory, use a small memory area as DMA data transfer area. If this area falls in the 64KB boundary (64K/128K/192K/256K/320K/384K/448K/512K/576K) ie, if some part of the area is in one 64KB boundary and the other part is in the next 64KB area, then this will create error for the DOS. So during the format operation, if FORMAT command uses this area, then the format operation will fail with ‘Cylinder 0 Bad / Format Failure’ error message.

The address used as data transfer area by the FORMAT command depends on the memory location where the FORMAT command is loaded. This again depends on the value of Buffer and Files in the CONFIG.SYS. To change the memory location, change the ‘files =’ setting in our CONFIG.SYS file to ‘files = 99’ and restart the machine. Now once again try the FORMAT command. If the FORMAT command works without any problem, then change the ‘files =’ setting to its old value.

If the problem is not solved by the above method, then we have to Low Level Format the Cylinder 0, Head 0. If the low level formatting is also unsuccessful, then we have to discard the drive (before low level formatting, remember to backup some cylinders starting at cylinder 0 in a floppy). Once the formatting starts, immediately press the reset key or switch off the system, before format could format too many cylinders. Once the formatting operation is done, restore the backed up cylinders from floppy and rebuild the MBR.

If the Low Level Formatting is not able to recover the MBR of the HDD, this shows that the MBR is physically damaged and the drive is not accessible.

Recovering Data from “Cylinder 0 Bad” Hard Disk Drive.

- 1) Take an identical drive to the drive with Cylinder 0 problem. Format and partition this new drive as the drive you want to recover.
- 2) Connect this drive to the system and switch ON the power. Once the system is booted from the new drive, disconnect the power supply cable from the drive

3) Next, remove the data/control cable from this new drive (Remember to remove the power cable first)

4) Connect the bad drive to the data/control cable and then connect the power cable to the bad drive. Here remember to connect the data/control cable first.

Next try to see the directory listing of the bad drive. Take the back ups of the complete drive and discard it.

Note:- This method may destroy the completely good new drive if we doesn't follow the instructions properly.

UPGRADING HARD DISK DRIVE

Why do we need to upgrade the HDD?

1. Requirement of more storage capacity
2. Requirement of faster Disk access

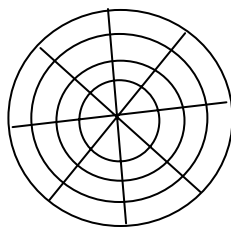
Alternative to new drive !

There are some software based alternatives available to increase the disk access speed and to increase the storage space.

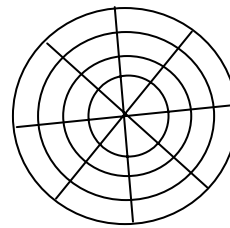
1. Speed Improvement

- i) **Disk/File Defragmentation:-** A file requiring more than one cluster can be scattered any where on the disk. Badly fragmented files make the hard disk drive to work hard and this slows down the effective performance of the drive. Disk Defragmenter is a special utility that is built in Windows 95 to speed up disk access by rearranging the clusters and the free space on your computer, so that all of the clusters for any given file will be contiguous. Defragmentation can be done by using software utilities such as **Speedisk** from Norton Utilities, **PC Tool Utilities** by Central Point, **Disk Organizer**, **DEFRAG.EXE** of DOS.

Before defragmenting



After defragmenting



- Advantages:** i) Increases the Drive's life as the R/W head will require to move less.
ii) Easier to undelete.

- ii) **Using a Disk Caching Software:** Disk Cache is a part of system's main memory (RAM) which is used by the cache software to store the frequently used information from the hard disk drive. Whenever a disk access occurs, the cache software reads the area around the read data and keeps it into the cache memory. When the next Read instruction is issued, then the cache software checks the cache memory first, to see if the required data is found in the cache memory. If there, then the data is provided to the CPU, without requiring any disk access (cache hit). If the required data is not found in the cache memory (cache miss) then only the drive is read.

- **Note:** Guessing method and size of cache memory together make sure that most of the time cache hit occurs.
- Main memory access is much faster than accessing the mechanical drive.

Software Utilities:

NCACHE from Norton Utilities

PCTOOL Utilities from Central Point

SMARTDRV.EXE program provided with DOS 6.XX / MS WINDOWS

iii) Using BIOS Setup

Most of the current BIOS have some options to improve the disk access speed when they are used with IDE drives. The facilities provided by them are :

- a) Enabling the IDE prefetch read buffer
- b) Enabling the IDE block mode

Enabling these two options will improve the disk access speed of the IDE drives

2. Increasing Storage Space

- i) **Using Disk Compression:** Disk Compression method works by compressing the data that is stored on the disk drive at the time of writing of the data and expanding the data to its original form while reading. This is done by replacing the repeating data with some type of token value. Later when the file is retrieved, this token value is replaced with the original value. This type of lossless compression method provide an average 2:1 compression ratio. ie. a 10KB file can be compressed to a file of 5KB size - there by increasing the effective storage space.

Software Utilities: (Memory resident programs)

Stacker from Stacker Electronics – can be used with HDD & FDD and is available in DOS, Windows and OS/2 Versions.

DBLSPACE.SYS – by Microsoft Corp.

Another method is Lossy Compression, which is used to compress image and sound data files with an average compression ratio of 25:1

- ii) **Using File Compression:** Here the files that are not frequently used are compressed before storing them to the Disk Drive – can be compressed up to 90%.

Disadvantage:- *Not a memory resident program - One has to manually compress each file before storing in the drive and to uncompress them before using. – Applied only to those files that are required only once in a week.*

Software Utilities:

PKZIP from PKWare

ARC from SEA

LHA from Yoshi

Note: *File compression programs are Shareware programs – are available for free trial – If user finds the program useful, then only he needs to pay*

Hard Disk Drive Specifications

1. **Disk Access Time:** It is the average time it takes for the information requested from the disk to arrive in the computer's main memory – measured in milliseconds. Smaller the value, better will be the system performance.
2. **Disk Storage Capacity:**

For DOS based software	: 100 MB minimum
For Windows based software	: 600 MB minimum
Windows 2000/NT	: 1 GB

Required Disk Capacity = (Space required for all softwares + Data + any temporary area) × 3 or 4.
Always go for a highest capacity HDD

3. **Cost per Megabyte:** Find out the complete cost of upgrading. Divide this value with the number of mega bytes (MB) that you will gain by installing the new drive. Cost per megabyte decreases as the storage capacity of the drive increases.
4. **Physical Size (Form Factor):** Form factor is the size of the platter inside the HDD. Two standard size are available : 3.5 inches and 5.14 inches
5. **Seek Time:** To read any data on the HDD, first the R/W head needs to be moved to the required cylinder/track. The time required to move the R/W head to the required cylinder is called the Seek Time. We will have an average Seek Time – measured by calculating the time required for the R/W head to move 1/3rd of the way across the disk. – 10ms to 100ms.
6. **Rotational Latency Period:** Once the head reaches the required cylinder, the disk is rotated until the required data is under the R/W head, then only the drive can start reading the data. Rotational Latency period is the time required for the required data to rotate under the R/W head, after the R/W head has located on the required cylinder.
Average Rotational Latency period is calculated by finding out the time required to make half the revolution. For an HDD having speed = 7200 RPM, one rotation will take 60/7200 of a second. Therefore, half the rotation will take 60/14400 seconds = 4.166 ms.
7. **Access Time:** It is the time required by the HDD to move the head to the required data after a read or write command is received from CPU/Controller.
Access Time = Seek Time + Rotational Latency Period. Average Access Time of almost all HDDs = 20ms or better.
8. **Data Transfer Rate:** Most important figure when comparing two different HDD systems. Latest SCSI HDDs provide Data Transfer Rate of 40 GB/Sec or more
9. **Mean Time Buffer Failure (MTBF):** It is the average time for which an HDD will operate before failing. MTBF rating of 10000 hours means that it will work for 10000 hours without failure.
10. **Buffer Size:** Many hard disks provides some kind of data buffer like the external cache memory to improve the performance of the hard disk drive.- very small compared to software based external cache – 8KB/16KB
11. **Warranty:** For most of the manufacturers, the warranty period starts when the product is sold to your vendor and not to you, so it may expire soon.

RAID:-

RAID is an acronym for *Redundant Array of Independent (Inexpensive) Disks* and was designed to improve the fault tolerance and performance of computer storage system. Initially RAID is so designed that a group of smaller, less expensive drives, interconnected with special hardware and software to make them appear as a single larger drive to the system. To improve the reliability and performance, scientists proposed seven levels (corresponding to different methods) of RAID. These levels provide varying emphasis on either fault tolerance (reliability), storage capacity, performance, or a combination of the three. The levels are as follows:-

RAID Level 0 – Striping. File data is written simultaneously to multiple drives in the array, which act as a single larger drive. Offers high read/write performance but very low reliability. Requires a minimum of two drives to implement.

RAID Level 1 – Mirroring. Data written to one drive is duplicated on another, providing excellent fault tolerance (if one drive fails, the other is used and no data lost), but no real increase in performance as compared to a single drive. Requires a minimum of two drives to implement.

RAID Level 2 – Bit-level ECC. Data is split one bit at a time across multiple drives, and error correction codes (ECCs) are written to other drives. Intended for storage devices that do not incorporate ECC internally (all SCSI and ATA drives have internal ECC). Provides high data rates with good fault tolerance, but large numbers of drives are required.

RAID Level 3 – Striped with parity. Combines RAID Level 0 striping with an additional drive used for parity information – Achieves a high level of data integrity or fault tolerance. Requires a minimum of three drives to implement.(two or more for data and one for parity)

RAID Level 4 - Blocked data with Parity. Similar to RAID 3 except data is written in larger blocks to the independent drive, offering faster read performance with larger files. Requires a minimum of three drives to implement (two or more for data and one for parity)

RAID Level 5 – Blocked data with Distributed Parity. Similar to RAID 4 but offers improved performance by distributing the parity stripes over a series of hard drives. Requires a minimum of three drives to implement.(two or more for data and one for parity)

RAID Level 6 – Blocked Data with Double Distributed Parity. Similar to RAID 5 except parity information is written twice using two different parity schemes to provide even better fault tolerance in case of multiple drive failure. Requires a minimum of four drives to implement (two or more for data and two for parity)

COMPLETE BOOT PROCESS

The process of transferring the Operating System files from secondary storage area to the primary memory is called Booting. The complete boot process is explained as follows:-

1. After the machine is switched ON, the power supply performs a self check and once the output becomes stable, it sends a *powergood* signal to the computer's motherboard.
2. After the timer chip on the motherboard receives the powergood signal, it stops sending *reset* signal to the CPU. CPU starts executing the BIOS program from location FFFF:0000 onwards.
3. The BIOS program at location FFFF:0000h starts checking all the main devices like CPU, DMA controller, RAM etc, any error is displayed on the screen and indicated by the error-beep.
4. Next, BIOS looks for the video ROM. If a video ROM is found, its checksum is tested. If the checksum test fails "**ROM Error**" message is displayed, otherwise the Video ROM is executed. The video ROM initializes the display system and the cursor appears on the screen. If no video ROM is found, then motherboard-ROM's video driver initialize the display system and the cursor appears on the screen.
5. BIOS checks memory C800:0000 to DF80:0000 in 2K increments for any other ROM, if any ROM is found, its checksum is tested and after a successful test the ROM program is executed. A checksum test failure is displayed by "**XXXX ROM Error**" error message on the screen, where XXXX is the segment value of the failed ROM.
6. BIOS check the word at location 0000:0472, if this word is 1234h then a warm boot is done; any other value indicates a cold boot. A warm boot makes the memory test to be skipped during the POST process. During cold start the BIOS performs the full POST procedure.
7. Next the Power On Self Test (POST) is done. Any error is displayed on the screen and indicated by the error-beep sound. A POST without any error is indicated by a single beep sound.
8. BIOS looks for DOS Volume Boot Sector at Cylinder 0, Head 0, Sector 1 on the default boot drive, ie. **the first sector in the floppy disk A** (BIOS on today's system enable us to select the default boot device and its order) This sector is loaded into the memory location 0000:7C00 and checked.
9. If the first sector cannot be read or if the drive is empty and there is no hard disk present, then "**Drive not ready, Insert boot disk in A; Press any key when ready**" error message is displayed and the system stops.
10. If the first byte of the loaded boot sector is less than 6h or if the first byte is equal to or more than 6h and the first nine words contain the same data pattern then, "**602: Diskette Boot Record Error**" message is displayed and the system stops. Otherwise the sector loaded at 0000:7C00 is executed.
If the DOS diskette was formatted with version earlier to 3.3 and if the boot sector is corrupt, then the message "**Disk Boot Failure**" is displayed and the system stops.
11. **This Boot Sector program loaded from Cylinder 0, Head 0, Sector 1, checks for the two system files IO.SYS and MS-DOS.SYS (on MS-DOS systems). If the boot sector is corrupt or if these two files are not the first two files in the root directory, or if a problem is encountered in loading them then**

**“Non-System disk error,
Replace and press any key when ready”** error message is displayed.

12. If the DOS volume boot sector cannot be read from the drive, then the BIOS tries to read the MBR from **Cylinder 0, Head 0, Sector 1 of the Hard disk drive**. If this sector is found then it is loaded into the memory address 0000:7C00 and the signature (55AAh) of this sector is checked.

If the signature byte (ie. the last two bytes of the sector) is not 55AAh then BIOS invokes a software interrupt INT 18h and an error message is displayed **“No Boot Device Available, Press F1 to retry, F2 to run Setup”**.

13. If the signature byte of the MBR is correct, then the program at the MBR is given the control. This program looks at the partition table entry for any extended partitions. If an extended partition is found then the program loads the extended partition boot sector. Next this extended partition boot sector's partition table is searched for any more extended partition. This process continues until no more extended partitions are found.
14. Once all the partition tables are loaded into the memory, they are searched for a bootable partition. If none of the partition is marked bootable or if more than one partition is marked as bootable, then this will display the error message **“Invalid Partition Table”** and the system stops.
15. If the MBR finds an active (bootable) partition in the partition table, then the boot sector from that partition is loaded and tested for the signature byte. If the bootable volume / partition's boot sector could not be read successfully in five retries, then the following message appears and the system stops. **“Error Loading Operating System”**
16. After successful loading of the bootable volume's boot sector, if the signature byte is not 55AAh then the message **“Missing Operating System”** appears and the system stops
17. Once the bootable volume's boot sector is successfully loaded, the program at the boot sector is executed. If this is a DOS Boot sector, then this program checks for the two system files IO.SYS and MSDOS.SYS. If these two files are not present or if they are not the first two files in the directory or if they could not be loaded properly or if the boot sector is corrupt then DOS 4.0 or later version will display the following messages.

**“Non-System Disk Error or Disk Error
Replace and strike the key when ready”**

18. Once the IO.SYS can be read, this program is loaded into the main memory (RAM) and executed. On execution, the first thing this program does is to move itself into the highest memory available.
19. Next, IO.SYS loads the MSDOS.SYS into the main memory and executes it.
20. The MSDOS.SYS initializes device drivers, resets the disk status, determines the status of devices connected to the system and sets default parameters for the system operation.
21. Now the complete DOS is active. IO.SYS is again given the control and it reads the CONFIG.SYS and processes it. This is a 4 stage process.
22. During the first pass, IO.SYS reads all the CONFIG.SYS statements except DEVICE, INSTALL and SHELL statement.

23. During the 2nd pass, all the DEVICE statements are executed in the order in which they are given in the CONFIG.SYS file. This makes all the device drivers specified in the CONFIG.SYS to be loaded and executed.
24. During the 3rd pass, all the INSTALL statements are executed in the order in which they appear in the CONFIG.SYS file which makes all the programs specified in the INSTALL statement to be loaded and executed.
25. During the 4th pass if CONFIG .SYS contains any SHELL command, then the command processor specified in the SHELL is loaded and executed, otherwise COMMAND.COM is loaded as the default command processor.
26. COMMAND.COM checks for AUTOEXEC.BAT, if present then each command in the AUTOEXEC.BAT is executed and finally DOS prompt appears on the screen.
27. If AUTOEXEC.BAT is not present then COMMAND.COM executes DATE and TIME command and shows the DOS prompt after displaying a copyright message.