ATARI HARD DISK FILE SYSTEMS REFERENCE GUIDE

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Table of Content

How to Read this Document

I have created this document as a reference manual that I use personally to find specific information related to usage of Hard Disks. It provides technical information about the different File Systems used on the Atari platform as well as a practical short guide for using and partitioning Hard Disks on Atari (more specifically SD Cards connected to **Satan** / **UltraSatan** / **CosmosEx** devices).

Therefore most probably you do not want to read this document from front to back. This is why I have organized it so you can quickly access information.

The first part contains practical information while the second part goes into more technical details when needed.

Part I

The first part of the document focuses on practical information and procedures for partitioning Atari Hard Disks. It also contains a basic presentation of the Atari and DOS File systems to better understand the choices and limitations of the different types of partitions.

- The Partitioning Information chapter provides basic information about partitioning disks and minimum knowledge you should have about Atari file system. It is short and therefore it is a recommended reading.
- The Types of Partition used on Atari Chapter gives an overview of the different types of partition used on Atari: TOS partitions, DOS/FAT partitions, and TOS&DOS partitions. It also provides some Notes on Creating and Installing Partitions on Atari Desktop.
- The TOS/GEMDOS Limitations chapter provides information about the limitations of TOS/GEMDOS and is good to read if you run into mysterious problems using your hard disk.
- The Atari Hard Disk Drivers Packages chapter contains simplified guides for usage of several hard disk driver packages (HDDRIVER, PPDRIVER, AdSCSI, and CBHD) with **Satan**, **UltraSatan**, and **CosmosEx** devices. Which Hard Disk Driver Should I use help you select a hard disk driver package for Satan, UltraSatan, and CosmosEx devices.
- The PC Utilities chapter review several programs, available on the PC platform, related to Hard Disk usage.
- The Atari Utilities chapter review several programs, available on the Atari platform, related to Hard Disk usage and File System related bug fix. It also contains a short presentation of the BigDOS program.
- The File System Problems and Solutions chapter describes several commonly encountered problems and their solutions. It is recommended reading when hard disks do not work as expected.

Part II

Technical details about TOS, DOS/FAT, and TOS&DOS file systems are presented in the second part of this document.

The goal of the second part of this document is thus to provide in-depth technical information about Atari hard disks partitioning (layout). For that matter I describe in detail the TOS File System as well as the DOS/FAT File System as both of them are used on the Atari platform. The DOS/FAT File System study is limited to what is useful in the context of the Atari platform. I also describe the TOS&DOS File system used by PPDRIVER and HDDRIVER. Examples of File System partitioning are analyzed deeply.

- The Hard Disk Presentation chapter provides a high level presentation of hard disk partitioning as well as practical partitions limits for the different type of file system.
- The Information about TOS Partitions provides an in-depth presentation of the TOS file system.

- The Information about DOS/FAT Partitions provides an in-depth presentation of the DOS/FAT file system.
- The Information about TOS&DOS Partitions provides an in-depth presentation of the TOS&DOS file system as created and used by PPDRIVER and HDDRIVER.

Notes:

*Although the information presented here applies to generic ASCI/SCSI Hard Drives, specific details are provided for the **CosmosEx, UltraSatan** and Satan Devices.*

Note that the Satan Drive has the following limitations:

- The maximum size officially supported is 1GB SD card. However the **PPDRIVER** hard disk driver allows usage of 2GB SD Card.
- SDHC cards are not handled,
- Only one SD card can be plugged,
- And Satan Drive only works with the PPDRIVER and HDDRIVER hard disk drivers.

A word of caution: All the procedures described in this document have been tested on Atari ST and STE. To a certain extent they should also apply to Atari Mega ST(e) / TT / Falcon. However no test has been performed on these platforms and therefore some of the described procedures **might not work** on these platforms. Use at your own risk!

The information presented here is based on a compilation of many documents as well as personal knowledge and experimentations. The reference section lists most of the sources used in this document and, whenever possible, links to the originals are provided.

Enjoy!

PART I – ATARI HARD DISK FILE SYSTEM PARTITIONING GUIDE

Chapter 1. Partitioning Information

This section provides basic information about Atari & PC hard disk **partitioning** (layout). For technical details on the TOS and FAT file systems please refer to the second part of this document.

1.1 Hardware Consideration

Atari ST / STE computers provide an external ***DMA bus*** connection through the Atari Computer System Interface (**ASCI**) connector. This bus is very similar (simplified version) to the standard SCSI bus and allows connection of different type of devices such as hard disks.

Atari Mega STe, TT, Falcon computers provide direct support for IDE and/or SCSI Hard disk buses.

The disk drives are connected to Atari ST ASCI bus through a ***Host Adapter***. The host adapter acts as an interface between the Atari DMA bus and the drive controller. For example a *SCSI disk* can be connected to the ASCI bus through an ***ICD AdSCSI Plus*** host adapter, or an *SD card* can be accessed through a ***CosmosEx*** Device that acts as a host adapter.

🖉 When several devices are connected to an ASCI bus you **must** assign a unique ID to each of them.

The maximum usable size of a hard disk is limited by several factors:

- The size of the hard disk itself,
- The Hard Disk Driver software,
- The File System limitations, and
- The Host Adapter capability.

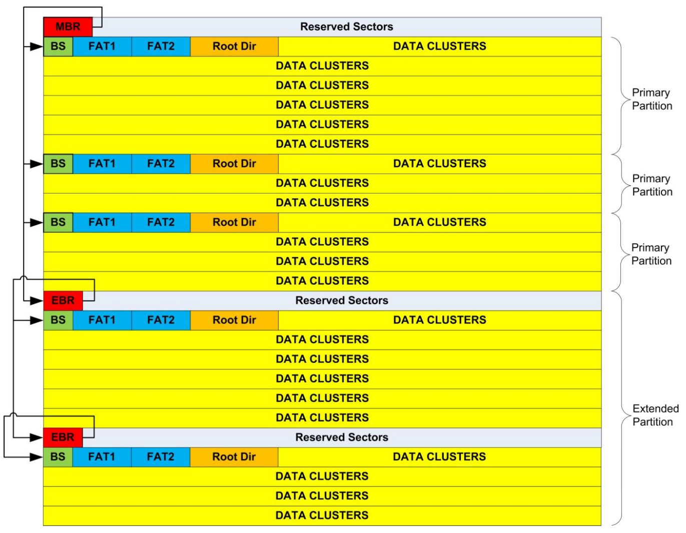
We can differentiate two families of host adapters:

- The host adapters that strictly implement the ASCI-AHDI command set (corresponding to the SCSI group 0 command set). With this type of host adapter the maximum size of the drive is **limited to 1GB** (2^11 sectors of 512 bytes). For examples: The ICD ***Link I***, the ***Satan Drive***.
- The host adapters that implement the ICD extended command set (corresponding to the SCSI group 1 command set). With this type of adapter the maximum size of the drive is **lifted to 2TB** (2^32 sectors of 512 bytes). For examples: The ICD ***Link II***, the ***CosmosEx*** device.

*To access drives bigger than 1GB you need to have a host adapter **and** a hard disk driver that both understand the ICD extended command set.*

1.2 Hard Disk File System Primer

The Atari ST/STE platform uses natively the TOS file system as defined in the Atari AHDI 3.0 document. The PC platform uses a wide variety of file systems but in this document we will only look at the DOS/FAT file system that can be used on an Atari platform.



While both of these file systems look similar they are *different*. Therefore we need to have a basic comprehension of both file systems in order to appreciate their limitations and incompatibilities. Detailed technical information on TOS, DOS file systems can be found in Part II of this document.

The picture on the right shows an example of layout for a partitioned and initialized hard disk with three primary partitions and an extended partition that contains two primary partitions (see 9.4.2 for more details).

An already partitioned and initialized disk is composed of:

- The *Reserved area*: containing the **Master Boot Record** (MBR), located at physical sector 0, and followed by reserved sectors. The **MBR** defines the number of partitions and their positions on the disk.
- The *Partition area*: containing from one to 4 partitions (primary or extended) with the actual data.

There are two types of partitions:

- The Primary partition contains several control structures and the actual file and directory data.
- The Extended partition is a special kind of partition which is itself subdivided into one or several primary (aka as secondary) partitions allowing a number of partitions superior to 4 on the disk.

A primary partition contains:

- The **Boot Sector** located at the very beginning of the partition (logical sector 0). It contains an important area called the **BPB** (*BIOS Parameter Block)* that gives basic file system information. Frequently it also contains the ***boot loader*** code.
- The **FATs** are maps of the Data, indicating which clusters are used by files and directories.
- The **Root Directory** stores information about the files and directories.
- The **Data Region** is where the actual file and directory data is stored.

Most of the problems of compatibility between the TOS and FAT file systems are located in the **BPB** area of the **Boot Sector**. Following is a description of the critical parameters of the BPB:

- Two important parameters in the BPB are the number of bytes per sector (**BPS**) and the number of sectors per cluster (**SPC**). They are interpreted ***differently*** by TOS and DOS/FAT but together they define the notion of **Logical Sector**[1]. On a TOS file system a Logical Sector = BPS and can range from 1024 to 8192[2] Bytes and the SPC is always equal to 2. On a DOS/FAT file system a Logical Sector = BPS * SPC. The BPS is always 512 bytes but the SPC can range from 2 to 128 resulting to logical sector of 1024 to 65536 Bytes. Therefore we can see that the two file systems use a different scheme to define *logical sectors* bigger than 512 bytes. For example a logical sector of 8192 bytes is achieved with a BPS = 8192 and a SPC = 2 on the TOS file system. The same 8192 bytes logical sector is achieved with a BPS = 512 and a SPC = 16 on the DOS file system.
- Another important parameter in the BPB is the total number of sectors. On a TOS file system this number is stored as a 16-bit quantity (**NSECTS** parameter). This results in a maximum size of 512MB (2^16 * 8192 bytes) for a TOS partition[3]. On DOS/FAT file system the number of sectors can be stored as a 32-bit quantity (**HSECTS** parameter) allowing definition of partitions up to 2TB.

For technical details look at TOS Boot sector and DOS/FAT Boot sector

1.3 Preparing a Drive

A drive needs to be "prepared" before it can be used to store data. With modern drive, this is done in two steps:

- The first step is called ***partitioning***:
  Hard drives are divided into smaller logical drive units called **partitions**. In this way a single hard drive can appear to be two or more drives to the OS. Besides simply keeping drive sizes under the file system size limits, dividing a drive also allows partitions to be used for specific purposes, keeping the drive organized.
- The second step is called ***high-level formatting*** (also referred as ***formatting*** or ***initialization***[4]):
  This is the process of creating and initializing the basic disk's control structures: namely the **Boot Sector**, the **FATs**, and the **Root Directory** as described in the previous section.

✎ Note: On old hard disks you also had to ***format*** them (also referred as ***low level formatting***) before partitioning. Low level formatting allows the magnetic medium on the surfaces to be divided into tracks containing numbered sectors that the controller can find. With "modern" SCSI / IDE drives and with drives using SD cards this operation is not required anymore and therefore is not described in this document.

[1] Note that the term *logical sector* is used differently on Atari and PC platforms.
[2] 32768 for TOS4.0 on Falcon (but officially supported only 16384)
[3] For TOS < 1.04 max partition size = 256MB (2^{15} * 8192), and for TOS 4.x max partition size = 2GB (2^{16} * 32768).
[4] The term "Formatting" is used in PC environment while the term "Initialization" is often used in Atari environment.

Chapter 2. Types of Partition used on Atari

Before we detail the partitioning procedures for several hard disk drivers, we need to understand the basic types of partitions used on Atari and their limitations.

2.1 TOS Partitions

This is the “native” type of partition used an Atari as described in the Atari AHDI documentation. It is supported by all the Atari hard disk drivers and in fact some of the old drivers only support this type of partition. This is the type of partitions that you want to use on Atari unless you plan to use the media (HD or SD card) to transfer data between Atari and PC computers.

Remember that the maximum size for a partition depends on: the hard disk size, the hard disk driver, the host adapter capability, and the TOS version.

With recent *hard disk driver* and *host adapters* (that is supporting the ICD extended commands set) the maximum size for a partition is:

- Up to 256MB for TOS < 1.04
- Up to 512MB for TOS ≥ 1.04
- Up to 2GB for TOS ≥ 4.x (Falcon)

Contrary to widely spread belief, the boot partition (usually the first partition on disk) can be a big partition (BGM) and therefore can use the maximum size supported by the TOS (For example 512MB for 1.04 ≤ TOS < 4.x). The actual limitation to 32MB (GEM) for the boot partition does not come from TOS/GEMDOS file system but from some hard disk driver. Only very old hard disk driver like SCSITools and AHDI hard disk driver exhibit this limitation.

2.2 DOS/FAT Partitions

2.2.1 Type and Limit of DOS/FAT Partitions

The following table summarizes the characteristics of different types of DOS/FAT partitions that are of interest for Atari users:

Partition Type	Fdisk	Size	Fat Type	Version
01	PRI DOS	0-15 MB	12 bits (FAT12)	MS-DOS 2.0
04	PRI DOS	16-32 MB	16 bits (FAT16A)	MS-DOS 3.0
05	EXT DOS	0-2 GB	n/a	MS-DOS 3.3
06	PRI DOS	32 MB-2 GB	16 bits (FAT16B)	MS-DOS 4.0
0E	PRI DOS	32 MB-2 GB	16 bits (FAT16B)	Windows 95[5]
0F	EXT DOS	0-2 GB	n/a	Windows 95
0B	PRI DOS	512 MB - 2 TB	32 bits (FAT32)	OSR2
0C	EXT DOS	512 MB - 2 TB	32 bits (FAT32)	OSR2

2.2.2 Small DOS/FAT Partitions

By Small DOS partition we mean partitions with a size < 32MB. These partitions are referred as:

- Type $04 (aka **FAT-16A**) with a size of < 32MB

As we have seen previously, the TOS and FAT file systems **do not handle** large logical sector the same way. As a result it is only possible to use a logical sectors size of 1024 for partitions that can be accessed directly on both platforms. This results to a maximum size of 32MB (65536 * 512 bytes) for compatible partitions. However we will see later that some solutions exist to overcome this limitation.

Some of the Atari hard disk drivers directly recognize the DOS/FAT partitions. This type of partition can therefore be useful to transfer data between an Atari and a PC. But as the partition size is very small (32MB) it is not well suited for large disks.

2.2.3 Large DOS/FAT Partitions

By large DOS partition we mean partitions with a size ≥ 32MB and < 2GB. These partitions are referred as:

- Type $06 or $0E (aka **FAT-16B**) with a size range of 32MB – 2GB
- Type $05 or $0F (aka **Extended FAT-16B**) with a size range of 32MB – 2GB

[5] Type 0x0E and 0x0F forces usage of LBA addressing instead of CHS addressing (recognized by Windows 95 and above).

As we have seen due to the constraints imposed by the TOS file systems and the DOS file systems it seems that it is only possible to access Small **FAT16A** (≤ 32 MB) DOS partitions with an Atari.

However the **BigDOS** freeware allow access to Large DOS partitions. BigDOS works with several hard disk driver for example HDDRIVER and CBHD. But unfortunately it does not work with some other drivers like the ICD AdSCSI or PPDRIVER hard disk driver. See BigDOS section for more information.

We have seen most of the problems related to the file system (for example the fix value of SPC=2) come from code inside GEMDOS. As BigDOS replaces GEMDOS at boot time it allows to remove many of these limitations. More specifically it permits the support of SPC values of up to 64, and the maximum number of sectors is specified as a 32-bit value (instead of the TOS 16-bit value). Therefore BigDOS can deal with more than 65536 big logical sectors and this removes the 32MB limitation.

For example using BigDOS and HDDRIVER it is possible to create several 2GB partitions on an 8GB SD Card and to successfully transfer data from Atari and PC platforms.

2.2.4 Huge DOS/FAT Partitions

By Huge DOS partition we mean partitions with a size ≥ 2GB. These partitions are referred as:

- Type $0B (aka **FAT32**) with a size range of 512MB – 2TB
- Type $0C (aka **Extended FAT32**) with a size range of 512MB – 2TB

It is not possible to directly access huge DOS/FAT partitions on Atari (even when using BigDOS) with the Atari hard disk drivers discussed in this document.

You should know that there are some solutions to access Huge DOS partitions on an Atari (for example by using Mint) but they are not covered in this document.

2.3 TOS&DOS Partitions

The ***PPDRIVER*** and ***HDDRIVER*** hard disk drivers described in this document use a hybrid type of partition called ***TOS&DOS*** (or ***TOS&Windows***) partitions. These partitions are processed by Windows PC computers as DOS/FAT partitions and by Atari computers as TOS partitions. For each TOS&DOS partition **two** boot sectors are written: one for the DOS file system and one for the TOS file system. The maximum size of a TOS&DOS partitions follows the TOS file system limitation (for example 512MB for TOS ≥ 1.04). There is no standard for this type of partition and even though HDDRIVER and PPDRIVER packages use similar technique the two drivers are in practice **incompatible**.

TOS&DOS partitions are accessible on both Atari and PC platforms, they can be made bootable on Atari, and they can have a large size for example up to 512MB for TOS 1.04. Therefore they are well suited for data transfer between Atari and PC computers using SD cards plugged for example into **CosmosEx** device.

✐ **IMPORTANT WARNING:** A TOS&DOS partition is **not** a regular TOS partition and therefore it should only be accessed on the Atari with the **matching** hard disk driver. For example using the ICD AdSCSI hard disk driver gives the impression to access TOS&DOS partitions correctly (it even report correctly the size) but if you try to read beyond the first 32MB of the partition you will get incorrect results and even worse if you try to write you will **definitively corrupt the partition.**

2.4 Notes on Creating and Installing Partitions

2.4.1 Creating TOS Partitions

As we will see later all the Atari Hard Disk driver packages provide a utility that to create TOS partitions. It is interesting to note that whatever hard disk driver utility you use the resulting TOS partitions follow the AHDI standard and therefore will be compatibles with all HD drivers. Therefore you can use the partitioning tool from one package and use the resulting TOS partitioned drive with any other Atari hard disk driver.

The following table shows the minimum logical sector size required for specific partition sizes:

Partition Size[6]	Logical Sector Size
Up to 32MB	512
32MB – 64MB	1024
64 MB – 128MB	2048
128 MB – 256MB	4096
256MB – 512MB	8192
512MB – 2GB[7]	32768

During partitioning you only need to specify the size of the partitions you want to create and the driver will compute for you the optimum logical sector size. However it is possible in some cases to modify this size during the "initialize" command. In that case you have to make sure that you specify a value superior or equal to the minimum value presented in the table above.

2.4.2 Creating DOS partitions

Some hard disk drivers support creating DOS/FAT partitions. However it is usually **easier** and **safer** to create the DOS partitions directly on a PC. This is covered in Creating FAT Partitions on a PC.

2.4.3 Creating TOS&DOS partitions

TOS&DOS partitions can only be created by PPDRIVER and HDDRIVER packages. Only use TOS&DOS partitions with the **matching** driver (as they are not compatible) **and never use them with any other driver** (see § 2.3 for important warning).

2.4.4 Creating Bootable Partitions

Most probably you also want to define at least one bootable partition on a drive so that the Atari can be started from the hard disk without a diskette. The procedure to render a partition bootable is described, for each reviewed hard disk driver, in the next chapter. For detailed information look at TOS Boot Sequence in Part II of this document.

2.4.5 Installing Disk Partitions on the Atari Desktop

After a drive has been partitioned you need to add a drive icon on the Atari desktop for each of the partitions. Without these drive icons, the partitions will not be accessible from the desktop.

The procedure is the following:

- On the Atari desktop, click on the icon associated with the floppy disk A and choose **Install Disk Drive...** from the **Options** drop-down menu.
- Change the **drive identifier** letter to "C" for example and the **Icon label** name to whatever name to you want to see on the Atari desktop for this partition.
- Click on **Install**, then move the new icon to the position you want it on the Atari desktop.
- Repeat this procedure for each of the partitions on the drive(s), incrementing the **Drive Identifier** letter each time.

✐ Make sure you use capital letter (for example C) for the drive identifier. Otherwise the system will think you are specifying a cartridge and the hard drive partition will not be accessible.

- Once you have added drive icons for all the partitions of all the hard disk drives, you can save the desktop by selecting **Save Desktop** command from the **Options** menu. This will write the **DESKTOP.INF** file on the boot drive. This file is used, when the computer is booted, to retrieve the defined environment (including disk drive icons).

[6] Partition size is given for TOS ≥ 1.04. Prior to this version the maximum partition size should be divided by 2
[7] Only supported in TOS 4.0. Officially only sector size of 16384 is supported (maximum size 1GB)

Chapter 3. TOS/GEMDOS Limitations

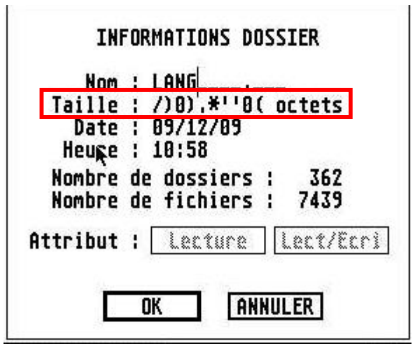
We have seen that the file system used to partition a hard disk introduces some limitation. On top of that the TOS/GEMDOS OS adds more limitations which are different for different versions of TOS and GEMDOS. The following sections present some of these limitations.

3.1 TOS and Long File Name (LFN)

On Atari the file names recognized by TOS/GEMDOS system are limited to 8+3 Characters. Before transferring files from a PC to an Atari you have to make sure that all files and folders names are following the 8+3 specification and contains only capital letters. A PC tool like ***Total Commander*** can help you for that matter. If you do not follow these **two constraints** you may get unexpected behaviors.

Of course this problem only applies to the **DOS** or **TOS&DOS** partitions that are accessible on a PC as it is not possible to create such files on a TOS system. The long file names on FAT16 partitions are stored using special invalid entries in the directory table that TOS do not understand, and therefore **do not handle** correctly.

If a partition contains files with long file name watch out for the following problems:


INFORMATIONS DOSSIER

Nom : LANG
Taille : /)0).*''0(octets
Date : 09/12/09
Heure : 10:58
Nombre de dossiers : 362
Nombre de fichiers : 7439
Attribut : Lecture Lect/Ecri

- If you ask for the size of a folder (or drive) containing LFN, with for example the desktop ***"File Info …"*** you will get a large and erroneous number for the size of a tree. The number can get so huge (resulting in an overflow) that invalid character will show up in the size field (see picture - ***Taille*** is ***Size*** in French).
- If a program tries to copy a directory that contains LFN it will probably complains of not being able to access files with strange name and terminates. This is the case for example if you try to copy this kind of directory by dragging and dropping it from the desktop. In this case the copy is done partially with a very brief error message and the copy operation terminates prematurely.
- If you delete a file with a long file name **the directory structure will get corrupted** (it will contains invalid entries left over that won't be understood even by Windows).

Note that BigDOS fix the problem of LFN for DOS/FAT or TOS&DOS partitions. You won't be able to see Long File Names on the Atari but they will be handled correctly if BigDOS has been loaded.

Technical details:

If you are interested by technical details you can read the rest of this section (see also DOS/FAT Long file names for more information)

Here is an example of the content of the directory table with long file name:

```
Offset     0  1  2  3  4  5  6  7   8  9  A  B  C  D  E  F
0002A000  53 48 4F 52 54 20 20 20  54 58 54 20 00 0F 9B 81   SHORT   TXT ..›□
0002A010  8D 3B 8D 3B 00 00 A0 8C  8C 3B 02 00 0E 00 00 00   □;□;.. ŒŒ;......
0002A020  44 54 00 58 00 54 00 00  00 FF FF 0F 00 43 FF FF   DT.X.T...ÿÿ..Cÿÿ
0002A030  FF FF FF FF FF FF FF FF  FF FF 00 00 FF FF FF FF   ÿÿÿÿÿÿÿÿÿÿ..ÿÿÿÿ
0002A040  03 52 00 59 00 20 00 4C  00 4F 00 0F 00 43 4E 00   .R.Y. .L.O...CN.
0002A050  47 00 20 00 4E 00 41 00  4D 00 00 00 45 00 2E 00   G. .N.A.M...E...
0002A060  02 41 00 4D 00 50 00 4C  00 45 00 0F 00 43 20 00   .A.M.P.L.E...C .
0002A070  4F 00 46 00 20 00 41 00  20 00 00 00 56 00 45 00   O.F. .A. ...V.E.
0002A080  01 54 00 48 00 49 00 53  00 20 00 0F 00 43 49 00   .T.H.I.S. ...CI.
0002A090  53 00 20 00 41 00 4E 00  20 00 00 00 45 00 58 00   S. .A.N. ...E.X.
0002A020  54 48 49 53 49 53 7E 31  54 58 54 20 00 92 9D 81   THISIS~1TXT .’□□
0002A0B0  8D 3B 8D 3B 00 00 A0 8C  8C 3B 03 00 0E 00 00 00   □;□;.. ŒŒ;......
0002A0C0  53 48 4F 52 54 46 4C 44  20 20 20 10 00 72 A3 81   SHORTFLD   ..r£□
0002A0D0  8D 3B 8D 3B 00 00 A4 81  8D 3B 04 00 00 00 00 00   □;□;..¤□□;......
0002A0E0  42 41 00 4D 00 45 00 00  00 FF FF 0F 00 68 FF FF   BA.M.E...ÿÿ..hÿÿ
0002A0F0  FF FF FF FF FF FF FF FF  FF FF 00 00 FF FF FF FF   ÿÿÿÿÿÿÿÿÿÿ..ÿÿÿÿ
0002A100  01 4C 00 4F 00 4E 00 47  00 20 00 0F 00 68 46 00   .L.O.N.G. ...hF.
0002A110  4F 00 4C 00 44 00 45 00  52 00 00 00 20 00 4E 00   O.L.D.E.R... .N.
0002A120  4C 4F 4E 47 46 4F 7E 31  20 20 20 10 00 4E A7 81   LONGFO~1   ..N§□
0002A130  8D 3B 8D 3B 00 00 A8 81  8D 3B 05 00 00 00 00 00   □;□;..¨□□;......
0002A140  00 00 00 00 00 00 00 00  00 00 00 00 00 00 00 00   ................
```

Relevant information:

- Entry 1 at 0x2A000 is a file entry (FA = 0x20 – Archive bit at 0x2A00B). As the file has a short name it is entered directly in the DOS file name field. In this case "SHORT.TXT"
- Entries 2 to 5 starting at 0x2A020 are dummy LFN entries (FA = 0x0F – RO +Hidden + System + Volume at 0x2A02B). This is where the long name is coded using UTF-16 Format. The name is scattered in each record (shown in blue above). The first byte of each entry is the sequence number.
- Entry 6 starting at 0x2A020 is the actual descriptor for the file (FA = 20) with the long file name. The name field contains a short (and unique) 8.3 equivalent of the long name. In this case "THISIS~1.TXT".

If we delete the first file with a long file name on an Atari the directory table is modified as follow:

```
Offset      0  1  2  3  4  5  6  7   8  9  A  B  C  D  E  F
0002A000   53 48 4F 52 54 20 20 20  54 58 54 20 00 0F 9B 81   SHORT   TXT ..›□
0002A010   8D 3B 8D 3B 00 00 A0 8C  8C 3B 02 00 0E 00 00 00   □;□;.. ŒŒ;......
0002A020   44 54 00 58 00 54 00 00  00 FF FF 0F 00 43 FF FF   DT.X.T...ÿÿ..Cÿÿ
0002A030   FF FF FF FF FF FF FF FF  FF FF 00 00 FF FF FF FF   ÿÿÿÿÿÿÿÿÿÿ..ÿÿÿÿ
0002A040   03 52 00 59 00 20 00 4C  00 4F 00 0F 00 43 4E 00   .R.Y. .L.O...CN.
0002A050   47 00 20 00 4E 00 41 00  4D 00 00 00 45 00 2E 00   G. .N.A.M...E...
0002A060   02 41 00 4D 00 50 00 4C  00 45 00 0F 00 43 20 00   .A.M.P.L.E...C .
0002A070   4F 00 46 00 20 00 41 00  20 00 00 00 56 00 45 00   O.F. .A. ...V.E.
0002A080   01 54 00 48 00 49 00 53  00 20 00 0F 00 43 49 00   .T.H.I.S. ...CI.
0002A090   53 00 20 00 41 00 4E 00  20 00 00 00 45 00 58 00   S. .A.N. ...E.X.
0002A0A0   E5 48 49 53 49 53 7E 31  54 58 54 20 00 92 9D 81   åHISIS~1TXT .'□□
0002A0B0   8D 3B 8D 3B 00 00 A0 8C  8C 3B 03 00 0E 00 00 00   □;□;.. ŒŒ;......
0002A0C0   53 48 4F 52 54 46 4C 44  20 20 20 10 00 72 A3 81   SHORTFLD   ..r£□
0002A0D0   8D 3B 8D 3B 00 00 A4 81  8D 3B 04 00 00 00 00 00   □;□;..¤□□;......
0002A0E0   42 41 00 4D 00 45 00 00  00 FF FF 0F 00 68 FF FF   BA.M.E...ÿÿ..hÿÿ
0002A0F0   FF FF FF FF FF FF FF FF  FF FF 00 00 FF FF FF FF   ÿÿÿÿÿÿÿÿÿÿ..ÿÿÿÿ
0002A100   01 4C 00 4F 00 4E 00 47  00 20 00 0F 00 68 46 00   .L.O.N.G. ...hF.
0002A110   4F 00 4C 00 44 00 45 00  52 00 00 00 20 00 4E 00   O.L.D.E.R... .N.
0002A120   4C 4F 4E 47 46 4F 7E 31  20 20 20 10 00 4E A7 81   LONGFO~1   ..N§□
0002A130   8D 3B 8D 3B 00 00 A8 81  8D 3B 05 00 00 00 00 00   □;□;..¨□□;......
0002A140   00 00 00 00 00 00 00 00  00 00 00 00 00 00 00 00   ................
```

We can see that now only the 8.3 entry at 0x2A0A0 is mark as erased (0xE5) but the associated dummy LFN entries (grayed above) starting at 0x2A020 are left untouched which is pretty bad!

It is also interesting to note that even with BigDOS loaded the same, bad, behavior happen that is the dummy LFB are **not** erased. ??? TODO check

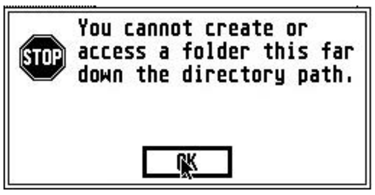
3.2 TOS Maximum Path Depth

All the TOS versions prior to 2.x have a limitation for the maximum depth level of a path that can be manipulated from the desktop. This maximum level is equal to 8.

By depth level I mean the number of path elements located between separators. For example C:\Folder1 is one level deep; C:\FOLDER1\Folder2 is two level deep, etc…

Therefore from the desktop:

- You cannot create a folder above 8 levels
- You cannot copy a folder tree that has more than 8 levels
- Universal Item selector won't let you create a new folder on level above 8.


You cannot create or access a folder this far down the directory path.

However:

- You can access from the desktop folder and files at any level (of course if they already exist).
- From a **program** it is possible to create and access correctly more than 8 levels. This seems to indicate that the problem does not reside in GEMDOS.

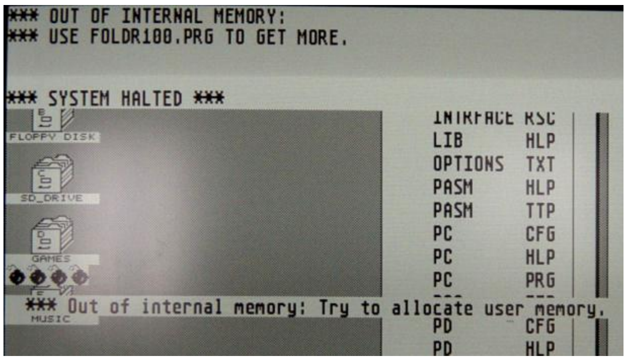
3.3 TOS Maximum Number of Folders

Atari's TOS has a bug; known as the "40-folders limit". Every time you access a folder information about that folder is loaded into a memory table. As the memory table's size is small it runs out of space after you've touched around 40 folders. After that the disk operating system might write incorrectly sectors resulting in lost clusters, cross-linked clusters, etc. To make this worse, folder "slots" are used up just by doing ***"Show Info…"*** and therefore it is easy to run out of folder slots. One common symptom of this is that when you open up a new directory box, and you get data or program files that belong somewhere else. Or you get “0 files in 0 items” box, making you think everything has just been erased.

✐ If this happens, reboot immediately; if you write anything to that hard disk, you're going to damage the directory structure. Your data is probably still out there and still okay. Upon restarting, go immediately to the offending directory, and try again; if it works this time you were lucky.

Atari has released an "official" 40-folder bug fixer program, called FOLDRXXX. What you do is put this program in your AUTO folder with the XXX replaced by how many folder slots you'd like to reserve. For instance, for 100 folders, name the program "FOLDR100.PRG" in the AUTO folder. At boot-up, FOLDRXXX adds more memory to the folder memory space.

Starting with TOS 1.04 or above Atari has rewritten the GEMDOS and this problem is **partially** solved: Memory is used only by open folders and not anymore by touched folders (prior to 1.04 the memory was not recycled). This means that you are running out of folder memory less rapidly. But you can still run out of folders (see the Discussion of OS Pool for more details).

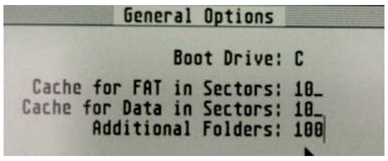


```
*** OUT OF INTERNAL MEMORY:
*** USE FOLDR100.PRG TO GET MORE.

*** SYSTEM HALTED ***
*** Out of internal memory: Try to allocate user memory.
```

It seems that TOS 2.X and above definitely fix the problem (but I have not tested it).

The TOS system does not handle gracefully running out of folders. The picture shows the messages displayed by the system when a program tries to access too many folders.

Several programs/utilities fix the “40-folder bug”. We have already mentioned the FOLDRXXX.PRG released by Atari but many other utilities also fix this problem. In particular many Hard Disk driver provide an option to increase the number of buffers allocated for folder. The picture on the right shows the option (in general options) to allocate additional folders with the HDDRIVER hard disk driver.



```
General Options

          Boot Drive: C

Cache for FAT in Sectors: 10_
Cache for Data in Sectors: 10_
      Additional Folders: 100
```

3.4 TOS Maximum number of files

Depending on the TOS version the maximum number of files and folders for FAT16 (AHDI) partitions is limited to a maximum of about 32000.

3.5 TOS Maximum number of partitions

It is difficult to find information about this limit in the literature. However it seems that the maximum number of Hard Disk partitions that can be “installed” (or I should say “mounted”) on a system is 14. The standard Atari File Selector only goes from letter A to P (2 letters for the floppy disks, and 14 letters for the hard disks). This limitation is clearly indicated in the Atari AHDI 3.00 Release notes (in the PUN section page 15) where the MAXUNITS parameter is defined as 16 (including floppy drive A: and B:). It does not seem that new releases of TOS have changed this limit.

Note that this maximum limit is to ***share*** *for all the connected drive. This also implies also that the maximum number of partitions for one drive is 14.*

With BigDOS the limit is uplifted to 29 (C – Z except U) + 1-6.

With Mint the limit is 23 partitions (C – Z except U).

3.6 Discussion of OS Pool (from Rainbow TOS release notes)

There are internal limits in GEMDOS which programmers and users must understand. In a broad sense, you should know that these limits have to do with the *maximum depth of your hierarchical file structure* (subdirectories), and the *number of open files* you can have at once. In most cases, users will never come up against any of these limits.

The limits come into play when you have lots of files open at the same time, and they are deep in different subdirectory trees. Also, programs which call the operating system function Malloc (memory allocator) influence these limits: lots of Malloc calls means less space is available for keeping track of open files and the subdirectories leading up to them.

Technically, the limits are as follows: there are 80 blocks in the system's "OS pool" two blocks are used per active folder. An "active" folder is one which is the root directory of the device it's on, or which has open files, or which is somebody's current directory, or which has an "active" child (subdirectory). Yes, this is a recursive definition. Remember that each process has a current directory on every logical device, but also remember that one folder only takes up two blocks, no matter how many reasons its "active."

In addition, one block is used per open file, and 1/4 block is used per memory chunk (allocated or free) in the system memory.

When files are closed, memory chunks are freed, and when processes terminate, blocks are treed back into the OS pool.

The TOS 1.4 and above has the following improvement over previous ROMs: the old definition of "active" was "seen" getting a list of the files in a directory caused all the folders there to take up blocks in the pool. In addition, blocks were never freed in the pool. Also, once parts of the pool had been used for managing Malloc memory chunks, they were unavailable for managing folders, and vice versa. All these restrictions are lifted.

It is still possible to run out of OS pool, of course. The program FOLDR100.PRG was released by Atari and is part of the HDX (hard disk utilities) distribution. It adds memory to the OS pool, and it still works, adding memory to the new kind of pool, too. Placing this program in your AUTO folder causes 200 more blocks to be added to the OS pool, which is room for 100 more folders (remember, only **active** folders take up room) or 800 more memory chunks, or any combination.

The name FOLDR100.PRG can be changed: the three digits in the name are interpreted as the number of "folders" you want to add at two blocks each. So FOLDRO5O.PRG would add only 100 blocks, while FOLDR200.PRG would add 400. No matter where the program is started from, it looks for itself in the \AUTO\ folder of the boot device to determine how many blocks to add.

It is to be stressed that this program usually will not be necessary. Only if you have an inordinate number and depth of folders, open files, etc. will you run out of pool, because it is so much more efficiently managed than before.

In the unlikely event that you do run out of pool, the following message will appear on your screen:

```
*** OUT OF INTERNAL MEMORY:
*** USE FOLDR100.PRG TO GET MORE

*** SYSTEM HALTED ***
```

This message appears in English regardless of the country you are in.

It is regrettable but true that there is nothing you can do at this point but hit the reset button or use the keyboard reset combination (CTRL-ALT-DELETE). Remember what you were doing when this happened: were you trying to create a directory that was 50 levels deep in the hierarchy? Were you opening the tenth different file in the tenth different subdirectory? If you really want to be able to do whatever you were stopped from doing, use FOLDR100.PRG (or increase the "100" if you're already using it).

Note: the system call Malloc will never cause a panic: it will just return 0, meaning it couldn't satisfy the request. When this happens, however, your program has stretched the limits of the system, because that means there is not even 1/4 of one block available for the memory manager. At this point a well-designed program will detect the condition (out of memory) and terminate, freeing up enough blocks to be useful.

3.7 TOS Version Specific Limitations

The information presented here comes from the *Towns' Little Guide to Revisions - Version 1.0* written by John Townsend from Atari Corporation

3.7.1 ROM TOS 1.0 - 520ST and 1040ST

The original TOS shipped with 520ST and 1040ST computers. This version is relatively slow and has a lot of problems with disk I/O. You should try to avoid using hard disks with this version.

Utilities: FOLDRXXX.PRG

3.7.2 MEGA TOS 1.02 - 520ST, 1040ST, Mega 2/4

This version of TOS fixes some minor problems in TOS 1.0 and has support for the BLiTTER chip and Real-Time Clock chip. This version is relatively slow and has a lot of problems with disk I/O. You should try to avoid using hard disks with this version.

Utilities: FOLDRXXX.PRG

3.7.3 Rainbow TOS 1.04 – 520ST, 1040ST, Mega 2/4

TOS 1.04 or Rainbow TOS, as it is commonly known is the latest version of TOS released for 520/1040/MEGA owners. It has been provided as a dealer upgrade. It has much more robust Disk I/O, Auto running of GEM programs at boot up, a fix for the 40 folder limit, and much more. Most of all is it much faster than previous versions of the Operating System.

Utilities: TOS14FIX.PRG, POOLFIX3.PRG, CACHEXXX.PRG, FOLDRXXX.PRG

3.7.4 STE TOS 1.06 - 1040STE and 520STE

TOS 1.06 is the TOS version that was shipped with the 1040STE and 520STE machines. It is essentially TOS 1.04 with support for the new hardware that the STe has.

Utilities: STE_FIX.PRG, POOLFIX3.PRG, CACHEXXX.PRG, FOLDRXXX.PRG

3.7.5 STE TOS 1.62 - 520STE, 1040STE

This is a slightly revised revision of TOS 1.6. It fixes the POOLFIX problem in GEMDOS and the problem in the Desktop that was present in TOS 1.06.

Utilities: CACHEXXX.PRG, FOLDRXXX.PRG

3.7.6 Mega STE TOS 2.05 - Mega STE

TOS 2.05 is the version of TOS shipping in the Mega STe.

Utilities: CACHEXXX.PRG, FOLDRXXX.PRG

3.7.7 TT TOS 3.01 - TT030

TOS 3.01 is the version of TOS that originally shipped in the TT030.

Utilities: CACHEXXX.PRG, FOLDRXXX.PRG

3.7.8 TT TOS 3.05 - TT030

TOS 3.05 is the latest version of TOS that shipped in the TT030.

Utilities: CACHEXXX.PRG, FOLDRXXX.PRG, SERPTCH1.PRG

3.7.9 Falcon TOS 4.X

TOS 4.x is the version of TOS that shipped in the Falcon

Chapter 4. Atari Hard Disk Drivers Packages

This chapter provides a quick guide of several Atari hard disk drivers usage. It is primarily written for users of **CosmosEX**, **UltraSatan**, and **Satan** devices. If you want to use these drivers with other hardware or need more advance options you should refer to the ***original documentation***.

For each driver we provide detailed procedures to:

- Partition and initialize a drive,
- Install the hard disk driver, and
- Eventually configure the installed hard disk driver.

4.1 Hardware Configurations Tested

Due to the fact that I have access to a limited set of hardware, and a limited time, I have performed the tests with the following Atari Computers and Devices:

- Atari 1040 ST with US TOS 1.04 and 4 MB of RAM
- Atari 520 STE with French TOS 1.62 and 4 MB of RAM
- ***Satan*** Device, ***UltraSatan*** Device, and ***CosmosEx*** Device

4.2 Information on Removable Drive

In order to support removable media a hard disk driver needs specific features described by AHDI.

4.2.1 Disk Change Support

When the removable media is changed, the driver must recognize this the next time the drive is accessed and the drive must be logged again. If the new media has more partitions than the previous one, these should be added after the currently logged partitions.

4.2.2 Specification of the Maximum Logical Sector Size

In most of the drivers you have to specify a maximum logical sector size. At boot time, the driver will use this number to allocate internal read and write buffers. This is especially important when you need to switch media on a removable drive (e.g. on an UltraSatan), and the media are partitioned differently.

For example, suppose that you boot up the system and the size of the biggest logical sector on all the logical drives plugged in is 2048 bytes. Later, you need something from a removable media that has partitions whose logical sectors are 4096 bytes big (call it removable media A). If the maximum logical sector size has been set to 2048, you cannot access the partitions on removable media A whose logical sectors are 4096 bytes big, because the driver buffers are not big enough for its logical sectors.

4.2.3 Number of Partitions on a Card

With drivers that support removable media, usually you can specify the number of drive letters to be reserved for each unit. This number will only be used if the unit supports a removable media.

This is useful when you need to switch media on a removable drive (e.g. on an UltraSatan), and the medias are partitioned differently. At boot time, the driver will use this number, or the number of logical drives on a removable drive, whichever is bigger, and assign that number of drive letters to that particular unit. For example, suppose that you boot with a media that has two partitions on it (call it media A) in the drive. Later, you need something from another media that has four partitions on it (call it media B). If the reserved number of drive letters for this removable drive has not been set to be greater than two, you cannot access the last two partitions on media B, because only two drive letters were reserved for this removable drive.

4.3 Things to check before you start

4.3.1 Satan device

Satan device has limited ICD command support and no HxSD card support. Therefore most driver will only support 1GB media except PPDRIVER that correctly detects cards up to 2GB.

4.3.2 UltraSatan device

Due to incompatibilities with the SCSI standard in old UltraSatan firmware versions HDDRIVER and PPDRIVER only supports UltraSatan firmware versions 1.13 or newer. It is therefore recommended that UltraSatan users flash their device to the latest firmware.

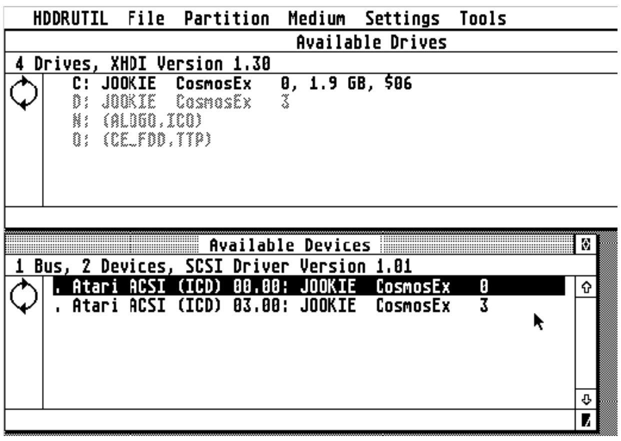
4.4 HDDRIVER 9.02 Driver Package

This section presents a quick procedure to follow to use **HDDRIVER** 9.02 hard disk driver package on **CosmosEx** or **UltraSatan** device. The HDDRIVER package is a commercial application that you can buy from Uwe Seimet HERE. **For detail information please refer to the provided documentation**.

Many improvements and bug fixes has been included in V9.x. For ***UltraSatan*** *and* ***CosmosEx*** *users on ST machine the most important feature added (actually added on version 8.40+) is the support for* ***multiple*** *TOS & Windows partition on compatible media. The configuration of the driver is also much easier as it automatically detect if the drive support ICD extensions.*

4.4.1 Partitioning a drive

In order to use the **HDDRUTIL.APP** utilities the HDDRIVER hard disk driver has to be loaded. Normally this is done automatically if you boot from the HDDRIVER diskette as the **HDDRIVER.PGR** program is located in the Auto folder. The driver displays a welcome screen and displays information about all the connected devices and eventually already existing partitions.

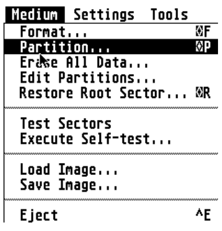


```
HDDRUTIL  File  Partition  Medium  Settings  Tools
                    Available Drives
4 Drives, XHDI Version 1.30
   C: JOOKIE  CosmosEx    0, 1.9 GB, $06
   D: JOOKIE  CosmosEx    3
   N: (ALDGO.ICO)
   O: (CE_FDD.TTP)

                    Available Devices
1 Bus, 2 Devices, SCSI Driver Version 1.01
 . Atari ACSI (ICD) 00.00: JOOKIE  CosmosEx   0
 . Atari ACSI (ICD) 03.00: JOOKIE  CosmosEx   3
```

HDDRUTIL.APP program displays two windows with all known devices and partitions. The device or partition to operate on can be selected from these lists. The operations available for the selected item are enabled in the main menu and are also offered by a context menu, which is displayed when selecting an item with the right mouse button.

As we are starting with a DOS formatted SD card on a CosmosEx device only one partition is shown here.

Select the device that contains the media you want to partition from the *Devices Window* and from the ***Medium*** menu select the ***Partition*** command.

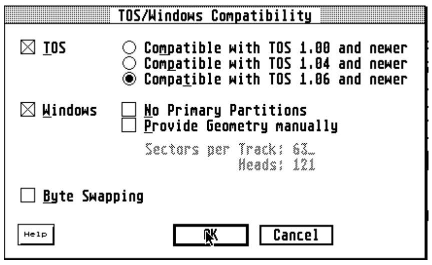


The Partition form will popup. If the hard disk has already been partitioned you will see the current values otherwise you will see some default values.

First you need to define the type of partition you want to create by clicking on the ***Compatibility*** button in the partition window. This open the *Compatibility Option* window. You have three choices: TOS only, Windows only, and TOS & Windows.

4.4.1.1 Creating a Windows only partition

If you want to create DOS/Window only partitions I recommend that you use specific tools directly on the PC.



```
TOS/Windows Compatibility

[x] TOS       ( ) Compatible with TOS 1.00 and newer
              ( ) Compatible with TOS 1.04 and newer
              (•) Compatible with TOS 1.06 and newer

[x] Windows   [ ] No Primary Partitions
              [ ] Provide Geometry manually
                  Sectors per Track: 63_
                              Heads: 121

[ ] Byte Swapping

Help                      OK      Cancel
```

4.4.1.2 Creating a TOS only partition

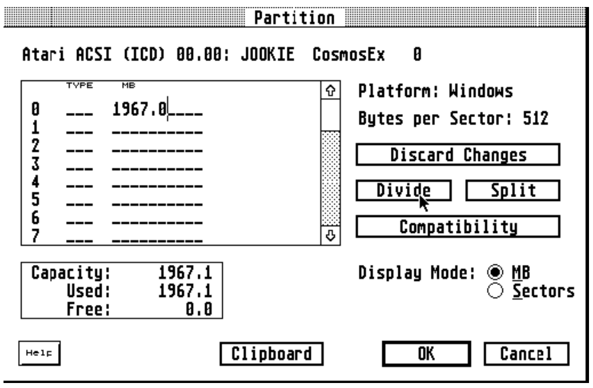
Check the ***TOS*** checkbox and uncheck the ***Windows*** checkbox. Select the TOS level of compatibility you want with the radio button and click ***OK***.

4.4.1.3 Creating a TOS & Windows Partition

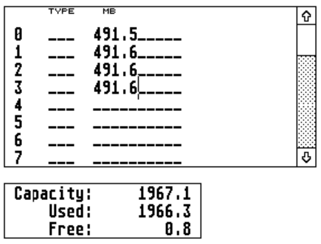
The "TOS & Windows Combined" checkbox from previous version of HDDRIVER has been removed. In order to create TOS & Windows compatible media simply check both the ***TOS*** and ***Windows*** checkboxes. Select the TOS level of compatibility you want with one of the radio buttons. You probably want to leave the two checkboxes in the Windows section uncheck, unless you know what you are doing (refer to your documentation). Click ***OK*** this return you to the partition window.

4.4.1.4 Actual Partitioning

Once you have defined the compatibility options for the partitions you are returned to the main partition window. In the ***MB*** field you have to specify the size of every partition you want to create. Usually you do not want to enter any value in the ***TYPE*** fields unless you know exactly what you are doing (please refer to the HDDRIVER documentation).



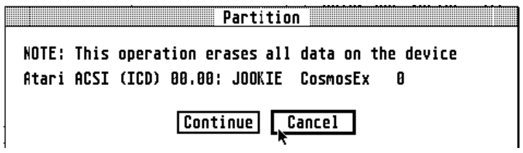
```
Partition
Atari ACSI (ICD) 00.00: JOOKIE  CosmosEx   0
  TYPE  MB
0 ___  1967.0____          Platform: Windows
1 ___  __________          Bytes per Sector: 512
2 ___  __________          [Discard Changes]
3 ___  __________          [Divide]  [Split]
4 ___  __________          [Compatibility]
5 ___  __________
6 ___  __________
7 ___  __________
Capacity:   1967.1         Display Mode: ● MB
    Used:   1967.1                       ○ Sectors
    Free:      0.0
[Help]      [Clipboard]      [OK]  [Cancel]
```



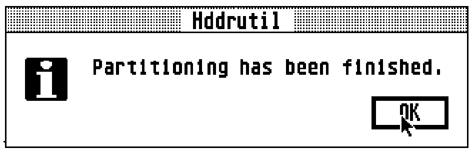
```
  TYPE  MB
0 ___  491.5_____
1 ___  491.6_____
2 ___  491.6_____
3 ___  491.6_____
4 ___  __________
5 ___  __________
6 ___  __________
7 ___  __________
Capacity:   1967.1
    Used:   1966.3
    Free:      0.8
```

Enter the size for all the partitions you want to create. Remember that for example with TOS 1.04 the partitions must be less than 512MB. Verify also that the total size of all partitions you have defined is less than the available capacity.

Click ***OK*** to start the partitioning. At the end a window indicates that the partitioning has been finished. Note that the initialization of the partitions is done as part of the partitioning.

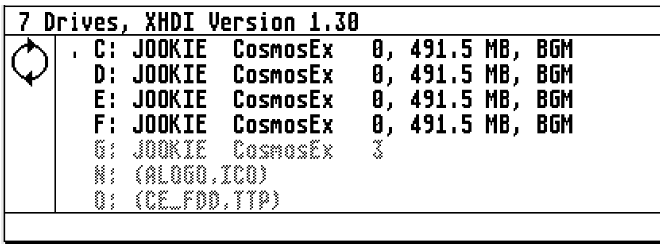


```
Partition
NOTE: This operation erases all data on the device
Atari ACSI (ICD) 00.00: JOOKIE  CosmosEx   0
        [Continue]  [Cancel]
```

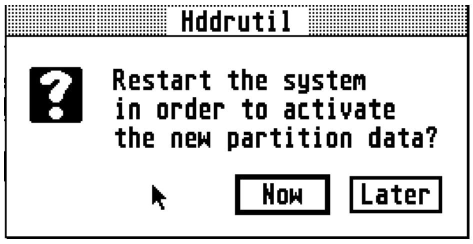


```
Hddrutil
Partitioning has been finished.
                         [OK]
```

The Drives Window now displays all the created partitions. The program proposes to restart the system and it is better to select Now.



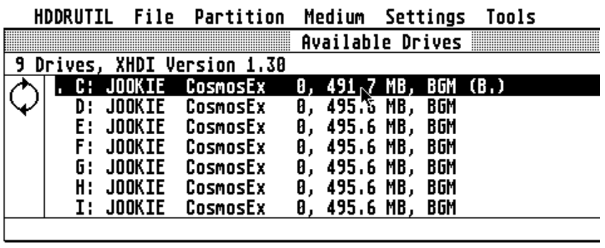
```
7 Drives, XHDI Version 1.30
. C: JOOKIE  CosmosEx   0, 491.5 MB, BGM
  D: JOOKIE  CosmosEx   0, 491.5 MB, BGM
  E: JOOKIE  CosmosEx   0, 491.5 MB, BGM
  F: JOOKIE  CosmosEx   0, 491.5 MB, BGM
  G: JOOKIE  CosmosEx   3
  N: (ALOGO.ICO)
  O: (CE_FDD.TTP)
```



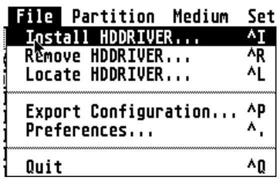
```
Hddrutil
Restart the system
in order to activate
the new partition data?
        [Now]  [Later]
```

4.4.2 Enabling and Disabling Auto boot

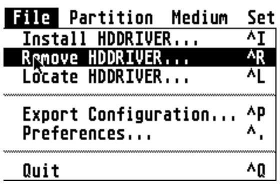
Execute the **HDDRUTIL.APP** program. Select the Partition you want to use to boot from. The primary partitions suitable for an installation are marked with a leading '**.**'.



```
HDDRUTIL  File  Partition  Medium  Settings  Tools
Available Drives
9 Drives, XHDI Version 1.30
. C: JOOKIE  CosmosEx   0, 491.7 MB, BGM (B.)
  D: JOOKIE  CosmosEx   0, 495.6 MB, BGM
  E: JOOKIE  CosmosEx   0, 495.6 MB, BGM
  F: JOOKIE  CosmosEx   0, 495.6 MB, BGM
  G: JOOKIE  CosmosEx   0, 495.6 MB, BGM
  H: JOOKIE  CosmosEx   0, 495.6 MB, BGM
  I: JOOKIE  CosmosEx   0, 495.6 MB, BGM
```



From the ***File*** menu select the ***Install HDDRIVER…*** command. A confirmation will be asked and a popup window will indicate that the driver has been installed.



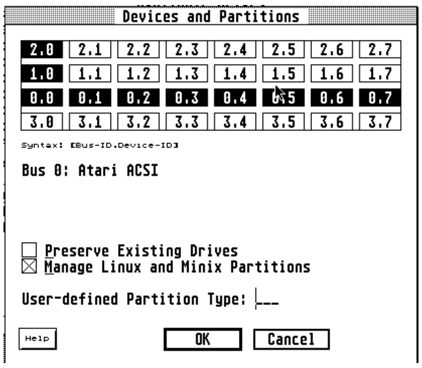
To disable the Auto boot: From the ***File*** menu select the ***Remove HDDRIVER…*** command and follow the instructions.

4.4.3 Configuring the HDDRIVER Hard Disk Driver

Run the **HDDRUTIL.APP.** The **hddriver.sys** driver of the boot partition is automatically selected for you. With HDDRIVER 9.x most of the default values required for **CosmosEx**, and **UltraSatan** users are already set to what you want.

4.4.3.1 Devices & Partitions managed by HDDRIVER

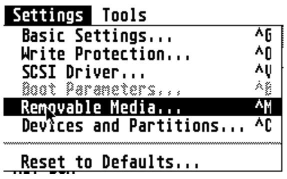
- From the ***Settings*** menu select the ***Devices and Partitions…*** command. You are presented a window with the Devices and Partitions options. Make sure that all devices 0.x are checked (other might be checked too). This will ensure that all ACSI devices (with IDs from 0 to 7) are handled by HDDRIVER.



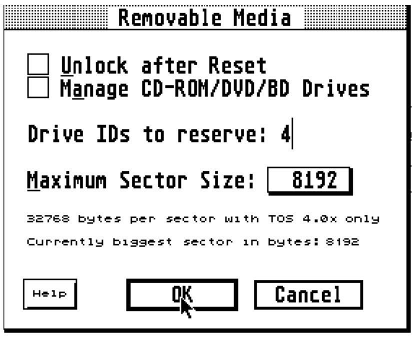
```
Devices and Partitions

2.0  2.1  2.2  2.3  2.4  2.5  2.6  2.7
1.0  1.1  1.2  1.3  1.4  1.5  1.6  1.7
0.0  0.1  0.2  0.3  0.4  0.5  0.6  0.7
3.0  3.1  3.2  3.3  3.4  3.5  3.6  3.7
Syntax: [Bus-ID.Device-ID]

Bus 0: Atari ACSI

[ ] Preserve Existing Drives
[X] Manage Linux and Minix Partitions

User-defined Partition Type: ___

Help          OK      Cancel
```

4.4.3.2 Removable Medium Drive Support

The HDDRIVER driver supports removable media drives. When the media is changed, the driver recognizes this the next time the drive is accessed. If the new card has more partitions than the previous, these are added after the currently logged partitions. To support removable medium you need to set the minimum number of partitions and sector size (see Important Parameters for Removable Drive).



Run the **HDDRUTIL.APP**. From the ***Settings*** menu select the ***Removable Media…*** command.



```
Removable Media

[ ] Unlock after Reset
[ ] Manage CD-ROM/DVD/BD Drives

Drive IDs to reserve: 4

Maximum Sector Size: 8192

32768 bytes per sector with TOS 4.0x only
Currently biggest sector in bytes: 8192

Help        OK        Cancel
```

You are presented a window with the Removable media options. Set the ***Drive ID to reserve*** to the maximum number of partitions to be expected on any of the media you plan to use. Set also the ***maximum sector size*** to the larger value for all the partitions on all the media.

4.4.4 Accessing DOS Partitions

HDDRIVER can directly access FAT16A partitions of less than 32 Mbytes.

When used with **BigDOS** the HDDRIVER allows access to FAT16B partitions of up to 2GB.

4.4.5 Accessing TOS & Windows Partitions

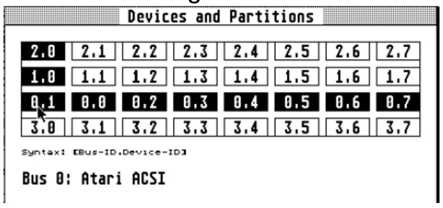
HDDRIVER allows access to TOS & Windows partitions created by HDDRIVER.

Important Warning: never try to access TOS&DOS partitions created by PPDRIVER hard disk driver with HDDRIVER as they are not compatible.

Remember that with TOS 1.04 the size of the partitions is limited to 512MB. It is possible to create several TOS & Windows partitions on a SD card with HDDRIVER. All these partitions can be accessed by the TOS on Atari and by Windows on a PC.

4.4.6 Special Care to boot from device other than ACSI ID0

If the device you want to boot from is not on ACSI ID0 you have to be very careful. Suppose you want to boot from an USB memory stick found on ACSI ID1. Just follow the standard procedure described in section 4.4.1. Reboot the system load the HDD driver and run the HDDUTIL. Install the driver on the first partition of the drive as described in 4.4.2 and immediately before you reboot enable all devices as described in 4.4.3.1. This will ensure that your device at ID1 will be seen correctly by HDD. You probably also want to mount this partition as C drive. By default ID0 device will get a reserved mount letter C. To change this you need to modify the order the HDD driver will scan the boot devices. In the ***Devices and Partitions*** form drag and drop the 0.1 entry on top of the 0.0 entry. This will force HDD to scan ID1 before ID0 and therefore the boot partition of the drive found at ACSI ID1 will be mounted as C.



```
Devices and Partitions

2.0  2.1  2.2  2.3  2.4  2.5  2.6  2.7
1.0  1.1  1.2  1.3  1.4  1.5  1.6  1.7
0.1  0.0  0.2  0.3  0.4  0.5  0.6  0.7
3.0  3.1  3.2  3.3  3.4  3.5  3.6  3.7
Syntax: [Bus-ID.Device-ID]

Bus 0: Atari ACSI
```

4.5 PPDRIVER 1.0 Driver Package

This section presents a quick procedure to use PPDRIVER 1.0 hard disk driver package with **UltraSatan** or **CosmosEx** devices.

The PPDRIVER package is a cheap 10€ application developed by P.Putnik that you can buy from HERE. This driver has limitations compared to HDDRIVER as it has been designed almost exclusively for **Satan**, **UltraSatan** and **CosmosEX** devices. It provides:

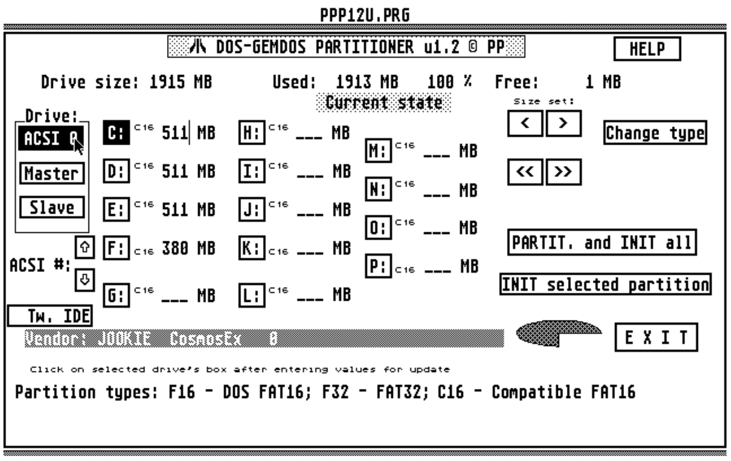
- Support Multiple TOS/DOS compatible partitions
- Bootable TOS&DOS Partition (512MB for TOS 1.04)
- Hot-swap support
- Easy selection of active C partition during boot
- Low RAM usage, Good Performance (pure ASM only code)
- Works on ST, STE, Mega ST, Mega STE, TT with minimum TOS v. : 1.02
- Ideal for gaming - easy setting, usage, no Timer dependence
- Directly support FAT16A DOS Partitions (< 32MB) and plain AHDI TOS partitions
- Maximal support for gamers: driver loadable without XHDI, in top RAM, with HOLE (for old games, not compatible with higher TOS versions)

4.5.1 Partitioning a drive

Start the Atari in medium or high resolution, insert the PPDRIVER diskette and double click on **PP12U.PRG**.

You first need to select the ACSI Id that contains the CosmosEx device. ***ACSI 0*** is shown by default. Ignore the ***Master***, ***Slave*** buttons that are used for IDE drives. If the drive is at a different ACSI Id address use the up and down arrows to select an Id between 0-7. ***Tw. IDE*** is for people with twisted IDE cable.

Once selected the correct ID click on the drive's button (for example ACSI 0), the disk Vendor and capacity will be shown. If any the previous partitioning is displayed for DOS compatible partitions.



```
PPP12U.PRG
DOS-GEMDOS PARTITIONER v1.2 © PP                    HELP
Drive size: 1915 MB      Used:  1913 MB   100 %  Free:    1 MB
                              Current state
                                                  Size set:
Drive:
ACSI 0    C: C16 511 MB   H: C16 ___ MB           <  >   Change type
                                     M: C16 ___ MB
Master    D: C16 511 MB   I: C16 ___ MB           <<  >>
                                     N: C16 ___ MB
Slave     E: C16 511 MB   J: C16 ___ MB
                                     O: C16 ___ MB
          F: C16 380 MB   K: C16 ___ MB           PARTIT. and INIT all
ACSI #:                              P: C16 ___ MB
          G: C16 ___ MB   L: C16 ___ MB           INIT selected partition
Tw. IDE
Vendor: JOOKIE  CosmosEx   0                       E X I T
Click on selected drive's box after entering values for update
Partition types: F16 - DOS FAT16; F32 - FAT32; C16 - Compatible FAT16
```

You now have to enter the desired sizes for each partitions starting with partition C. Each time you enter a value for a partition the free space field is updated. If the sum of all partitions gets bigger than the available space the free indicator shows NEG and in that case you must decrease some partitions.

C16 is default partition type, which correspond to TOS & DOS compatible FAT16A partition. You can also create FAT32 partitions, but you will need Magic or Mint to be able to access them on Atari. It is therefore recommended to leave the type to C16. To change the type you can click the Change type button or click the type indicator close to the drive letter.

Once you are satisfied with the partition sizes, click the ***PARTIT. and INIT all*** button.

Nothing is written on disk until you press the ***Go on!*** Button.

Note that ***Init*** button here means practically same as "format" in PC terminology.

After partitioning, you may check the result by clicking again the Drive button - it should show the new partitions as they are set.

Now you can Click ***EXIT***

4.5.2 Installing the Auto boot Driver

To install the auto boot driver you need to execute the **USAB10.TOS** program.

The driver installer will show all attached ACSI devices with target # and capacity detected. You first have to select the device you want by typing the target value and press ***I*** key to confirm installation (any other key will result in exit without install).

The program will install the driver in few seconds and will confirmed the installation. The drive is now ready. You can restart computer, and it will auto boot, and mount the partitions defined.

Note that contrary to other HD drivers, PPDRIVER does not install the boot code in a specific partition but in the free space (30KB) just after the MBR. This allow to select the C partition you want to use from the list of all the available partitions on the media at boot time.

Option for uninstalling driver does not exist, because it makes no sense. Driver will be simply deactivated if you install another driver on the media.

PPDRIVER supports TOS/DOS partitions created with the **PP12U.PRG** utility. It should also work with TOS&DOS partitions created with HDDRIVER.

Note that PPDRIVER does not have any configurable option. It does not support XHDI and does not include FOLDER100. This was done on purpose not to waste any space for gamers.

4.5.3 Removable Medium Drive Support

The PPDRIVER driver provides support for removable medium drives. The driver detects media change and reinstalls all partitions at the next disk access after the media has changed.

The user needs to refresh the Desktop with ***Escape*** key. If you close a window, and reopen it, the window will still show the old content until you press Escape key. This is strange, and indicates that obviously TOS do not use media change detection for hard disks in the Desktop.

4.5.4 Accessing DOS Partitions

PPDRIVER can directly access FAT16A partitions of less than 32 Mbytes.

PPDRIVER driver is not designed to work with BigDOS as it does not provide XHDI support. If want to use partitions over 512MB with BigDOS, you can download an older (and free) driver from P.Putnik site.

4.5.5 Accessing TOS&DOS Partitions

*Note that latest version of PPDRIVER allow access to TOS&DOS (TOS & Windows) partitions created by PPDRIVER **and** by HDDRIVER.*

Remember that with plain TOS the size of the partitions is limited to 512MB. Although it is possible to create several TOS & Windows partitions on a SD card with PPDRIVER, Windows normally only access one partition on a removable media. However by using the procedure describe in Accessing Multiple Partitions from SD Cards it is possible to access all the partitions created by PPDRIVER directly in Windows.

For example I have created 4 partitions using a 2GB SD card plugged on a CosmosEx device. As all the resulting partitions are below 512MB they can be read correctly directly from ST. Using the **Hitachi Microfilter** driver it is also possible to directly access these 4 partitions directly on Windows.

4.5.6 Driver usage

Most interesting feature is selecting active C partition during boot - just follow messages on screen.

Although driver auto boots only from DOS/TOS compatible partitions it handles AHDI (TOS) type partitioned disks/medias too. Therefore if drive with TOS partitions is attached (can't be a boot device), the partitions will be mounted.

Of course, you need to take care about the TOS partitions limit with a maximum of 14 (C-P).

There is another limit in this driver: a maximum of 3 ACSI targets is supported.

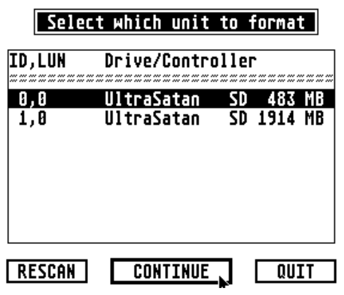
4.6 *ICD AdSCSI Pro 6.5.5 Driver Package*

This section presents the ICD AdSCSI Pro 6.5.5 hard disk package. This package used to be a commercial package but is now widely available as an abandon-ware. You can find it here.

4.6.1 Partitioning a drive

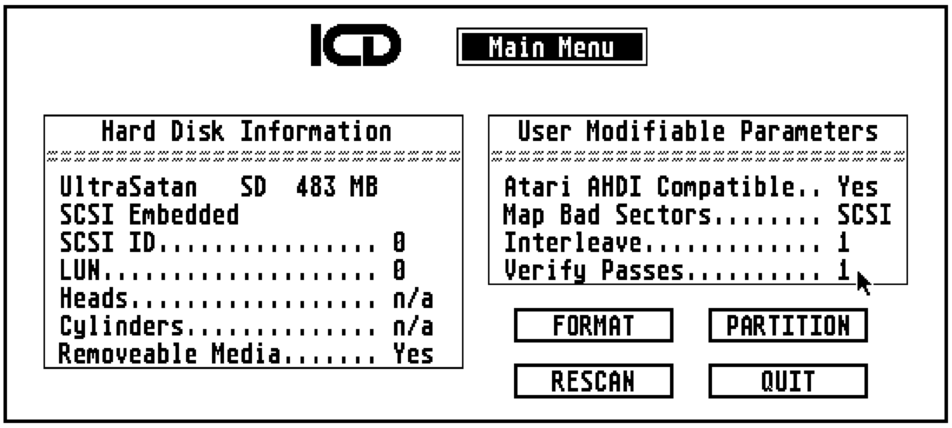
In order to use the ICD utilities the ICD hard disk driver has to be loaded first. If you boot your Atari with the ICD distribution diskette inserted in the floppy drive, the driver should load automatically as a copy of the **ICDBOOT.PRG** is placed in the AUTO folder. Otherwise you will have to manually execute the **ICDBOOT.PRG**. The driver displays a welcome screen as well as information about all the devices connected and eventually the already existing partitions on the drive.

You should now run the **ICDFMT.PRG**. After displaying a welcome screen the program will scan for hard drives and controllers. All the units found will be listed in a form. Select the Drive you want to partition (for example a specific SD Card inserted in an UltraSatan drive) and click ***CONTINUE***.



```
Select which unit to format

ID,LUN    Drive/Controller
0,0       UltraSatan    SD  483 MB
1,0       UltraSatan    SD 1914 MB
```

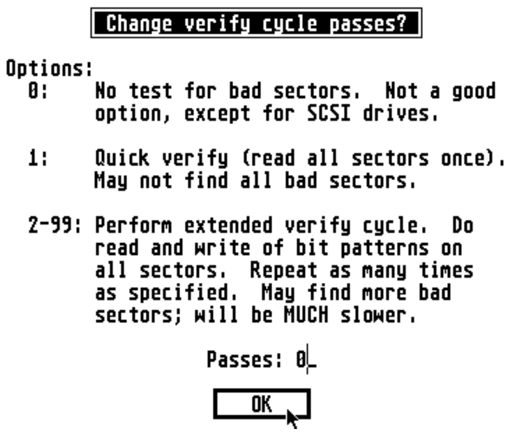
You will be brought to the main menu that displays some information, about the hard disk selected, on the left side and some user modifiable parameters on the right side.



```
Main Menu

Hard Disk Information
UltraSatan   SD  483 MB
SCSI Embedded
SCSI ID............... 0
LUN................... 0
Heads................. n/a
Cylinders............. n/a
Removeable Media...... Yes

User Modifiable Parameters
Atari AHDI Compatible.. Yes
Map Bad Sectors........ SCSI
Interleave............. 1
Verify Passes.......... 1
```

Usually the only parameter you need to modify is the ***Verify Passes*** (it is set to 1 initially). This parameter indicates the number of times each sector will be checked after partitioning to see if it is a bad sector.

Click ***Verify Passes***: This will bring a new form. Set the ***Passes*** parameter to 0, to bypass the sectors verification, and then click ***OK***.

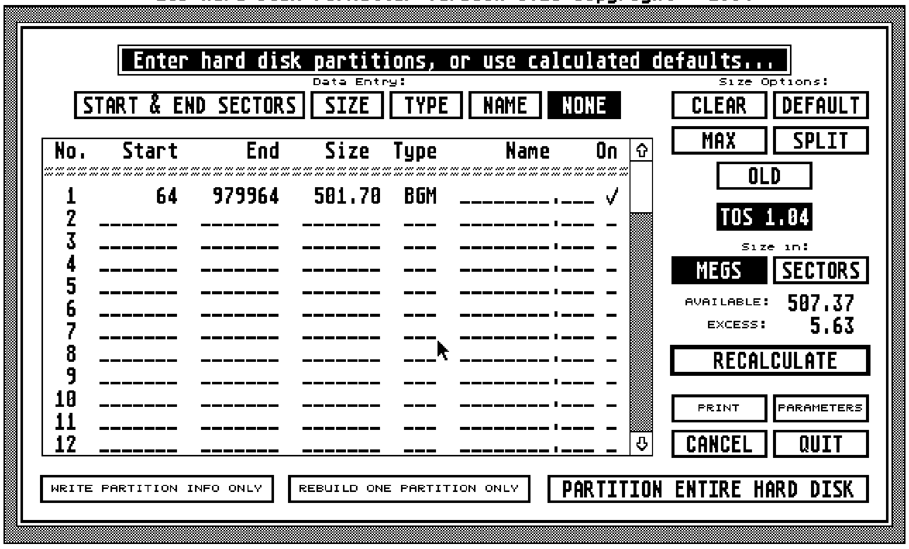


```
Change verify cycle passes?

Options:
  0:    No test for bad sectors.  Not a good
        option, except for SCSI drives.

  1:    Quick verify (read all sectors once).
        May not find all bad sectors.

  2-99: Perform extended verify cycle.  Do
        read and write of bit patterns on
        all sectors.  Repeat as many times
        as specified.  May find more bad
        sectors; will be MUCH slower.

              Passes: 0_
```

✐ If you do not set the Verify Passes parameter to 0 the partition operation will check all sectors in all the partitions on the drive and this can take a **very long time** on a large drive.

Now you should click ***PARTITION***. You are now presented the partition Main form. If the drive had already been partitioned you will see the values from the previous partitioning otherwise you will see some computed default values.

ICD Hard Disk Formatter Version 6.20 Copyright © 1994



Enter hard disk partitions, or use calculated defaults...

Data Entry: START & END SECTORS | SIZE | TYPE | NAME | NONE

No.	Start	End	Size	Type	Name	On
1	64	979964	501.78	BGM	--------.---	✓
2	-------	-------	-------	---	--------.---	-
3	-------	-------	-------	---	--------.---	-
4	-------	-------	-------	---	--------.---	-
5	-------	-------	-------	---	--------.---	-
6	-------	-------	-------	---	--------.---	-
7	-------	-------	-------	---	--------.---	-
8	-------	-------	-------	---	--------.---	-
9	-------	-------	-------	---	--------.---	-
10	-------	-------	-------	---	--------.---	-
11	-------	-------	-------	---	--------.---	-
12	-------	-------	-------	---	--------.---	-

Size Options: CLEAR | DEFAULT | MAX | SPLIT | OLD

TOS 1.04

Size in: MEGS | SECTORS

AVAILABLE: 507.37
EXCESS: 5.63

RECALCULATE | PRINT | PARAMETERS | CANCEL | QUIT

WRITE PARTITION INFO ONLY | REBUILD ONE PARTITION ONLY | PARTITION ENTIRE HARD DISK

The window has many fields that you can modify but the most useful ones are:

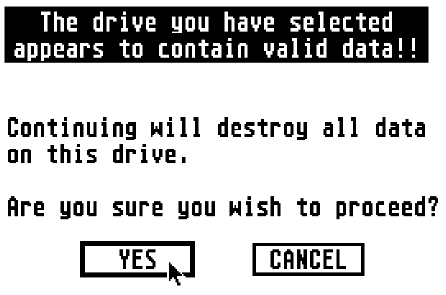
- The ***Size*** that specifies the size for each partition. Here you can enter the desired sizes for all the partitions that you want to create. At any time you can click ***RECALCULATE*** or hit return key to update the excess field (display the remaining space).
- ***Name*** is the name of the partitions. The ***Show Info...*** from the Atari desktop will display this value.
- The ***On*** column contains check marks for enabled partitions. Normally you always want to set a checkmark for all the partitions otherwise they will not be accessible (hidden).

Note that the size displayed and entered values are in MEGS (1000^2) and not in megabytes (1024^2).

Click ***PARTITION ENTIRE HARD DISK***: This writes the partition information based on values you have entered into the MBR of the hard drive. It will also write the boot sector, FAT, and directory information to each partition.

✐ **WARNING**: Before partitioning make sure you that you have a check mark in the **On** column for all the partitions. Otherwise the program will warn you. You can click **CANCEL** and set **On** flags.

The program asks you to confirm and displays progress information …

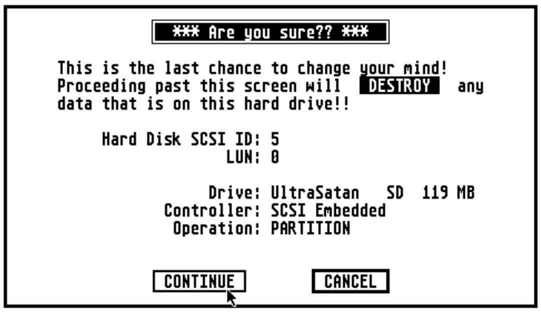


The drive you have selected appears to contain valid data!!

Continuing will destroy all data on this drive.

Are you sure you wish to proceed?

YES | CANCEL



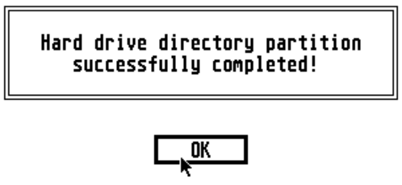
*** Are you sure?? ***

This is the last chance to change your mind! Proceeding past this screen will DESTROY any data that is on this hard drive!!

```
Hard Disk SCSI ID: 5
              LUN: 0

        Drive: UltraSatan   SD  119 MB
   Controller: SCSI Embedded
    Operation: PARTITION
```

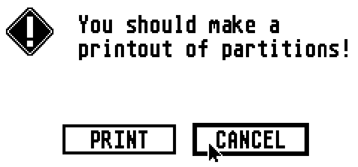
CONTINUE | CANCEL

At the end it should indicates that partitioning has terminated successfully. You are then offered to print the partitions information and you probably want to click ***CANCEL***.



Hard drive directory partition successfully completed!

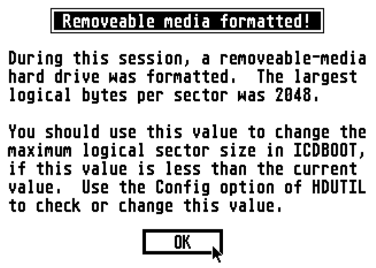
OK



You should make a printout of partitions!

PRINT | CANCEL

If you are using removable media (for example a SD card on an UltraSatan) the program also displays a window indicating that a removable drive has been formatted and the maximum number of bytes for the logical sectors. Write down this value as you will need it to set the driver parameters and click ***OK***.


Removeable media formatted!

During this session, a removeable-media hard drive was formatted. The largest logical bytes per sector was 2048.

You should use this value to change the maximum logical sector size in ICDBOOT, if this value is less than the current value. Use the Config option of HDUTIL to check or change this value.

OK

A new window is presented to indicate that the partitions have changed and offers you to reboot the computer, click ***OK***. During reboot the ICD driver should display all the drives connected and a list of all the partitions found.

The ***write partition only*** command allows rewriting only the MBR of the drive. This command can be used if the MBR of the drive have been corrupted and you are trying to save the data already existing on the drive. You should make sure that you have not changed the size of any partition when you use this command.

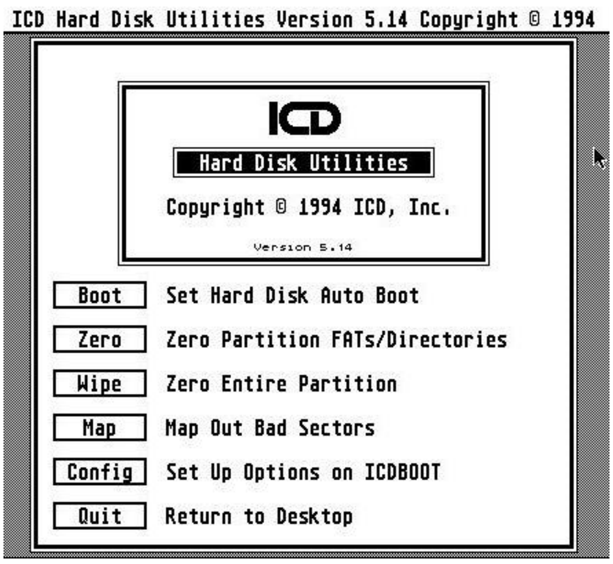
The ***rebuild one partition only*** command reinitializes a specific partition (rebuild boot sector, FAT, and the Root Directory). The program will ask you which partition you want to rebuild. This command can be useful if you have only one partition corrupted and you want to keep the data in the other partitions. You should make sure that you have not changed the size of any partition when you use this command.

4.6.2 Enabling and Disabling Auto boot

Auto boot allows your system to boot directly from the hard drive. This eliminates the need for a boot floppy diskette and speeds the booting process.

Run the ICD utility program **HDUTIL.PRG**. This brings you to the main menu.

To enable Auto boot, click ***Boot*** from the main menu. The program default to partition C selected. If you wish to boot from a partition other than C, click on that partition. Locate the **ICDBOOT.PRG** (usually on floppy drive A) and click on ***OK***. You will be prompted to be sure that you have the proper disk in. The boot sector of the partition will be modified to reflect Auto boot status, and the **ICDBOOT.PRG** file will be copied to the root directory of the boot partition and renamed to **ICDBOOT.SYS**. When this is done you will be returned to the main menu.


ICD Hard Disk Utilities Version 5.14 Copyright © 1994

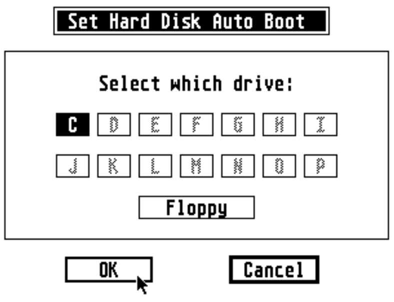
ICD Hard Disk Utilities

Copyright © 1994 ICD, Inc.

Version 5.14

Boot	Set Hard Disk Auto Boot
Zero	Zero Partition FATs/Directories
Wipe	Zero Entire Partition
Map	Map Out Bad Sectors
Config	Set Up Options on ICDBOOT
Quit	Return to Desktop

If you want to disable Auto boot from hard click select ***Floppy*** *as the boot drive* and click on ***OK***.


Set Hard Disk Auto Boot

Select which drive:

C D E F G H I

J K L M N O P

Floppy

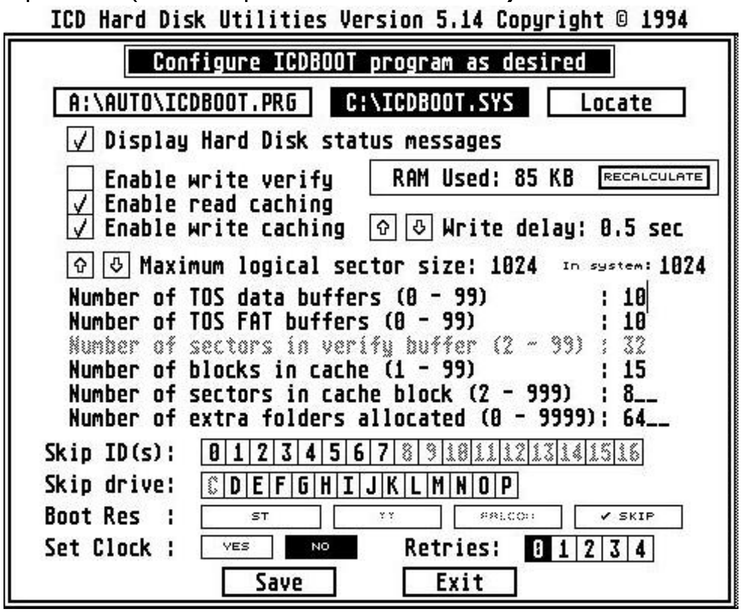
OK Cancel

Note*: If you wish to boot from floppy only on occasion it is not necessary to disable boot from hard drive. Simply hold down the CONTROL, SHIFT, and ALTERNATE keys simultaneously while booting the computer. This will bypass Auto boot temporarily. On some newer computers it is necessary to wait for the floppy drive access light to come on before pressing these keys.*

4.6.3 Configuring the AdSCSI Hard Disk Driver

Run the ICD utility program **HDUTIL.PRG**. This brings you to the main menu.

Click ***Config***: All parameters are grayed because you first have to select the driver you want to configure. Select the driver from your boot partition (for example **C:\ICDBOOT.SYS)**. You should see all the current parameters of the driver installed. You probably do not want to change any of these parameters with the following exceptions:



```
ICD Hard Disk Utilities Version 5.14 Copyright © 1994

          Configure ICDBOOT program as desired
 A:\AUTO\ICDBOOT.PRG   [✓ C:\ICDBOOT.SYS]   Locate
 [✓] Display Hard Disk status messages
 [ ] Enable write verify        RAM Used: 85 KB  RECALCULATE
 [✓] Enable read caching
 [✓] Enable write caching       ⇧ ⇩ Write delay: 0.5 sec
 ⇧ ⇩ Maximum logical sector size: 1024   In system: 1024
 Number of TOS data buffers (0 - 99)           : 10
 Number of TOS FAT buffers (0 - 99)            : 10
 Number of sectors in verify buffer (2 - 99)   : 32
 Number of blocks in cache (1 - 99)            : 15
 Number of sectors in cache block (2 - 999)    : 8
 Number of extra folders allocated (0 - 9999)  : 64
Skip ID(s):  0 1 2 3 4 5 6 7 8 9 10 11 12 13 14 15 16
Skip drive:  C D E F G H I J K L M N O P
Boot Res  :  ST   TT   FALCON   [✓ SKIP]
Set Clock :  YES  [✓ NO]        Retries: [✓ 0] 1 2 3 4
              Save          Exit
```

- Max size for logical sector: If you are using removable media (e.g. SD cards on an UltraSatan) <u>you must adjust</u> the size for logical sector with the value that was reported at the end of the partitioning operation. This is done by pressing the up/down arrow buttons at the beginning of the line. See 4.2.2
- Set Clock: you have to select ***NO*** for the clock option unless you are using AdSCSI Plus ICD board.

Click ***Save***: The program displays a file selector: select save to **C:\ICDBOOT.SYS**. Now click the ***Exit*** button to terminate the configuration.

The program returns to the main screen and you can now click on ***QUIT***.

A new window will pop up to remind you that **ICDBOOT.SYS** has been modified and offer you to reboot the computer: click ***OK***.

🖉 Note: The maximum size for logical sector is an important parameter as it reserves buffers required by the driver. If you are using several SD cards this parameter should set to the maximum of the values reported during formatting of all the partitions on all the cards. See also section 4.2.2

There are some other parameters that can be changed and that will affect the performance of the driver but they are beyond the scope of this document and therefore not described. Please refer to the ICD documentation for more information.

4.6.4 Removable Medium Drive Support

The ICDBOOT driver supports removable medium drives. When the card is changed, the driver recognizes this the next time the drive is accessed, a "Disk Change" message is flashed in the upper right-hand corner of the screen, and the drive is logged again. If the new card has more partitions than the previous, these are added after the currently logged partitions. However it is not possible to reserve a number of partitions attached to a drive.

4.6.5 Accessing DOS Partitions with ICD

The AdSCSI hard disk driver only supports DOS partitions of type FAT16A. **<u>Remember that these partitions are limited to 32MB</u>**. AdSCSI Hard disk driver does not support XHDI 1.2 and consequently the BigDOS program cannot be used with this driver. Note that *this is strange as ICD advertise XHDI 1.2 and BigDOS support <u>here</u>.*

4.6.6 Accessing TOS&DOS Partitions

ICD AdSCSI does **NOT** support TOS&DOS partitions.

🖉 **<u>Important Warning</u>**: Never try to access TOS&DOS partition with the ICD AdSCSI hard disk driver. You will get invalid data returned and you will probably **corrupt** the accessed partition.

4.7 *CBHD 5.0.2 Driver Package*

This section presents procedures for partitioning and using a drive with the CBHD package.

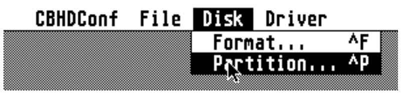
This CBHD 502 package is widely available as a freeware.

Note: The original CBHD package is in German. However most of the program and utilities have been translated to English. This is the version presented below.

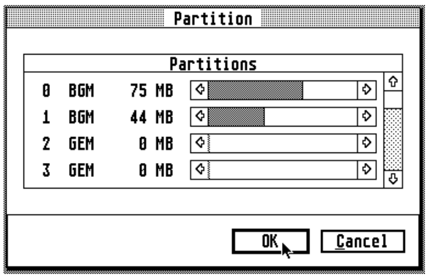
4.7.1 Partitioning a drive

In order to use the CBHD utility the **SCSIDRV.PRG** program needs to be executed first. The driver displays a welcome screen but more importantly it displays information about all the devices connected.

Run the **CBHDCONF.APP**: From the ***Disk*** menu select the ***Partition…*** command. Select the drive you want to partition. If the drive was already partitioned you will be presented with the existing partitions.

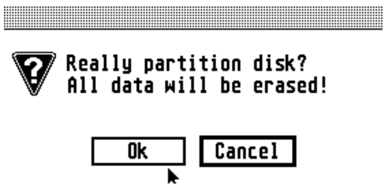


You can change the size of any partition by clicking on the arrow icons. When you reach the maximum size available on the disk you will not be able to increment the partitions. Specifying size for large partition can be painful!


```
Partition
Partitions
0  BGM   75 MB
1  BGM   44 MB
2  GEM    0 MB
3  GEM    0 MB
```

Once you have specified the sizes click ***OK***. Confirm with ***OK*** that you want to partition disk.

This will write the partitioning information on the drive, and it will also initialize the content of all the partitions. Reboot the system.

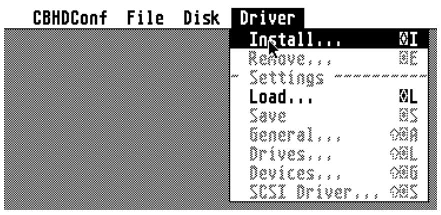

```
Really partition disk?
All data will be erased!
```

4.7.2 Enabling Auto boot

Auto boot allows your system to boot directly from the hard drive. This eliminates the need for a boot floppy diskette and speeds the booting process.

Enabling auto boot with CBHD is “a bit unusual”. Please carefully follow the following steps:

- Run the SCSIDRV.PRG then Run CBHDCONF.APP.
- From the ***Driver*** menu select the ***Install…*** entry. This will write the boot loader to the selected partition, but it will not copy the driver to the boot partition for you.
- Run the **CBHD.PRG**. You should now be able to access the “C” boot partition from the desktop. If there is no hard disk icon on the desktop you need to install a hard disk icon.
- Copy the **CBHD.PRG** file from your installation floppy to this partition. Rename this file to **CBHD.SYS** using ***File Show Info…*** from the desktop menus.

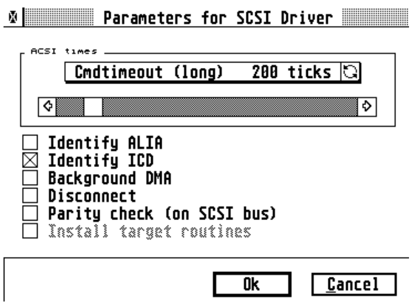


You should now reboot the system. The CBHD hard disk driver should load automatically and display all the drives and partitions.

4.7.3 Configuring the CBHD Hard Disk Driver

Run the **SCSIDRV.PRG** then Run **CBHDCONF.APP**. Load the **CBHD.SYS** from your boot partition using ***Driver*** menu ***Load…*** command.

You can now modify several parameters according to your host adapter and drives. For UltraSatan Drive I only found one parameter that need to be checked.

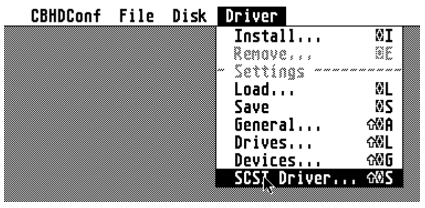

Parameters for SCSI Driver

ACSI times

Cmdtimeout (long) 200 ticks

- ☐ Identify ALIA
- ☒ Identify ICD
- ☐ Background DMA
- ☐ Disconnect
- ☐ Parity check (on SCSI bus)
- ☐ Install target routines

From the ***Driver*** menu select ***SCSI Driver…*** Verify that the Identify ICD is check marked (it should be by default).



4.7.4 Removable Medium Drive Support

Not sure if there is any support for removable media in CBHD?

4.7.5 Accessing DOS Partitions

CBHD502 can directly access FAT16A partitions of less than 32 Mbytes.

When used with **BigDOS** the CBHD502 allow access to FAT16B partitions of up to 2GB. For example I have tested a 2GB DOS partitions without problem.

Of course it is not recommended to use such a large partition for performance reason.

4.7.6 Accessing TOS&DOS Partitions

CBHD502 does **not** support TOS&DOS partitions.

✐ **Important Warning**: Never try to access TOS&DOS partition with the CBHD502 hard disk driver. You will get invalid data returned and you will probably **corrupt** the accessed partition.

4.8 *SCSITools 6.5.2, and AHDI Driver Packages*

Originally I had planned to present these hard disk drivers. However after testing it I discovered that they only support a maximum size of 32MB for bootable partitions.

Because of this limitation and the fact they are very old I decided not to describe the procedures in this document.

4.9 Which Hard Disk Driver Should I use

Here we will only consider PPD1x, HDD9xx, ICD655, and CBHD502 drivers used with CosmosEX, UltraSatan, and Satan devices on Atari ST.

The CBHD502 driver is very old and do not support well the new devices designed by Jookie and therefore it should be avoided.

If you want a free solution then you have no other choice than using ICD655. This driver is not maintained anymore but work relatively well with CosmosEx and UltraSatan disk.

If you use your system mainly for gaming with CosmosEx, UltraSatan, or Satan devices then PPDRIVER is an excellent choice. It is cheap and it is the only one to support correctly multiple TOS&DOS partitions on Windows.

The most powerful hard disk driver is HDDDRIVER. It supports all sorts of ACSI and SCSI devices and has many features not found on other driver.

4.9.1 Hard Disk Driver Summary Table

	PPDRIVER	**HDDRIVER**	**ICD655**	**CBHD502**
Boot TOS partition[8]	512MB	512MB	512MB	512MB
Boot TOS&DOS	Many	Many	No	No
Multi Boot	At boot time	Yes	No	Yes
FAT16A (32MB)	Yes	Yes	Yes	Yes
FAT16B (2GB)[9]	No	BigDOS	No	BigDOS
Removable media	Yes	Yes	Limited	?
XHDI	No	Yes	No	Yes
Maintained	Yes	Yes	No	No
Price	10 €	45 €	Free	Free
Performance[10]				

[8] The size of the Boot partition actually depends on TOS version. The value presented here is for TOS version bigger or equal to 1.04 and less than 4.x

[9] BigDOS means support by adding BigDOS program in the AUTO folder

[10] Values given here are only useful as relative performance measured with my HDTEST program using the **same** SD card on an UltraSatan drive.

Chapter 5. PC Utilities

This chapter describes few programs that can be useful in relation with Atari Hard disk. For example to partition, display content, and work with images of hard disks to be used on an Atari System.

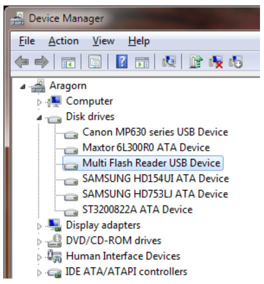
5.1 Accessing Multiple Partitions from SD Cards

To access the SD card you will need a SD card reader on your PC. This can be for example an USB card adapter. On this kind of adapter Windows allows access to only one partition even if your card has multiple DOS&TOS partitions. To be able to read multiple partitions on Windows system the trick is to force Windows to think that the removable media is a fix disk. Interesting article on the subject Filter Drivers – Removable Media as Fixed Disk in Window

5.1.1 32 bits Windows - Hitachi Microfilter

There several solutions to access multiple partitions from an SD Card plugged into a PC card reader. Here I present the solution I am using with the **Hitachi Microfilter** driver. You can find it from many places like here. The Hitachi Microfilter is a card reader driver that allows seeing the card reader as a hard drive.

Setting up the driver is very easy. You first need to extract the two files **cfadisk.inf** and **cfadisk.sys** in a directory. Then start the Device Manager by executing the **devmgmt.msc** command.


Device Manager
File
Action
View
Help
Aragorn
Computer
Disk drives
Canon MP630 series USB Device
Maxtor 6L300R0 ATA Device
Multi Flash Reader USB Device
SAMSUNG HD154UI ATA Device
SAMSUNG HD753LJ ATA Device
ST3200822A ATA Device
Display adapters
DVD/CD-ROM drives
Human Interface Devices
IDE ATA/ATAPI controllers

- In the device manager locate the card reader in the disk drive list, right click on it and select ***Update driver software..***.
- Select ***Browse*** my Computer for driver software.
- Select let me pick from a list of device driver on my computer.
- Click ***have disk*** button and locate the directory where the two driver files are located.
- Select the **cfadisk.inf** file and in the Install from disk window click **OK**, ignore the fact that the driver not digitally signed message and click ***Next***.

The driver is now installed for your SD card reader and let you access multiple partitions on any SD card plugged into it.

*Note that the procedure described above is for **Windows 32 bits version only**. The driver has been tested on Windows XP, Vista, and 7 (all 32-bits pro editions).*

Warning: When using the Hitachi driver your SD cards are now seen as hard disks. The consequence is that if you delete files on a partition, Windows will automatically create two **invisible** folders (marked with system and hidden flags): The System Volume Information folder and the $Recycle.bin folder. Information about deleted files will be placed into these two folders.

5.1.2 64 bits Windows – Diskmod from Karyonix

The Hitachi filter does not work in the Windows 64 environment. There are several solutions available to access Multiple Partitions from SD Cards on Windows 64 system. The Diskmod device driver is not signed and installing it on a 64 bit systems is somewhat dangerous. Therefore I have decided to only provide reference links that offers information about installation of this driver.

- Flip removable media bit on windows 7 x64 - make a removable drive fixed
- Multiple partitions & UEFI bootable SD card (Windows 8.1) and HERE
- Diskmod 0.0.2.2

5.1.3 64 bits Windows – Access through virtual 32 bits machine

If you want to access Multiple Partitions from your SD Cards on a 64 bits system you can use a much safer solution based on running a 32 bits version of windows on a virtual machine. For example you can run an image of Windows 7 x86 with VMWARE. In the VM tab under removable devices you should see an entry for your card reader you just need to connect it to the VM and the default driver is installed. After that you just need to follow the procedure describe above for the Hitachi Microfilter.

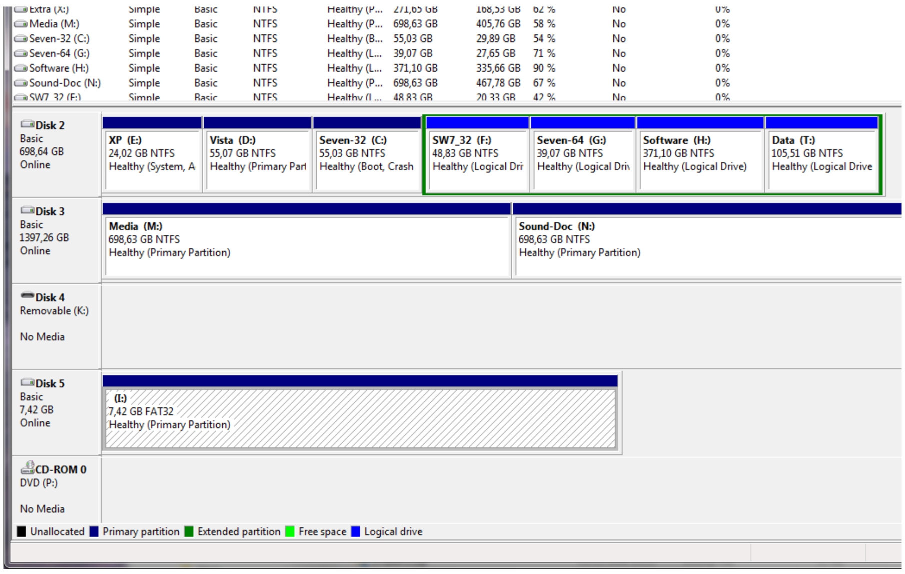
5.2 Creating DOS Partitions on a PC

As we have seen most of the Atari Hard disk drivers do not provide a utility to create DOS partitions. It is therefore very convenient to create DOS partitions directly on a PC. If you connect directly a drive (for example a SCSI drive) to a PC it is possible to create multiple partitions directly. However if you are using an SD card, connected to a PC card reader, and want to create multiple partitions you first need to install a specific driver, as explained in Accessing Multiple Partitions from SD Cards.

Windows comes with a reasonable utility for partitioning drives called the ***Disk Management Console***. You can execute it by executing the **diskmgmt.msc** command.

You are presented with a list of all the drives and the partitions on the drives.

Your SD card should be displayed. In the example on the left the 8GB SD Card is shown as Disk 5. When you buy it the card is formatted by default as a FAT32 (only format for partitions ≥ 2GB).



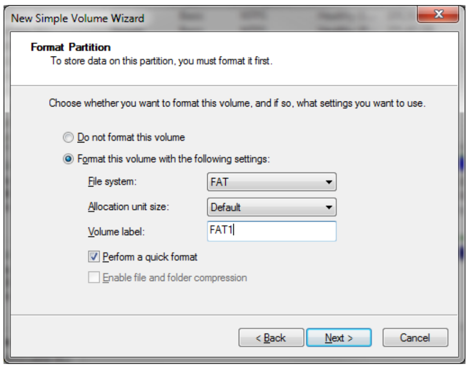
```
Extra (X:)      Simple  Basic  NTFS  Healthy (P...  271,65 GB  168,53 GB  62 %  No  0%
Media (M:)      Simple  Basic  NTFS  Healthy (P...  698,63 GB  405,76 GB  58 %  No  0%
Seven-32 (C:)   Simple  Basic  NTFS  Healthy (B...  55,03 GB   29,89 GB   54 %  No  0%
Seven-64 (G:)   Simple  Basic  NTFS  Healthy (L...  39,07 GB   27,65 GB   71 %  No  0%
Software (H:)   Simple  Basic  NTFS  Healthy (L...  371,10 GB  335,66 GB  90 %  No  0%
Sound-Doc (N:)  Simple  Basic  NTFS  Healthy (P...  698,63 GB  467,78 GB  67 %  No  0%
SW7_32 (F:)     Simple  Basic  NTFS  Healthy (L...  48,83 GB   20,33 GB   42 %  No  0%
```

```
Disk 2      XP (E:)              Vista (D:)           Seven-32 (C:)        SW7_32 (F:)          Seven-64 (G:)        Software (H:)            Data (T:)
Basic       24,02 GB NTFS        55,07 GB NTFS        55,03 GB NTFS        48,83 GB NTFS        39,07 GB NTFS        371,10 GB NTFS           105,51 GB NTFS
698,64 GB   Healthy (System, A   Healthy (Primary Part Healthy (Boot, Crash Healthy (Logical Dri Healthy (Logical Driv Healthy (Logical Drive) Healthy (Logical Drive
Online

Disk 3      Media (M:)                          Sound-Doc (N:)
Basic       698,63 GB NTFS                      698,63 GB NTFS
1397,26 GB  Healthy (Primary Partition)         Healthy (Primary Partition)
Online

Disk 4
Removable (K:)

No Media

Disk 5      (I:)
Basic       7,42 GB FAT32
7,42 GB     Healthy (Primary Partition)
Online

CD-ROM 0
DVD (P:)

No Media

■ Unallocated ■ Primary partition ■ Extended partition ■ Free space ■ Logical drive
```

Suppose we want to partition the 8GB SD Card into four 2GB partitions. We plug the card into a card reader that can handle SDHC and multiple partitions (for example with the Hitachi microfilter driver. We first have to delete the existing partition (normally FAT32) by using the ***delete volume*** command.

We now use the ***new simple volume*** command. The new simple volume wizard pops up. We specify the volume size to 1900MB, and in the format windows we select ***FAT*** for the file system and we can keep ***Default*** for the allocation unit size.

We repeat the same operation for the three remaining partitions.



New Simple Volume Wizard

Format Partition
To store data on this partition, you must format it first.

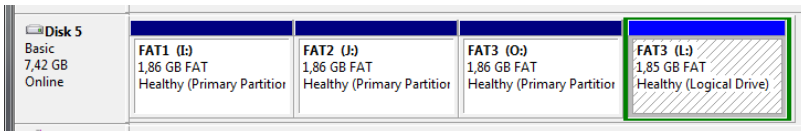
Choose whether you want to format this volume, and if so, what settings you want to use.

○ Do not format this volume
● Format this volume with the following settings:

File system: FAT
Allocation unit size: Default
Volume label: FAT1
☑ Perform a quick format
☐ Enable file and folder compression

< Back | Next > | Cancel

At the end of this process we end up with our four 2GB partitions and we can immediately transfer information from the PC on them.

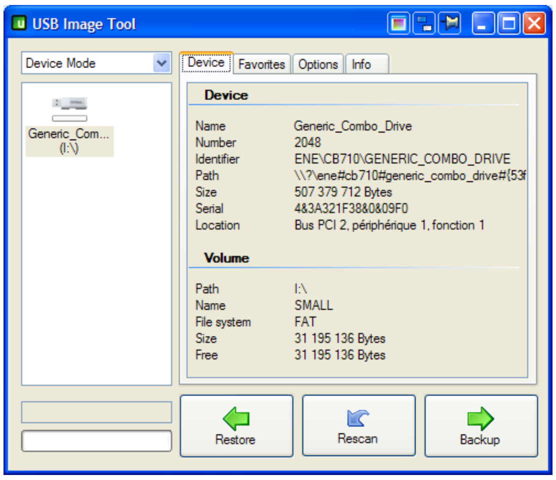


```
Disk 5    FAT1 (I:)                 FAT2 (J:)                 FAT3 (O:)                 FAT3 (L:)
Basic     1,86 GB FAT               1,86 GB FAT               1,86 GB FAT               1,85 GB FAT
7,42 GB   Healthy (Primary Partitio Healthy (Primary Partitio Healthy (Primary Partitio Healthy (Logical Drive)
Online
```

Remember that in order to access these large FAT16B partitions on Atari you need to use BigDOS along with your hard disk driver.

If you want to use a professional application for partitioning I recommend that you use The Hard Disk Manager from Paragon.

5.3 Working with Disk Images



Generic_Com... (I:\)

Device

Name Generic_Combo_Drive
Number 2048
Identifier ENE\CB710\GENERIC_COMBO_DRIVE
Path \\?\ene#cb710#generic_combo_drive#{53f
Size 507 379 712 Bytes
Serial 4&3A321F38&0&09F0
Location Bus PCI 2, périphérique 1, fonction 1

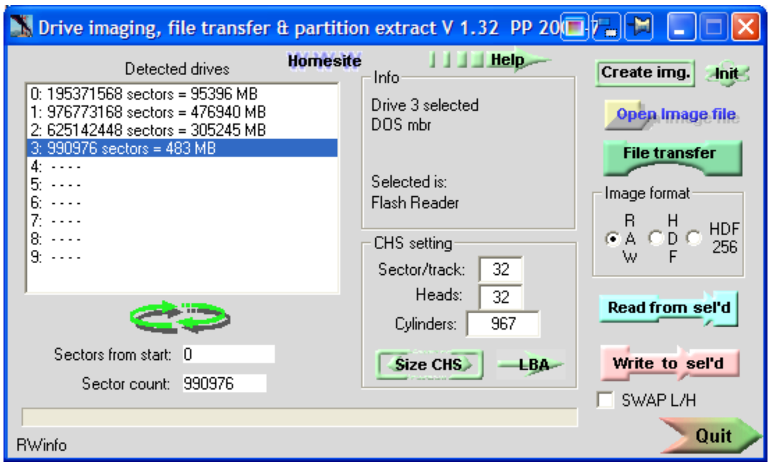
Volume

Path I:\
Name SMALL
File system FAT
Size 31 195 136 Bytes
Free 31 195 136 Bytes

A disk image is a file that contains an exact binary copy of the raw content of the disk. Images are useful to backup/restore SD card, to transfer information, and to run with Atari emulators. There many tools available for creating and reading disk images.

One nice tool for imaging/restoring SD card plugged into a card reader is the USB-Image tool (currently in version 1.68) that you can get from HERE. The card reader containing the SD card should be displayed on the left side. Select the drive you want and from there you can use the backup and restore commands. The backup command allows saving the content of the SD card into an image file. While the restore command takes an image file and write it to the SD card.

I do not use this USB-image tool very often because it does not recognize an SD card plugged into a card reader when using the Hitachi Microfilter driver described above. This is due to the fact that when using this driver the card is not seen any more as an USB stick but as a hard drive that this utility does not handle.



Detected drives

```
0: 195371568 sectors = 95396 MB
1: 976773168 sectors = 476940 MB
2: 625142448 sectors = 305245 MB
3: 990976 sectors = 483 MB
4: ----
5: ----
6: ----
7: ----
8: ----
9: ----
```

Info
Drive 3 selected
DOS mbr
Selected is:
Flash Reader

CHS setting
Sector/track: 32
Heads: 32
Cylinders: 967

Image format: [✓ RAW] HDF HDF 256

Sectors from start: 0
Sector count: 990976

SWAP L/H

Therefore my prefered tool for creating and restoring images to be used on Atari is the Drive Image program from Peter Putnik. It works well with SD card with or without the Hitachi driver.

Not only it allows creating and restoring images of a drive, but it also permits to look and modify the content of the all the partitions inside the image. For example it is possible to add or extract files inside a partition. It also allows dealing with TOS partitions directly.

Two very nice utilities to deal with disk content are the WinHex editor and HxD freeware editor. As their name indicates there main purpose is to edit the binary content of a raw disk or disk image. But they are also capable to create and restore disk images of an SD card. And of course they offer many more capabilities, for example I have used WinHex to look at the detail content of SD cards and/or disk images of SD cards.

And last but not least are the capabilities of Atari emulators to deal with disk images:

- With Steem emulator it is possible to create and/or use Atari disk images by using the Pasti hard disk low level emulation. Unfortunately the current Pasti limits the size of the disk images to 1GB. You will also need a tool like WinHex to transfer the images to/from SD Cards.
- With Hatari emulator it is possible to use Atari disk images. I have tested quickly this capability that seems to work well. And again you will need a tool like Drive Image to transfer the images to/from an SD Cards.

5.4 Partition Table Editor

Ptedit is a Free Portable Partition Table Editor created by Powerquest (Symantec). Ptedit32 can be used to quickly and easily edit Partition Tables. For example it could be used to mark a partition active "toggle the bootable flag" from within Windows. This is done by changing the boot indicator from 00 to 80. This tool can be stored and run from a USB device. You can download the Portable Partition Table Editor HERE. Some technical details HERE or HERE (in French).

Note that on Windows 7 and Windows 8 you need to run the "resolve compatibility problem" for the program to work.

Another alternative is the Bootice program.

Related to this there is nice small utility called **ptcalc** that allows conversion between LBA and CHS.

See Tools and References for the MBR and OS Boot Records and Free Tools to Backup and Restore the Master Boot Record (MBR)

5.5 PC File Transfer Tools

In order to use files and directories without problems on an Atari you should not use Long File Names. A tool like Total Commander can be very useful to do that.

TODO

Chapter 6. Atari Utilities

6.1 BigDOS

BigDOS freeware Copyright© 1995 by Rainer Seitel

BigDOS is an ISO 9293 file system that replaces the GEMDOS of TOS.

6.1.1 Features

- GEMDOS / ISO 9293:1987 / MS-DOS file system
- 32 Drives: A..Z 1..6 or A..Z [\]^_`
- Up to 65518 cluster.
- 1 to 64 sectors per cluster.
- More than 65535 sectors and therefore every MS-DOS partition possible. That means also more than 32 MB.
- 1 or 2 FAT.
- The legal characters are - configurable for each drive - restricted for GEMDOS, d-characters as in ISO 9293 resp. ISO 9660 or MS-DOS. You know in advance, that a MS-DOS computer or restrictive CD writing software can read all files. With setter.ttp from the HSModem archive, or the GEM version of Setter, from Markus Kohm, this can be permanently set in BigDOS.
- The disk label will also be written to an MS-DOS boot sector.
- Works with or without MiNT.
- BigDOS tries to lock removable cartridges using XHDI, if there were open files on it.
- For TOS 1.04 and 1.06 no POOLFIX3.PRG, PFIX_CB.PRG or POOLFX92.PRG is needed.
- For TOS 4 no F030HFIX.PRG is needed.
- 94 standards handles for open files, instead of 75.
- Cookies ¯DATE® and ¯TIME® as in DTCOOKIE and LED-Panel.
- Shows names of the loaded accessories.

6.1.2 Installing BigDOS

BigDOS.PRG (for the Falcon at present BigDOS-F.PRG) should be the first program in your AUTO folder after the boot selector. In any case before every program in the GEMDOS trap which not use XBRA. BigDOS.PRG installs itself at the end of the XBRA chain. You can use the Autosort program to reorder the programs in your AUTO folder.

For MS-DOS partitions bigger than 32 MB, you also need a hard disk driver which can handle big MS-DOS partitions (type 6) and allows access to more than 65535 sectors via Rwabs(). This should be a driver with XHDI 1.20, because BigDOS tries to change the DOS limits via XHDOSLimits(). This function could be checked with XHDItest.ttp.

6.1.3 BigDOS Sundries

DOSMODE.TOS shows and alters the legal characters for filenames on each drive:

- GEMDOS: A..Z0..9!#$%&'()-@^_`{}~"+,;<=>[]| and capital umlauts
- ISO: A..Z0..9_
- MS-DOS: A..Z0..9!#$%&'()-@^_`{}~ and capital umlauts

With setter.ttp from the HSModem archive, or the GEM version of Setter, from Markus Kohm, this can be permanently set in BigDOS.

XHDITEST.TTP shows for all or a given drive letter the partition size, bad values in the BPB, name and XHDI version of the hard disk driver and tests the DOS-limits function:

- :-(not available
- :-/ available, but could not change the limits
- :-) available and could change the limits

BigDOS, NVDI and the Screenblaster driver doesn't work together. Omit one of them.

There are several Programs that initialize the file system not correct. By the first access or after a media change, an error message is printed on the screen. If you type J or Y for yes the correct value will be written on disk. Contact the responsible programmer and tell him about the bug. (Now you can switch off this check with Setter.)

- BigDOS: FAT start of ?: shall be $F?, $FF, $FF [$FF]! Write? [YN]
- BigDOS: Media byte in boot sector of ?: is $??, shall be $F?! Write? [YN]

6.2 FOLDRXXX Utility

FOLDRXXX.PRG will add more entries into your OS Pool. In TOS 1.0 and TOS 1.02, the limit for the number of directories that you can enter is around 40. With this program you can extend that limit much higher. If you are using a hard drive, this program is recommended highly. It will work with all TOS versions and will improve the performance of your system.

6.3 TOS14FIX Utility

TOS14FIX.PRG solves some small problems in the AES (for additional information, please see the documentation that accompanies the TOS14FIX.PRG program).

6.4 POOLFIX3 Utility

POOLFIX3.PRG fixes a bug in GEMDOS. Documentation that accompanies the POOLFIX3.PRG program explains (in detail) the problem that it fixes.

6.5 CACHEXXX Utility

CACHEXXX.PRG is a new program that adds GEMDOS buffers to your system. The caching of data and disk directories by GEMDOS (when this program is used) will result in your system running much faster! This program is highly recommended and requires TOS 1.04 or higher for full benefits!

6.6 STE_FIX Utility

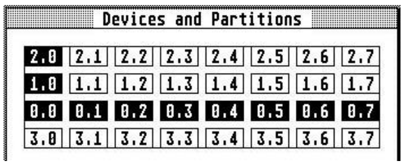
STE_FIX fixes the infamous Desktop Medium/Low resolution bug. The problem is that there is a bug in the desktop code in this version of TOS that prevents the user from booting into Medium Resolution. The patch program STE_FIX will solve the problem. Once it is executed in the AUTO folder, the problem no longer exists.

Chapter 7. File System Problems and Solutions

In this section we do not cover hardware problems. However in case of problem this is the first thing to check. For examples: proper connection, proper termination …

The problems reported in Red are usually pretty bad and can cause loss of data on drives.

- I do not see all my drives.
  For example when loading a hard disk driver, or when trying to partition only some of the devices are shown …
  As a confirmation you can check the ID of all connected drives by using a utility like the IDCHECK.PRG provided in the ICD AdSCSI hard disk driver package. These utilities scan the ASCI bus and eventually the IDE and SCSI busses and report all connected devices.
  - First make sure you do not have an ASCI ID conflict. All drives connected to an ASCI bus **must have** a unique ID. This includes drives eventually located inside your computer (e.g. Mega STe.). Beware that not following this rule might result in hard disk data corruption.
  - If you are using HDDRIVER make sure that you have correctly enabled all the devices you are using. This is done from the ***Settings*** menu ***Devices and Partitions…*** command. Make sure that all devices 0.x are checked (other might be checked too). This will enable the usage of all the ACSI devices (with IDs from 0 to 7) by HDDRIVER.



- I can only see/access 1GB on my drive
  - First check that your host adapter support the ICD extended command set. For example LINK II or UltraSatan support large drive size but ICD Link I only supports 1GB.
  - If you are using a Satan drive the size it reports is incorrectly limited to 1GB. For example if you use HDDRIVER and a 2GB SD card it will only use the first MB. However as Satan Drive supports the ICD extend command set, a smart driver as PPDRIVER can access the full 2GB.
  - Make sure that your hard disk driver support as well the ICD extended command set. For example a driver like AHDI can only access 1GB even connected to an UltraSatan drive.

- Data on my drive display incorrectly or get corrupted
  - You first have to check your hardware (check if you do not have an Atari with a bad DMA chip)
  - If you are using TOS&DOS partitions make sure **you use the appropriate driver**.
    For example if the partitions has been done with HDDRIVER do **NOT TRY TO USE** the partition with any other hard disk driver (like ICD or CBHD). This problem will not show immediately but it might corrupt your complete partition if you try to write beyond the 32MB limit. The rules are simples: With HDDRIVER TOS&DOS partitions use HDDRIVER driver ONLY. With PPDRIVER TOS&DOS partitions use PPDRIVER driver ONLY.
  - If you see strange names for files and partitions or zero size files… Check that you do not have hit the 40-folder problem (especially if using TOS 1.0 or TOS 1.2). If you see this problem reset your system immediately and uses the FOLDRXXX (or equivalent) program.
  - If you see some strange name displayed, if you cannot delete a folder that seems empty, if the size of a folder tree is incorrectly huge… Check that you do not have files with Long File Name inside this tree. If this is the case BigDOS might help, but most probably you want to fix the problem by connecting your drive on a Windows system.
  - If you are not able to access all the partitions on your drives check that you do not have more than 14 partitions total on all drives (unless you use BigDOS).

- Performance is not as good as expected
  - Performance is always less than expected! But you may want to check some flags in your hard disk driver.
  - When working with Satan or UltraSatan Drives use good quality SD / SDHC card.

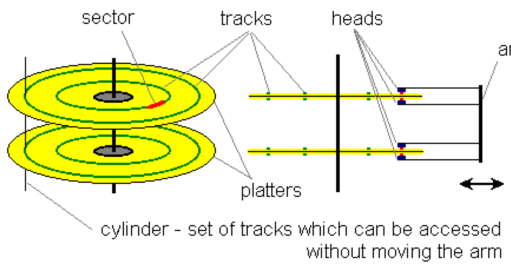
PART II – ATARI HARD DISK FILE SYSTEMS TECHNICAL INFORMATION

Chapter 8. Hard Disk Presentation

The goal of the second part of this document is to provide in-depth technical information about Atari hard disks partitioning (layout). For that matter I describe in detail the TOS File System as well as the DOS/FAT File System as both of them are used on the Atari platform. However the DOS/FAT File System study is limited to what is useful in the Atari platform context. In order to explain the compatibilities and limitations of the different types of partitioning several practical examples are analyzed.

8.1 Hard Disk Primer

First disks had a simple design. They had one or more rotating platters and a moving arm with read/write heads attached to it - one head on each side of the platter. The arm could move and stop at the certain number of positions. When it stopped each head could read or write data on the underlying track. Every read or write had to be done in blocks of bytes, called *Sectors*. Sectors were usually 512 bytes long and there were fixed number of sectors on each track.


sector
tracks
heads
arm
platters
cylinder - set of tracks which can be accessed without moving the arm

8.1.1 CHS Format

When IDE (Integrated Drive Electronics) disks came out the disk space was used more efficiently. Engineers had placed more sectors on the outer tracks, but still provided software writers with a convenient “cubical” look of the disk by doing internal translation of **CHS** (cylinders, heads, and sectors). Variable sector/cylinder count by early IDE drives is called Zone-bit recording. For example an old 340MB disk has only two platters = 4 heads (sides), but it reports 665 cylinders, 16 heads, and 63 sectors. In reality it, probably, has more then 4*63 sectors on each outer track and a little less than 4*63 on the most inner tracks, but we could never know for sure. With the early IDE disks CPU only has to tell the CHS of the sector that it wants to read and drive's electronics will position the heads to start data transfer.

The maximum allowable values for CHS addressing mode are: 0 to 1023 for cylinders, 0 to 255 for heads, and 1 to 63 for sector. If you multiply these values you will see that the largest hard disk that could be addressed with CHS addressing mode is 8GB. The (logical) number of cylinders, heads and sectors per track can be determined by the function 08h respectively 48h of the BIOS interrupt 13h.

8.1.2 LBA Format

The newest drives have a simpler interface. Instead of addressing sectors by their CHS (cylinder, head, and sector) address they use **LBA** (Logical Block Addressing) mode. In LBA mode a program has only to tell the number of the sector from the beginning of the disk (all sectors on disk are numbered 0, 1, 2, 3 ...). Virtually all modern operating systems use LBA addressing, but the CHS notation is still around. First of all, MS-DOS, which is about 20 years old, uses only CHS. Also some programs, like Partition Magic, would not work if partitions do not start at the cylinder or side boundary.

8.1.3 Conversion between CHS and LBA

It is possible to convert LBA format to CHS and vice versa. Conceptually both forms are equivalent. A sector C/H/S in the CHS format has the following LBA number:

```
LBA = C x Num_Head x Num_Sec + H x Num_Sec + (S - 1)
```

Here Num_Sec means the (logical) number of sectors per track and Num_Head the (logical) number of heads. *Only these two (logical) geometry parameters of the disk are relevant for the conversion*. The number of cylinders in unimportant for the conversion.

A nice utility is available to perform these conversions search for pcalc in the Partition Table Editor section.

8.2 Hard Disk Preparation Steps

Before a hard disk can be used to store data it must be "prepared". This is done in three steps:

- The first step is called ***low-level formatting*** (often referred as ***formatting*** in Atari world):
  It is used to create the actual structures on the surface of the media that are used to hold the data. The magnetic medium on the surfaces must be divided into tracks that contain numbered sectors that the controller can find. Once the disk has been formatted, the locations of the tracks and sectors on the disk are fixed in place.

✐ Note: With modern SCSI / IDE drives and with host adapter using SD card this operation **is not required anymore** since many years and therefore is not described in this document. You should never do this unless you understand exactly what you are doing.

- The second step is called ***partitioning***: Hard drives can be divided into smaller logical drive units called *partitions*. In this way a single hard drive can appear to be two or more drives to the computer. Besides simply keeping drive sizes under the file system limits, dividing a drive also allows partitions to be used for specific purposes, keeping the drive organized. The maximum size of a partition depends on the OS, the Hard Disk Drivers, and the Host Adapter. The partition information is stored in the first physical sector of the disk called the Root Sector for the TOS file system and the Master Boot Record for the DOS/FAT file system.
- The third step is called ***high-level formatting*** (often referred as ***Formatting*** in the PC world and ***Initialization*** in the Atari world): This is the process of creating the basic disk's logical structures: In order for the OS to use a disk it has to know about the number of tracks, the number of sectors per tracks, the size of the sectors and the number of heads. This information is defined in the Boot Sector. Beyond that it is necessary for the OS to find information (e.g. location of all the sectors belonging to this file, attributes ...) about any files stored on the diskette as well as global information (e.g. the space still available on the diskette). This information is kept in the File Allocation Tables (FATs) and the in the Root Directory structure.

8.3 TOS Partition Size

The following table indicates the minimum sector size based on TOS partition sizes:

Partition Size[11]	**Logical Sector Size**
Up to 32MB	512
32MB – 64MB	1024
64 MB – 128MB	2048
128 MB – 256MB	4096
256MB – 512MB	8192
512MB – 2GB[12]	32768

With most of the partitioning programs you only need to specify the size of the partition you want to create and the driver will compute for you the optimum Sector Size. With some hard disk drivers it is possible to modify the sector size (for example with HDDRIVER). In that case you have to make sure that you specify a value greater or equal to the one specified in the table above. Using larger value results in fewer FAT clusters allocation for big files, but with the drawback that small files will occupy more space on the disk.

The maximum size of a partition depends on the TOS version, the Hard Disk drivers, and the capability of the host adapter. With recent hard disk drivers and host adapters, that support the ICD extended command set, the partitions sizes may be:

- Up to 256 megabytes for TOS < 1.04,
- Up to 512 megabytes with TOS ≥ 1.4, and
- Up to 1GB with TOS ≥ 4.0 (Falcon).

8.4 DOS/FAT Partition Type and Size

The following table summarizes the characteristic of several types of DOS/FAT partition that are useful to know in the context of the Atari platform:

Partition Type	Fdisk	Size	Fat Type	Version
01	PRI DOS	0-15 MB	12 bits (FAT12)	MS-DOS 2.0
04	PRI DOS	16-32 MB	16 bits (FAT16A)	MS-DOS 3.0
05	EXT DOS	0-2 GB	n/a	MS-DOS 3.3
06	PRI DOS	32 MB-2 GB	16 bits (FAT16B)	MS-DOS 4.0
0E	PRI DOS	32 MB-2 GB	16 bits (FAT16B)	Windows 95[13]
0F	EXT DOS	0-2 GB	n/a	Windows 95
0B	PRI DOS	512 MB - 2 TB	32 bits (FAT32)	OSR2
0C	EXT DOS	512 MB - 2 TB	32 bits (FAT32)	OSR2

8.5 TOS&DOS Partition Size

The maximum size of a TOS&DOS partition follows the same rules as for a TOS partition. Therefore it depends on the TOS version, the Hard Disk drivers, and the capability of the host adapter. With recent hard disk drivers and host adapters, that support the ICD extended command set, the partitions sizes may be:

- Up to 256 megabytes for TOS < 1.04,
- Up to 512 megabytes with TOS ≥ 1.4, and
- Up to 2 GB with TOS ≥ 4.0 (Falcon).

[11] Partition size is given for TOS ≥ 1.04. Prior to this version the maximum partition size should be divided by 2
[12] Only supported in TOS 4.0. Officially only sector size of 16384 is supported (for a max partition size 1GB)
[13] Type 0x0E and 0x0F forces usage of LBA addressing instead of CHS addressing.

Chapter 9. Information about TOS Partitions

In this chapter we will describe the layout and various information concerning the Atari Hard Disks TOS partitioning as defined in the AHDI 3.00 specification.

Compared to the initial Atari AHDI specification, AHDI 3.00 adds support for hard disks with more than four partitions, and for partitions of size greater or equal to 32 MB (16 MB if TOS < 1.04).

9.1 *TOS Hard Disk Layout*

Partitioning and Initialization of the disk write information that defines the layout of the disk:

- The Root Sector (RS) defines the number of partitions and their positions on the disk.
- The optional Bad Sector List contains the list of bad sectors detected during low level formatting on the disk. This is not used anymore on "modern" drive (SCSI / IDE / SD Card…).
- One or up to 4 partitions. There are two kinds of partitions defined in AHDI 3.0 specification: standard partitions and extended partitions:
  - A standard partition contains a number of control structures, necessary to describe the partitions, but most of its content is the actual data. AHDI defines two types of standard partitions: regular partition (GEM) or big partition (BGM a partition whose size is ≥ 32MB).
  - An extended partition is a special partition that contains standard partitions.

9.2 *TOS Root Sector*

The **Root Sector** (RS) of a TOS File System is always the first 512-byte sector (Physical Sector 0) of a partitioned data storage device such as a hard disk. This is equivalent to the Master Boot Record in the FAT file System. The **Root Sector** contains:

- The disk's primary partition table, with one or several entries (up to 4) for the standard partitions. This partition table may also contain one entry for an extended partition.
- And eventually some *bootstrapping* code (also called the IPL).

By definition, there are exactly four possible entries in the primary partition table of the **Root Sector**. The partition size and the partition start address are stored as 32-bit quantities. Because the physical sector size is always 512 bytes, this implies that neither the maximum size of a partition nor the maximum start address (both in bytes) can exceed 2^32 * 512 bytes, or 2 TB.

The content of the Root sector is described in the following table:

Offset	**Length**	**Description**
$0000	440	Boot loader code for a bootable disk. Not used and usually filled with 0 for a non-bootable disk
$1B6	2	Cylinders
$1B8	1	Heads
$1B9	1	$00 = SASI $FF = SCSI
$1BA	2	Write pre-compensation cylinder
$1BC	2	Reduced write current cylinder
$1BE	1	Parking cylinder offset
$1BF	1	Step rate
$1C0	1	Interleave
$1C1	1	Sectors per track
$01C2	4	Hard Disk Size in number of physical (512 bytes) sectors
$01C6	4 * 12	Table for the 4 possible partitions described by four 12-byte **partitions entry** (described below) starting at location $01C6 , $01D2, $01DE, $01EA
$01F6	4	Bad sectors list offset from beginning of disk. Specified in number of physical sectors.
$01FA	4	Bad sectors count in number of physical sectors
$01FE	2	Checksum

The grayed information is historical for very old drive, and is not used on "modern" drives.

The last word in the Root Sector (at offset $1FE) is reserved for the sector checksum. To be executable a **Root Sector** checksum must be equal to the *magic number* $1234.

Each partition (standard or extended) is defined by an entry in the partition table:

Offset	Length	Description	Partition entry locations
$00	1	Status: indicate the status of the partition ■ bit 0 when set partition *exist*, ■ bit 1-6 reserved ■ bit 7 when set partition *bootable* The BIOS will boot the first partition that has bit 7 set	$1C6, $1D2, $1DE, $1EA
$01	3	ID Name: a 3-bytes ASCII field that identifies the type of partition ■ GEM for regular (< 32MB) partition ■ BGM for big (≥ 32MB) partition ■ XGM for extended partition	$1C7, $1D3, $1DF, $1EB
$04	4	Offset to the beginning of the partition from the beginning of the hard disk. Specified in number of physical (512 bytes) sectors	$1CA, $1D6, $1E2, $1EE
$08	4	Size of the partition in number of physical (512 bytes) sectors	$1CE, $1DA, $1E6, $1F2

9.3 TOS Standard Partition

The following is an overview of the order of the structures in standard TOS file system partition:

	Boot Sector	*Reserved (optional)*	*FAT #1*	*FAT #2*	*Root Directory*	*Data Region for files and directories... (To end of partition or disk)*
size in sectors	(number of reserved sectors)		(number of FATs) * (sectors per FAT)		(number of root entries * 32) / 512	Number of clusters * Sectors per cluster

A TOS file system is therefore composed of these four different regions:

- The **Boot Sectors region** located at the very beginning of a partition: The first logical sector of a standard partition (logical sector 0) is the Boot Sector. It includes an area called the *BIOS Parameter Block* (**BPB**) and may contain some *boot loader* code. The BPB provides some basic file system information, in particular its type, and pointers to the location of the other sections. The total count of reserved sectors is indicated by a field inside the **Boot Sector**. Important information from the **Boot Sector** is accessible through a TOS structure called the *BIOS Parameter Block* (**BPB**).
- The **FAT region**: This typically contains two copies (may vary) of the File Allocation Table for the sake of redundancy checking, although the extra copy is rarely used, even by disk repair utilities. These are maps of the **Data region**, indicating which clusters are used by files and directories.
- The **Root Directory region**: It contains the Root Directory that stores information about the files and directories located in the **Root Directory**. The **Root Directory** has a fixed size which is pre-allocated at creation of the volume.
- The **Data Region**: This is where the actual file and directory data is stored and takes up most of the partition. The size of files and subdirectories can be increased arbitrarily (as long as there are free clusters) by simply adding more links to the file's chain in the FAT

The Atari AHDI 3.00 specifies two types of standard partition:

- ◆ The *regular partition* (GEM Partition) and,
- ◆ The *big partition* (BGM Partition)

9.3.1 Regular Partition (GEM) Limits

- ◆ Size of a physical sector in number of bytes = 512
- ◆ Maximum number of sectors = 2^15 = 32768 (< TOS 1.04[14])
- ◆ Maximum number of sectors = 2^16 = 65536 (>= TOS 1.04)
- ◆ Maximum size of a partition in number of bytes = 32768 * 512 = 16 MB (< TOS 1.04)
- ◆ Maximum size of a partition in number of bytes = 65536 * 512 = 32 MB (≥ TOS 1.04)

9.3.2 Big Partition (BGM) Limits

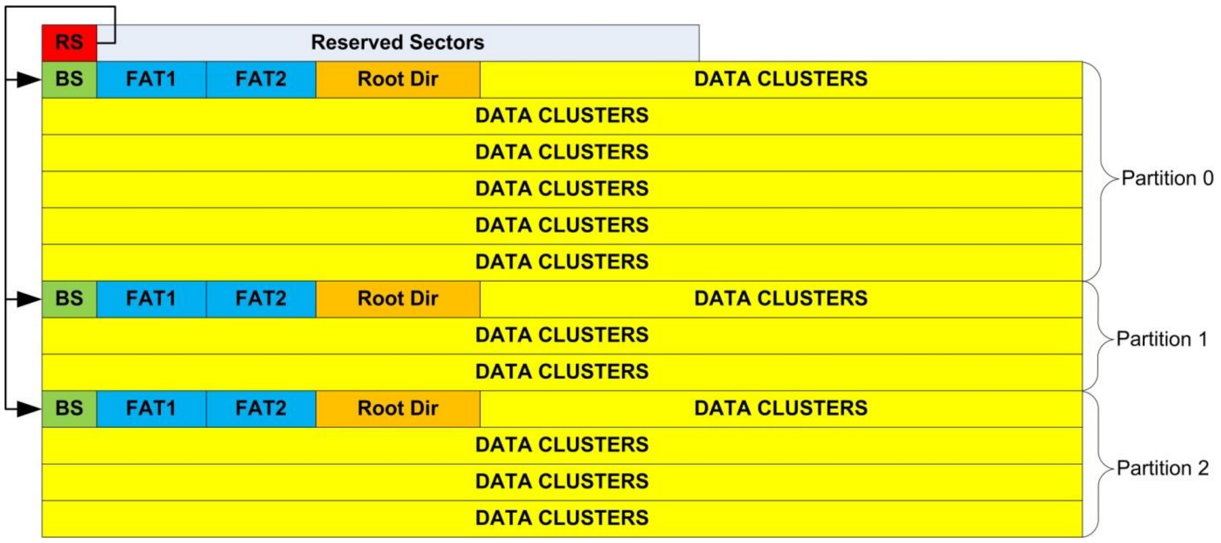
- TOS < 1.04:
  - ◆ Maximum size of a cluster in number of bytes = 2^14 = 16384
  - ◆ Size of a cluster in number of logical sectors = 2
  - ◆ Maximum size of a logical sector in number of bytes = 16384 / 2 = 8192
  - ◆ Maximum number of logical sectors = 2^15 = 32768
  - ◆ Maximum size of a partition in number of bytes = 32768 * 8192 = 256 MB

[14] Note that prior to TOS 1.04 the number of sectors is stored as a signed integer resulting in a maximum of 32768 sectors. Starting with TOS 1.04 the number of sectors is stored as an unsigned integer resulting in a maximum of 65536 sectors

- TOS ≥ 1.04 and ≤ 4.x
  - Maximum size of a cluster in number of bytes = 2^14 = 16384
  - Size of a cluster in number of logical sectors = 2
  - Maximum size of a logical sector in number of bytes = 16384 / 2 = 8192
  - Maximum number of logical sectors = 2^16 = 65536
  - Maximum size of a partition in number of bytes = 65536 * 8192 = 512 MB
- TOS 4.x (Falcon)
  - Maximum size of a cluster in number of bytes = 2^16 = 65536
  - Size of a cluster in number of logical sectors = 2
  - Maximum size of a logical sector in number of bytes = 65536/ 2 = 32768
  - Maximum number of logical sectors = 2^16 = 65536
  - Maximum size of a partition in number of bytes = 65536 * 32768= 2GB[15]

9.3.3 Example of layout with TOS standard partitions

In the following example we have a hard disk with 3 standard partitions. The **Root Sector** contains 3 pointers to the 3 partitions. These partitions can be either regular or big partitions.



9.4 *TOS Extended Partition*

Extended partition enables a hard disk to contain more than 4 partitions. Only one entry in the Atari partition table can contain an extended partition. The extended partition is identified by the ASCII characters "XGM" in the **id** field of the partition entry. Since an extended partition is not bootable, it must be preceded by at least one standard partition, so the hard disk can be made bootable. This requirement makes it impossible for the first partition to be an extended partition.

An extended partition is subdivided into smaller ones. Each subdivision consists of an **Extended Root Sector** (**ERS**), and a Standard Partition. Conceptually, each subdivision is like a stand-alone hard disk with only one partition on it. These subdivisions are *linked* together by a pointer in the **Extended Root Sector**.

9.4.1 TOS Extended Root Sector

The layout of an **Extended Root Sector** resembles that of the Root Sector, except that it only contains the partition table. Only two of the four partition table entries can be used, but not necessarily the first two. One of them is used to describe the *Standard Partition* in the current subdivision; the other one provides eventually a link to the next subdivision. The link should occupy the entry that follows the entry for the description of the standard partition. The other two unused entries should be filled with zeroes.

[15] Officially only 1GB is supported by TOS 4.x. However I think that this limitation is related to host adapter support of AHDI command set (2^11 * 512 = 1GB). With host adapter supporting the ICD extended command set the limit of 2GB should work fine.

For the standard partition description, the definitions of the fields in the partition table entry are:

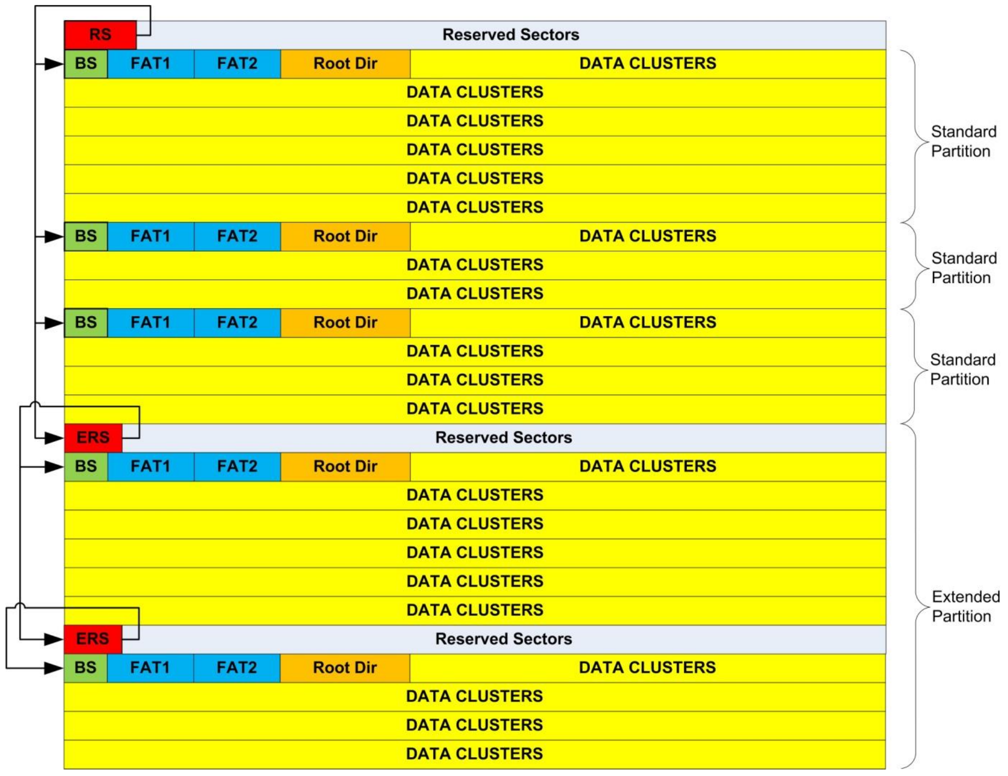
Offset	Length	Description
$00	1	Flag: indicate the state of the partition ■ bit 0 when set partition exist, ■ bit 1-7 reserved
$01	3	Id: a 3-bytes ASCII field that identifies the type of partition ■ GEM for regular (< 32MB) partition ■ BGM for big (≥ 32MB) partition
$04	4	Offset to the beginning of the standard partition from the beginning of the extended root sector that this structure reside in. In number of physical (512 bytes) sectors
$08	4	Size of the partition in number of physical (512 bytes) sectors

For the link to the next partition, the definitions of the fields in the partition table entry are:

Offset	Length	Description
$00	1	Flag: indicate the state of the partition ■ bit 0 when set partition exist, ■ bit 1-7 reserved
$01	3	Id: a 3-bytes ASCII field that identifies the type of partition ■ XGM must be used
$04	4	Offset to the beginning of the next subdivision from the beginning of the entire extended partition. In number of physical (512 bytes) sectors
$08	4	Size of the partition in number of physical (512 bytes) sectors

9.4.2 Example of layout with TOS extended partitions

In the following example we have a hard disk with 3 standard partitions and an extended partition that contains two standard partitions. The **Root Sector** contains 3 pointers to the 3 standard partitions and a pointer to the extended partition that starts with the first **Extended Root Sector**. This ERS contains a pointer to a standard partition and a pointer to the next **Extended Root Sector**. The second ERS contains only a pointer to the second standard partition as it is the last in the chain.



9.5 TOS Partition Structures

This section details the content of a TOS primary partition

9.5.1 TOS Boot sector

The **Boot Sector** is located in the first logical sector of a **logical drive** (standard partition) and it occupies one logical sector. When a logical sector contains more than one physical (512-byte) sectors, the **Boot Sector** will be bigger than 512 bytes. However, only the first 512 bytes of a **Boot Sector** are used, no matter how big the **Boot Sector** might be. The rest of the **Boot Sector** is zero-filled.

This sector is read by the **TOS** to find important information about the disk. Some parameters are loaded from this sector to be used by the BIOS and are stored in a TOS structure called the **BPB**[16] (Bios Parameter Block). Eventually the **Boot Sector** also contains a *bootstrap routine* that allow starting a relocatable program at boot time.

The fields in the **Boot Sector**:

Name	Offset	Bytes	Contents
BRA	$00	2	This word contains a 680x0 BRA.S instruction to the bootstrap code in this sector if the disk is executable, otherwise it is unused.
OEM	$02	6	These six bytes are reserved for use as any necessary filler information.
SERIAL	$08	2	The low 24-bits of this long represent a unique disk serial number.
BPS	$0B	2	This is an Intel format word (big-endian) which indicates the size of a logical sector in number of bytes.
SPC	$0D	1	This is a byte which indicates the number of sectors per cluster (must be a power of 2). The only value supported by GEMDOS is 2.
RES	$0E	2	This is an Intel format word which indicates the number of reserved logical sectors at the beginning of the logical drive, including the boot sector itself. This value is usually one.
NFATS	$10	1	This is a byte indicating the number of File Allocation Table's (FAT's) stored on the logical drive. Usually the value is two.
NDIRS	$11	2	This is an Intel format word indicating the total number of file name entries that can be stored in the root directory of the logical drive.
NSECTS	$13	2	This is an Intel format word indicating the total number of logical sectors on a logical drive including the reserved sectors.
MEDIA	$15	1	This byte is the media descriptor. For hard disks this value is set to $F8. It is not used by the ST BIOS.
SPF	$16	2	This is an Intel format word indicating the size occupied by each of the FATs in number of logical sectors[17].
SPT	$18	2	This is an Intel format word indicating the number of sectors per track. Not applicable to Hard Disk.
NHEADS	$1A	2	This is an Intel format word indicating the number of heads on the media. Not applicable to Hard Disk.
NHID	$1C	2	This is an Intel format word indicating the number of hidden sectors. Not applicable to Hard Disk.
	$1E		Boot Code if Any
	$1FE	2	Checksum

The grayed areas are read from the boot sector and stored in the BPB.

The last word in the boot sector (at offset $1FE) is reserved for the sector checksum. To be bootable a **Boot Sector** checksum must be equal to the *magic number* $1234. During system initialization, the first 512 bytes of the boot sector from a logical drive are loaded into a buffer. If the checksum is correct, the system JSRs the first byte of the buffer. Since location of the buffer is indeterminate, any code contained in the boot sector must be position independent.

[16] The Atari BPB is based on MS-DOS version 2.x BPB.

[17] Given this information, together with the number of FATs and reserved sectors listed above, we can compute where the root directory begins. Given the number of entries in the root directory, we can also compute where the user data area of the disk begins.

9.5.2 TOS File Allocation Table

The File Allocation Table structures (**FAT**) is an array used by the TOS to keep track of which clusters on a drive have been allocated for each file or directory. As a program creates a new file or adds to an existing one, the system allocates sectors for that file, writes the data to the given sectors, and keeps track of the allocated sectors by recording them in the FAT. To conserve space and speed up record-keeping, each record in the FAT corresponds to two or more consecutive sectors (called a cluster). The number of sectors in a cluster depends on the type and capacity of the drive but is always a power of 2 (the only value supported by GEMDOS is 2). Every logical drive has at least one FAT, and most drives have two, one serving as a backup should the other fail. The FAT immediately follows the Boot Sector and any other reserved sectors.

Depending on the number of clusters on the drive, the FAT consists of an array of either 12-bit or 16-bit entries. Drives with more than 4086 clusters have a 16-bit FAT; those with 4086 or fewer clusters have a 12-bit FAT (typically only used by Floppy disks).

The first two entries in a FAT are reserved. In most cases the first byte contains the media descriptor (usually $F8) and the additional reserved bytes are set to $FF. Each FAT entry represents a corresponding cluster on the drive. If the cluster is part of a file or directory, the entry contains either a marker specifying the cluster as an index pointing to the next cluster in the file or directory, or the last in that file or directory. If a cluster is not part of a file or directory, the entry contains a value indicating the cluster's status. The **SCLUSTER** field in the Root Directory corresponding to the file or directory specifies the index of the first FAT entry for the file or directory.

The following table shows possible FAT entry values:

FAT12 Value	FAT16 Value	Meaning
$000	$0000	Available cluster.
$002-$FEF	$0002-$FFEF	Index of entry for the next cluster in the file or directory. Note that $001 does not appear in a FAT, since that value corresponds to the FAT's second reserved entry. Index numbering is based on the beginning of the FAT
$FF0-$FF6	$FFF0-$FFF6	Reserved
$FF7	$FFF7	Bad sector in cluster; do not use cluster.
$FF8-$FFF	$FFF8-$FFFF	Last cluster of file or directory. (usually the value $FFF is used)

For example, the following segment of a 12-bit FAT shows the FAT entries for a file consisting of four clusters:

■ $000	$F8 $FF $FF (2 reserved entries)
■ $003	Cluster 2 points to cluster 3
■ $005	Cluster 3 points to cluster 5
■ $FF7	Cluster 4 contains a bad sector
■ $006	Cluster 5 points to cluster 6
■ $FFF	Cluster 6 is the last cluster for the file
■ $000	Clusters 7 is available
■ ...	

Note: If a cluster contains $000 this does not mean that it is empty but that it is available. This is due to the fact that when a file is deleted the data are not erased but only the first letter of the name of the file in the directory structure is set to $E5 and all clusters used by the deleted file are set to $000.

9.5.3 TOS Root Directory

The TOS arranges and stores file-system contents in directories. Every file system has at least one directory, called the **Root Directory** (also referred as the **Catalog** in Atari), and may have additional directories either in the **Root Directory** or ordered hierarchically below it. The contents of each directory are described in individual directory entries. The TOS strictly controls the format and content of directories.

The **Root Directory** is always the topmost directory and it is created during initialization of a partition. The **Root Directory** can hold information for only a fixed number of files or other directories, and the number cannot be changed without reformatting the partition. A program can identify this limit by examining the **NDIRS** field in the **BPB** structure described in the Boot Sector. This field specifies the maximum number of root-directory entries for the partition.

A user or a program can add new directories within the current directory, or within other directories. Unlike the **Root Directory**, the new directory is limited only by the amount of space available on the medium, not by a fixed number of entries. The TOS initially allocates only a single cluster for the directory, allocating additional clusters only when they are needed. Every directory except the **Root Directory** has two entries when it is created. The first entry specifies the directory itself, and the second entry specifies its parent directory (the directory that contains it). These entries use the special directory names "." (An ASCII period) and ".." (Two ASCII periods) respectively.

The TOS gives programs access to files in the file system. Programs can read from and write to existing files, as well as create new ones. Files can contain any amount of data, up to 4GB or the limits of the data region on a partition. Apart from its contents, every file has a name (possibly with an extension), access attributes, and an associated date and time. This information is stored in the file's directory entry, not in the file itself.

The **Root Directory** is located just after the FATs. Each entry in the **Root Directory** is described by the following 32 bytes long structure:

Name	Bytes	Contents
FNAME	8	Specifies the name of the file or directory. If the file or directory was created by using a name with fewer than eight characters, space characters (ASCII $20) fill the remaining bytes in the field. The first byte in the field can be a character or one of the following values: ■ $00: The directory entry has never been used. The TOS uses this value to limit the length of directory searches. ■ $05: The first character in the name has the value $E5. ■ $2E: The directory entry is an alias for this directory or the parent directory. If the remaining bytes are space characters (ASCII 20h), the **SCLUSTER** field contains the starting cluster for this directory. If the second byte is also $2E (and the remaining bytes are space characters), **SCLUSTER** contains the starting cluster number of the parent directory, or zero if the parent is the root directory. ■ $E5: The file or directory has been deleted.
FEXT	3	Specifies the file or directory extension. If the extension has fewer than three characters, space characters (ASCII $20) fill the remaining bytes in this field.
ATTRIB	1	Specifies the attributes of the file or directory. This field can contain some combination of the following values: ■ $01: Specifies a read-only file. ■ $02: Specifies a hidden file or directory. ■ $04: Specifies a system file or directory. ■ $08: Specifies a volume label. The directory entry contains no other usable information (except for date and time of creation) and can occur only in the root directory. ■ $10: Specifies a directory. ■ $20: Specifies a file that is new or has been modified. ■ All other values are reserved. (The two high-order bits are set to zero.) If no attributes are set, the file is a normal file.
RES	10	Reserved; do not use.
FTIME	2	Specifies the time the file or directory was created or last updated. The field has the following form: ■ Bits 0-4: Specifies two-second intervals. Can be a value in the range 0 - 29. ■ Bits 5-10: Specifies minutes. Can be a value in the range 0 - 59. ■ Bits 11-15: Specifies hours. Can be a value in the range 0 - 23.
FDATE	2	Specifies the date the file or directory was created or last updated. The field has the following form: ■ Bits 0-4: Specifies the day. Can be a value in the range 1 through 31. ■ Bits 5-8: Specifies the month. Can be a value in the range 1 through 12. ■ Bits 9-15: Specifies the year, relative to 1980.
SCLUSTER	2	Specifies the starting cluster of the file or directory (index into the FAT)
FSIZE	4	Specifies the maximum size of the file, in bytes.

9.5.4 Size and Position of the TOS Partition Structures

With the information given in the MBR and the information given in the Root sector, it is possible to compute the size and position of the different TOS partition structures.

EQ-1 The position of the **Boot Sector** P_{BS} (the beginning of a logical partition) is directly given in the **Root Sector** or in an **Extended Root Sector** of the **MBR**. Given as an offset

EQ-2 The position of the first FAT P_{FAT1} is:
$P_{FAT1} = P_{BS} + RES * (BPS/512)$

EQ-3 The position of the second **FAT** P_{FAT2} is:
$P_{FAT2} = P_{FAT1} + SPF * (BPS/512)$

EQ-4 The position of the **Root Directory** P_{RD} is:
$P_{RD} = P_{FAT2} + SPF * (BPS/512)$

EQ-5 The position of the first data cluster P_{DATA} is:
$P_{DATA} = P_{RD} + NDIRS * (32/512)$

EQ-6 The size of the partition is:
$S_P = BPS * NSECTS = (RES * BPS/512) + NFATS * (SPF * BPS/512) + NDIRS * 32/512 + S_{DATA}$

EQ-7 From this equation we can compute the size of the data region
$S_{DATA} = BPS * NSECTS - ((RES * BPS/512) + NFATS * SPF * BPS/512 + NDIRS * 32/512)$

9.5.5 Computing Boot Sector values from User Inputs

The partitioning program has to computes several values to place into the Boot Sector based on input from the user.

The following values are given by the user or known from the partitioning tool:

- OEM:
- SERIAL:
- BPS: The BPS is either specified by the user or can take default values as given in TOS Partition Size.
- SPC always equal to 2
- RES usually 1 but can be changed by the partitioning tool
- NFATS for GEMDOS this value is always equal to 2
- NDIRS is specified by the user and is usually 512
- MEDIA is not used but usually set to F8 for hard disk
- SPT, NHEADS, NHID not used can be set to any meaningful value or 0.

The partitioning tool has therefore to compute the following fields:

- NSECTS
- SPF

From the above equations we compute:

EQ-8 $NSECTS = S_P / BPS$

EQ-9 The minimum number of cluster entries in a FAT can be computed as follow:
$N_{CLUST} \geq (S_{DATA} / (BPS * SPC)) + 2$

9.6 TOS Boot Sequence

In this section we describe a *typical* sequence to load a hard disk driver from a bootable hard disk partition. The actual implementation differs from driver to driver.

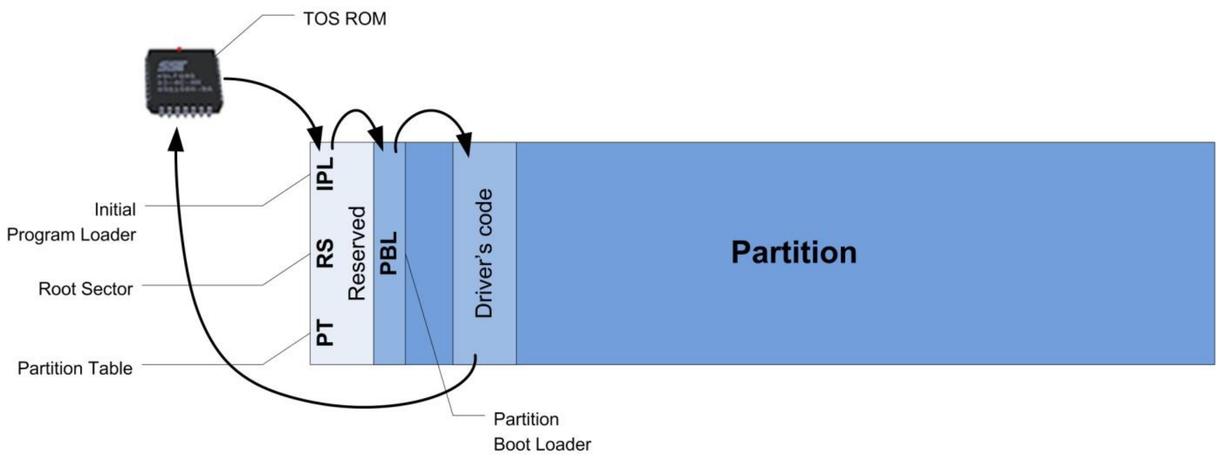
During the TOS ROM System initialization an attempt is made to load Root Sector (RS) from the DMA bus. For each of the eight DMA bus devices the TOS attempts a read operation on the first physical sector 0.

If the read is successful, and if the sector word checksum is equal to $1234, then the boot loader code from **the Root Sector** is executed. Remember that the **Root Sector** is composed of a boot-loader program and a partition table. A common name for the boot-loader program part of the Root Sector is the **Initial Program Loader** (IPL). The IPL is very small and quite limited. Its main job is usually to find and start the next program in the chain. For that matter it usually looks at the partition table to see if any of the entries there has a flag to indicate a *bootable partition*. If it find one then it usually goes to the very first byte of that partition (the Boot Sector) and starts the boot loader code that it finds there (If several partition are bootable the IPL select the first).

The next program in the chain is at the very beginning of the partition in the Boot Sector. This program is often called the **Partition Boot Loader** (PBL). The PBL will do its job and then start the next program: usually the hard disk driver loader. The location of the next program will be different for various hard disk drivers. During the installation of a hard disk driver (with a hard disk utility) the PBL will be written with the information necessary to find the driver file location. The boot loader code can perform a variety of tasks. In some cases it can, for example, load the hard disk driver from the first track of the disk, which it assumes to be “free” space (that is not allocated to any disk partition), and executes it. In others cases, it uses a table of embedded disk locations to locate the hard disk driver loader and execute it.

The last program in the chain is the actual hard disk driver loader. This program loads in memory the necessary code to handle the disk drives and finally returns to the TOS program to start GEMDOS.

For Atari the boot sequence is: BIOS / TOS → IPL → PBL → HD Driver → GEMDOS



In these graphic the RS is shown as a separate section at the very start of the hard drive. It is indeed separate and not connected in any way to the following partitions. Convention is to reserve a small section of the drive specifically for the RS to reside on. I've shown the PBL as a separate section but it is actually a part of the partition it is in.

Note that the PPDRIVER hard disk driver uses a slightly different boot sequence. It does not use (and therefore does not write) a PBL in any of the partitions. Instead the IPL call directly the HD driver loader code. This code is located in the reserved area at the beginning of the disk (starting at sector 2). This allows an easy selection at boot time of the boot partition. You can therefore switch between different configurations by selecting a specific partition with the required AUTO, ACC, Desktop Settings…

Chapter 10. Information about DOS/FAT Partitions

In this chapter I describe the layout and various information concerning the DOS/FAT Hard Disks partitioning. PC hard disk partitioning is a vast subject and I will only present here information that can be useful in the context of its usage on Atari.

The layout of PC DOS hard disks is similar but not identical to layout of Atari hard disks.

10.1 DOS/FAT File System Information

This information is taken from Wiki File Allocation Table Article

FAT			
Full Name	File Allocation Table		
	(12-bit version)	(16-bit version)	(32-bit version)
Partition identifier	0x01	0x04, 0x06, 0x0E, 0x0F	0x0B, 0x0C
Directory contents	Table		
File allocation	Linked List		
Max file size	4 GB minus 1 byte (or volume size if smaller)		
Max cluster count	4,077 (2^{12}-19)	65,517 (2^{16}-19)	268,435,437 (2^{28}-19)
Max filename size	8.3 filename, or 255 UTF-16 characters when using LFN		
Max volume size	32 MB	2 GB (up to 4GB)	2 TB (up to 8 TB)
Dates recorded	Creation, modified, access (accuracy today only)		
Date range	January 1, 1980 - December 31, 2107		
File Attributes	Read-only, hidden, system, volume label, subdirectory, archive		

10.2 DOS/FAT Hard Disk Layout

Partitioning and Initialization of the disk write information that defines the layout of the disk:

- The Master Boot Record (MBR) defines the number of partitions and their positions on the disk.
- The Reserved Sectors is optional. However, for historical reason, a partition on a FAT file system is aligned on a cylinder boundary (Cylinder 0, head 1, Sector 1 in CHS notation). The 62 (usual value) sectors gap between them is left unused. This is not required with LBA drives, but we need to follow this rule in order to make happy old software (MS-DOS for example).
- One or several partitions.

There are two types of partitions: *primary* partitions and *extended partitions*:

- A *primary partition* contains a number of control structures, necessary to describe the partitions, but most of its content is the actual data.
- An *extended partition* is a special kind of partition which itself is subdivided into *primary partitions*.

10.3 DOS/FAT Master Boot Record (MBR)

The first physical sector 0 on a disk on a hard disk contains the *Master Boot Record* structure (this equivalent to the Atari Root Sector):

Offset	Length	Description
0x0000	440	Boot loader code. Filled with zero if disk is not bootable.
0x01B8	4	Optional Disk signature
0x01BC	2	Usually Nulls; 0x0000
0x01BE 0x01CE 0x01DE 0x01EE	4 * 16	Table of partitions: Four 16-byte entries, IBM Partition Table scheme
0x01FE	2	MBR Signature $AA55 in little-endian format

The table of partitions has four 16-byte structures to describe each partition:

Offset	Length	Description	Partition entry locations
0x00	1	Status ■ 0x80 = bootable (*active*), ■ 0x00 = non-bootable, ■ other = invalid	$1BE, $1CE, $1DE, $1EE
0x01	3	CHS address of first sector in partition (next 3 bytes): ■ Head ■ Sector is in bits 5–0; bits 9–8 of Cylinder are in bits 7–6 ■ bits 7–0 of Cylinder	$1BF, $1CF, $1DF, $1EF
0x04	1	partition type	$1C2, $1D2, $1E2, $1F2
0x05	3	CHS address of last sector in partition (next 3 bytes): ■ Head ■ Sector is in bits 5–0; bits 9–8 of Cylinder are in bits 7–6 ■ bits 7–0 of Cylinder	$1C3, $1D3, $1E3, $1F3
0x08	4	LBA of first sector in the partition, in little-endian format	$1C6, $1D6, $1E6, $1F6
0x0C	4	Number of sector in partition, in little-endian format	$1CA, $1DA, $1EA, $1FA

10.4 DOS/FAT Primary Partition

A primary partition contains one FAT file system. The “partition type” code for a primary partition describes the type of the file system. The FAT file systems have made use of quite a number of partition type codes over time due to the limits of various DOS and Windows OS versions. Please refer to FAT Partition Type and Size for a short summary of partition types useful in the context of the Atari platform.

The following is an overview of the order of the structures in a primary FAT file system partition:

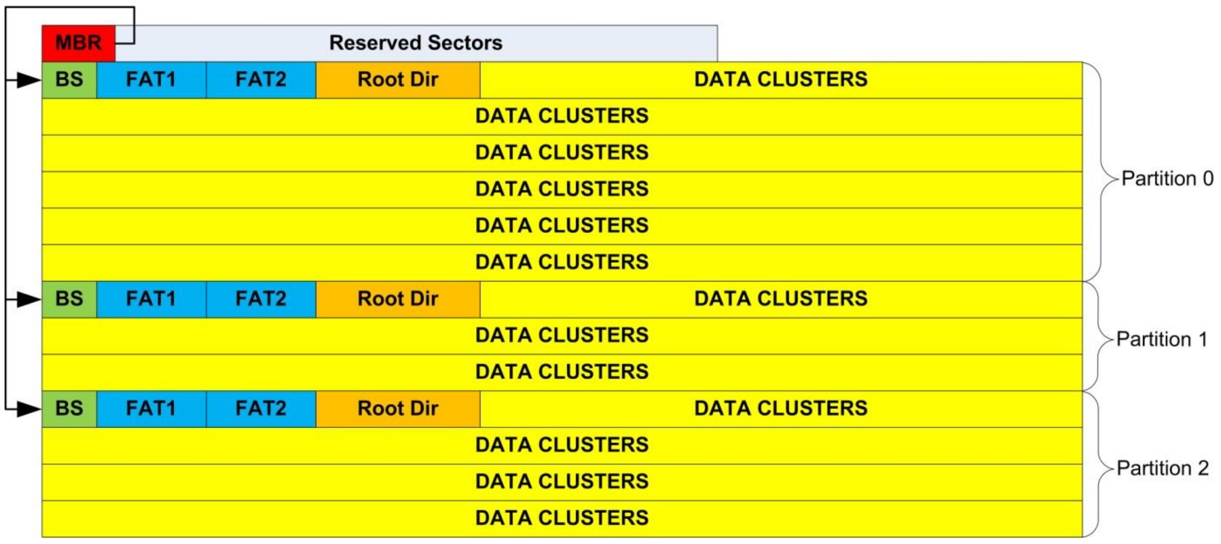
	Boot Sector	FS Information Sector (FAT32 only)	More reserved sectors (optional)	File Allocation Table #1	File Allocation Table #2	Root Directory (FAT12/16 only)	Data Region (for files and directories) ... (To end of partition or disk)
size in sectors	(number of reserved sectors)			(number of FATs) * (sectors per FAT)		(number of root entries * 32) / Bytes per sector	NumberOfClusters * SectorsPerCluster

A FAT file system is therefore composed of these four sections:

- The **Boot sectors region**, located at the very beginning of the partition: The first reserved sector (logical sector 0) is the Boot Sector. It includes an area called the *BIOS Parameter Block* (with some basic file system information, in particular its type, and pointers to the location of the other sections) and usually it contains the operating system's *boot loader* code. The total count of reserved sectors is indicated by a field inside the **Boot Sector**. Important information from the **Boot Sector** is accessible through a DOS structure called the *BIOS Parameter Block* (**BPB**). For FAT32 file systems, the reserved sectors include a File System Information *Sector,* usually at sector 1, and a **Backup Boot Sector,** usually at Sector 6. The exact location of these two sectors is specified in the Extended FAT32 BPB.
- The **FAT region**: This typically contains two copies (may vary) of the File Allocation Table for the sake of redundancy checking, although the extra copy is rarely used, even by disk repair utilities. These are maps of the **Data region**, indicating which clusters are used by files and directories.
- The **Root Directory region**: This is the Directory Table that stores information about the files and directories located in the **Root Directory**. It imposes on the **Root Directory** a fixed maximum size which is pre-allocated at creation of this volume.
- The **Data region**: This is where the actual file and directory data is stored and takes up most of the partition. The size of files and subdirectories can be increased arbitrarily (as long as there are free clusters) by simply adding more links to the file's chain in the **FAT**

10.4.1 Example of layout with DOS/FAT standard partitions

In the following example we have a hard disk with 3 primary partitions. The Master Boot Record contains 3 pointers to the 3 partitions. These partitions can be either regular or big partitions.



10.5 *DOS/FAT Extended Partition*

An extended partition is a special partition which contains *secondary partition(s)*. A hard disk may contain only one extended partition; which can then be sub-divided into many *logical drives*.

10.5.1 Extended Master Boot Record (EMBR)

The first sector of the Extended Partition contains an **Extended Master Boot Record** (EMBR). It is very similar to the Master Boot Record.

The **Extended Master Boot Record** contains the following information:

Offset	Length	Description
$0000	455	Normally unused and filled with 0.
$01BE	16	Partition Table's First entry
$01CE	16	Partition Table's Second entry
$01DE	32	Unused, should be filled with zero-bytes
$01FE	2	MBR Signature $AA55 in little-endian format

Where a Partition Table entry contains:

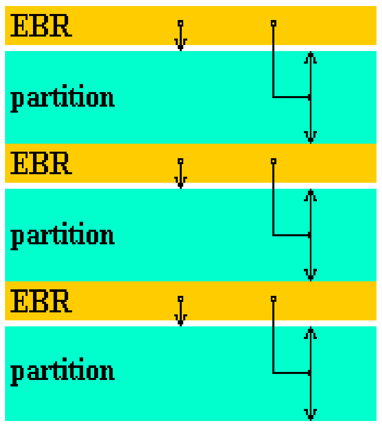
Offset	Length	Description	Locations
0x00	1	Status (0x80 = bootable (*active*), 0x00 = non-bootable)	$1BE, $1CE, $1DE, $1EE
0x01	3	CHS address of first sector in partition (next 3 bytes):	$1BF, $1CF, $1DF, $1EF
0x01	1	■ Head	
0x02	1	■ Sector is in bits 5–0; bits 9–8 of Cylinder are in bits 7–6	
0x03	1	■ bits 7–0 of Cylinder	
0x04	1	partition type	$1C2, $1D2, $1E2, $1F2
0x05	3	CHS address of last sector in partition (next 3 bytes):	$1C3, $1D3, $1E3, $1F3
0x05	1	■ Head	
0x06	1	■ Sector is in bits 5–0; bits 9–8 of Cylinder are in bits 7–6	
0x07	1	■ bits 7–0 of Cylinder	
0x08	4	LBA of first sector in the partition, in little-endian format	$1C6, $1D6, $1E6, $1F6
0x0C	4	number of sectors in partition, in little-endian format	$1CA, $1DA, $1EA, $1FA

The **first entry** of an EMBR partition table points to the logical partition belonging to that EMBR:

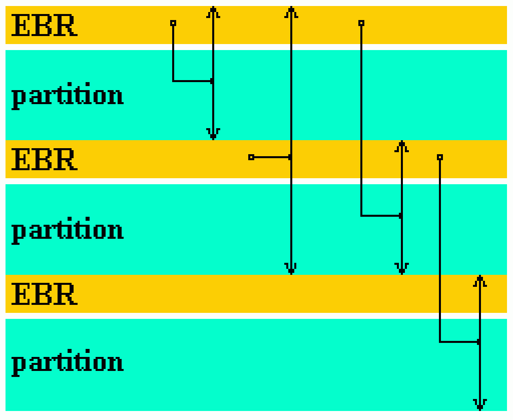
- Starting Sector = relative offset between this EMBR sector and the first sector of the logical partition. ***Note****: This will be the same value for each EMBR on the same hard disk; usually 63*.
- Number of Sectors = total count of sectors for this logical partition. Note: Any *unused sectors* between EBR and logical drive are not considered part of the logical drive.

The **second entry** of an EMBR partition table will contain zero-bytes if it's the last EMBR in the extended partition; otherwise, it points to the next EMBR in the EMBR chain:

- Starting Sector = relative address of next EMBR within current extended partition. In other words: Starting Sector = LBA address of next EMBR - LBA address of extended partition's **first** EMBR
- Number of Sectors = total count of sectors for next logical partition, but count starts from the next EMBR sector.
  Note 1: Unlike the first entry in an EMBR's partition table, this Number of Sectors count includes the next logical partition's EMBR sector along with the other sectors in its otherwise unused track.
  Note 2: Most operating systems that use the extended partitioning scheme (including Microsoft MS-DOS and Windows, and Linux) ignore the "partition size" value in entries which *point to* another EBR sector.



What the *Starting* and *Total Number of* sectors values of **1st entry** *point to* and *enumerate*.



What the *Starting* and *Total Number of* sectors values of an EBR's **2nd entry** *point to* and *enumerate*.

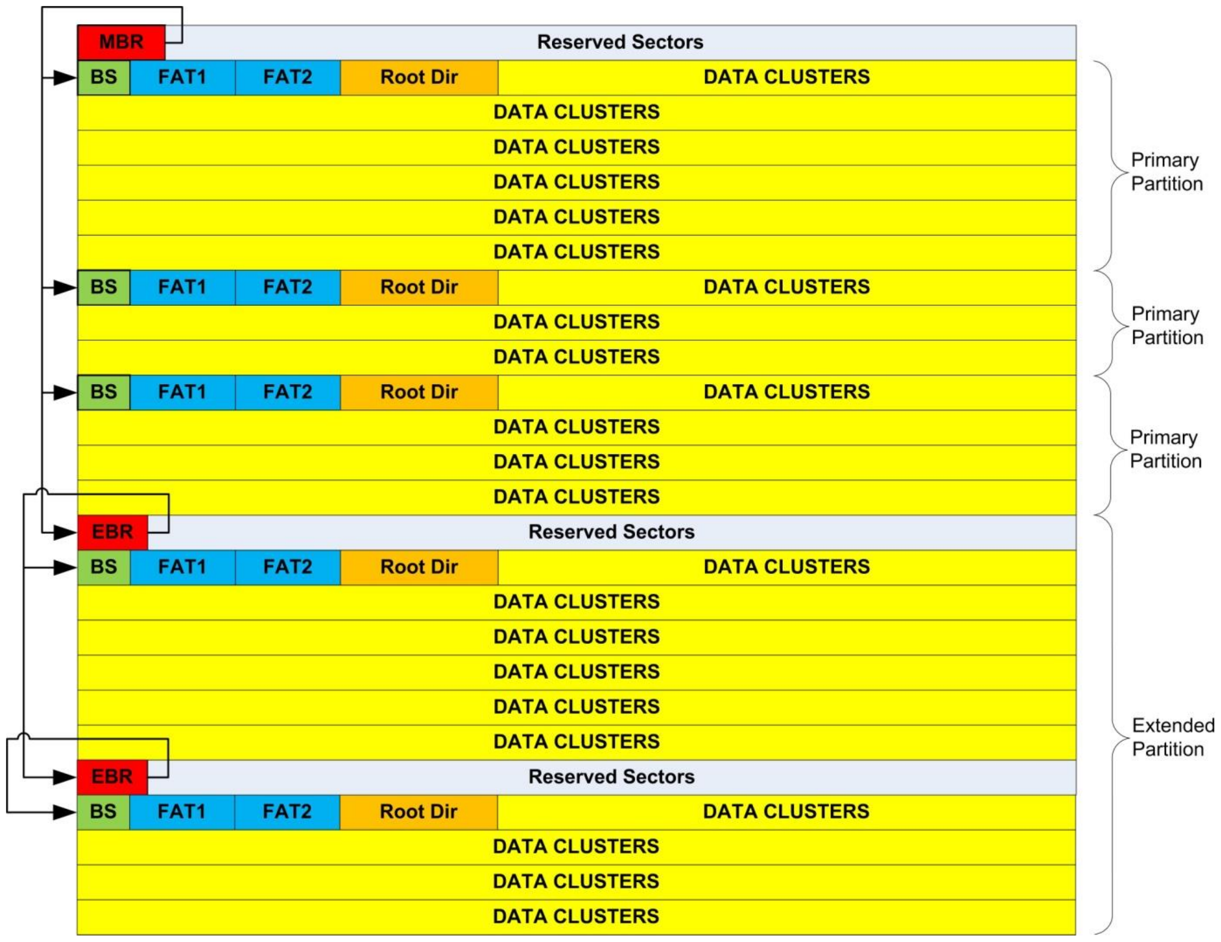
Remarks:

First, the diagrams above are not to scale: The thin white lines between each "EBR" and its logical "partition" represent the remainder of an unused area usually 63 sectors in length; including the single EBR sector (shown at a greatly exaggerated size).

Also, on some systems, a large gap of unused space may exist between the end of a logical partition and the next EBR, or between the last logical partition and the end of the whole extended partition itself, if any previously created logical partition has been deleted or resized (shrunk).

10.5.2 Example of layout with DOS/FAT extended partitions

In the following example we have a hard disk with 3 primary partitions and an extended partition that contains two embedded primary partitions. The Master Boot Record contains 3 pointers to the 3 *standard partitions* and a pointer to the *extended partition.* The first logical sector of the *extended partition* contains the first **Extended Master Boot Record**. This EMBR contains in turn a pointer to the primary partition and a pointer to the next **Extended Master Boot Record**. This second EMBR contains in turn a pointer to a primary partition.



10.6 DOS/FAT Partition Structures

10.6.1 DOS/FAT Boot sector

The boot sector is the first logical sector of a logical drive and it occupies one logical sector. The grayed areas are read from the boot sector and stored in the BIOS Parameter Block (BPB).

Name	Offset	Length	Description
BRA	0x00	3	Jump instruction. This instruction will be executed and will skip past the rest of the (non-executable) header if the partition is booted from.
OEM	0x03	8	OEM Name (padded with spaces). This value determines in which system disk was formatted. MS-DOS checks this field to determine which other parts of the boot record can be relied on.
BPS	0x0b	2	Bytes per Sector. A common value is 512, especially for file systems on IDE (or compatible) disks. The *BIOS Parameter Block* starts here.
SPC	0x0d	1	Sectors per Cluster. Allowed values are powers of two from 1 to 128. However, the value must not be such that the number of bytes per cluster becomes greater than 32KB.

RES	0x0e	2	Reserved sector count. The number of sectors before the first FAT in the file system image (including boot sector). Typically 1 for FAT12/FAT16 and 32 for FAT32.
NFATS	0x10	1	Number of file allocation table following the reserved sectors. Almost always 2. The second FAT is used by recovery program if the first FAT is corrupted.
NDIRS	0x11	2	Maximum number of root directory entries[18]. This value should always be such that the root directory ends on a sector boundary (i.e. such that its size becomes a multiple of the sector size). 0 for FAT32.
NSECTS	0x13	2	Total number of sectors on the drive. If the size of the drive is greater than 32MB, this field is set to zero and the number of sectors is specified in the huge number of sectors field at offset 0x20 (HSECTS). 0 for FAT32
MEDIA	0x15	1	Media descriptor: Usually 0xF8 for Hard disk. Same value of media descriptor should be repeated as first byte of each copy of FAT.
SPF	0x16	2	Number of Sectors per File Allocation Table
SPT	0x18	2	Number of Sectors per single Track
NHEADS	0x1a	2	Number of heads on the drive
NHID	0x1c	4	Number of Hidden sectors
HSECTS	0x20	4	Huge number of Sectors (when more than 65535 sectors) otherwise, see NSECTS at offset 0x13. This field allow support for drives larger than 32MB

10.6.1.1 Extended BIOS Parameter Block used by FAT12 and FAT16:

Name	Offset	Length	Description
DRNUM	0x24	1	Drive ID: Specifies whether the drive is the first hard disk drive (value 0x80) or not (value 0x00). Used internally by MS-DOS
	0x25	1	Reserved
EBSIG	0x26	1	Extended boot signature. Value is 0x29 (or 0x28).
VOLID	0x27	4	Volume serial number
VLAB	0x2b	11	Volume Label, padded with blanks (0x20).
FSTYPE	0x36	8	FAT file system type, padded with blanks (0x20), e.g.: "FAT12 ", "FAT16 ". This is not meant to be used to determine drive type; however, some utilities use it in this way.
	0x3E	448	Operating system boot code
	0x1FE	2	Boot sector signature (0x55 0xAA)

10.6.1.2 Extended BIOS Parameter Block used by FAT32:

Offset	Length	Description
0x24	4	Big Sectors per FAT
0x28	2	Extended FAT Flags
0x2a	2	FS Version
0x2c	4	First Cluster number of root directory
0x30	2	Sector number of FS Information Sector
0x32	2	Sector number of a copy of this boot sector
0x34	12	Reserved
0x40	1	Physical Drive Number (Drive ID)
0x41	1	Reserved for NT
0x42	1	Extended boot signature.
0x43	4	ID (serial number)
0x47	11	Volume Label
0x52	8	FAT file system type: "FAT32 "
0x5a	420	Operating system boot code

18 This value should always be such that the root directory ends on a sector boundary (i.e. such that its size becomes a multiple of the sector size).

0x1FE	2	Boot sector signature (0x55 0xAA)

10.6.2 FS Information Sector

The **FS Information Sector** was introduced in FAT32 for speeding up access times of certain operations (in particular, getting the amount of free space). It is located at a sector number specified in the boot record at position 0x30 (usually sector 1, immediately after the boot record).

Offset	Length	Description
0x00	4	FS information sector signature (0x52 0x52 0x61 0x41 / "RRaA")
0x04	480	Reserved (byte values are 0x00)
0x1e4	4	FS information sector signature (0x72 0x72 0x41 0x61 / "rrAa")
0x1e8	4	Number of free clusters on the drive, or -1 if unknown
0x1ec	4	Number of the most recently allocated cluster
0x1f0	14	Reserved (byte values are 0x00)
0x1fe	2	FS information sector signature (0x55 0xAA)

10.6.3 DOS/FAT File Allocation Table

A partition is divided up into identically sized **clusters**, small blocks of contiguous space. Cluster sizes vary depending on the type of FAT file system being used and the size of the partition, typically cluster sizes lie somewhere between 2 KB and 32 KB. Each file may occupy one or more of these clusters depending on its size; thus, a file is represented by a chain of these clusters (referred to as a singly linked list). However these clusters are not necessarily stored adjacent to one another on the disk's surface but are often instead *fragmented* throughout the Data Region.

The **file allocation table** (**FAT**) is a list of entries that map to each cluster on the partition. Each entry records one of five things:

- The cluster number of the next cluster in a chain
- A special *end of cluster chain* (*EOC*) entry that indicates the end of a chain
- A special entry to mark a bad cluster
- A special entry to mark a reserved cluster
- A zero to note that the cluster is unused

Each version of the FAT file system uses a different size for FAT entries. Smaller numbers result in a smaller FAT table, but waste space in large partitions by needing to allocate in large clusters. The FAT12 file system uses 12 bits per FAT entry, thus two entries span 3 bytes. It is consistently little-endian: if you consider the 3 bytes as one little-endian 24-bit number, the 12 least significant bits are the first entry and the 12 most significant bits are the second. In the FAT32 file system, FAT entries are 32 bits, but only 28 of these are actually used; the 4 most significant bits are reserved.

FAT entry values:

FAT12	FAT16	FAT32	Description
0x000	0x0000	0x00000000	Free Cluster
0x001	0x0001	0x00000001	Reserved value; do not use
0x002–0xFEF	0x0002–0xFFEF	0x00000002–0x0FFFFFEF	Used cluster; value points to next cluster
0xFF0–0xFF6	0xFFF0–0xFFF6	0x0FFFFFF0–0x0FFFFFF6	Reserved values; do not use.
0xFF7	0xFFF7	0x0FFFFFF7	Bad sector in cluster or reserved cluster
0xFF8–0xFFF	0xFFF8–0xFFFF	0x0FFFFFF8–0x0FFFFFFF	Last cluster in file

Note that FAT32 uses only 28 bits of the 32 possible bits. The upper 4 bits are usually zero (as indicated in the table above) but are reserved and should be left untouched.

The first cluster of the Data Region is cluster #2. That leaves the first two entries of the FAT unused. In the first byte of the first entry a copy of the media descriptor is stored (usually 0xF8). The remaining 8 bits (if FAT16) or 20 bits (if FAT32) of this entry are set to 1. In the second entry the end-of-cluster-chain marker is stored. The high order two bits of the second entry are sometimes, in the case of

FAT16, used for dirty volume management: high order bit 1: last shutdown was clean; next highest bit 1: during the previous mount no disk I/O errors were detected.

10.6.4 DOS/FAT Directory Table

A **Directory Table** is a special type of file that represents a directory (also known as a **folder**). Each file or directory stored within it is represented by a 32-byte entry in the table. Each entry records the name, extension, attributes (archive, directory, hidden, read-only, system and volume), the date and time of creation, the address of the first cluster of the file/directory's data and finally the size of the file/directory. Aside from the **Root Directory Table** in FAT12 and FAT16 file systems, which occupies the special **Root Directory region** location, all **Directory Tables** are stored in the **Data region**. The actual number of entries in a directory stored in the **Data region** can grow by adding another cluster to the chain in the FAT.

Legal characters for DOS file names include the following:

- Upper case letters `A`–`Z`
- Numbers `0`–`9`
- Space (though trailing spaces in either the base name or the extension are considered to be padding and not a part of the file name, also filenames with space in them could not be used on the DOS command line prior to Windows 95 because of the lack of a suitable escaping system)
- `! # $ % & ' ( ) - @ ^ _ ` { } ~`
- Values 128–255

This excludes the following ASCII characters:

- " * / : < > ? \ |
  Windows/MSDOS has no shell escape character
- + , . ; = [ ]
  They are allowed in long file names only.
- Lower case letters a–z
  Stored as A–Z. Allowed in long file names.
- Control characters 0–31
- Value 127 (DEL)

Directory entries, both in the **Root Directory** region and in subdirectories, are of the following format:

Byte Offset	**Length**	**Description**
0x00	8	DOS file name (padded with spaces). The first byte can have the following special values: ■ 0x00 Entry is available and no subsequent entry is in use ■ 0x05 Initial character is actually 0xE5. ■ 0x2E 'Dot' entry; either '.' or '..' ■ 0xE5 Entry has been previously erased and is available.
0x08	3	DOS file extension (padded with spaces)
0x0b	1	File Attributes ■ Bit Mask Description ■ 0 0x01 Read Only ■ 1 0x02 Hidden ■ 2 0x04 System ■ 3 0x08 Volume Label ■ 4 0x10 Subdirectory ■ 5 0x20 Archive ■ 6 0x40 Device (internal use only, never found on disk) ■ 7 0x80 Unused An attribute value of 0x0F is used to designate a long file name entry.
0x0c	1	Reserved
0x0d	1	Create time, fine resolution: 10ms units, values from 0 to 199.
0x0e	2	Create time. The hour, minute and second are encoded according to the following bitmap: ■ Bits Description ■ 15-11 Hours (0-23) ■ 10-5 Minutes (0-59) ■ 4-0 Seconds/2 (0-29) Note that the *seconds* is recorded only to a 2 second resolution. Finer resolution for file creation is found at offset 0x0d.
0x10	2	Create date. The year, month and day are encoded according to the following bitmap: ■ Bits Description ■ 15-9 Year (0 = 1980, 127 = 2107) ■ 8-5 Month (1 = January, 12 = December) ■ 4-0 Day (1 - 31)
0x12	2	Last access date; see offset 0x10 for description.
0x14	2	EA-Index in FAT12 and FAT16. High 2 bytes of first cluster number in FAT32
0x16	2	Last modified time; see offset 0x0e for description.
0x18	2	Last modified date; see offset 0x10 for description.
0x1a	2	First cluster in FAT12 and FAT16. Low 2 bytes of first cluster in FAT32. Entries with the Volume Label flag, subdirectory ".." pointing to root, and empty files with size 0 should have first cluster 0.
0x1c	4	File size in bytes. Entries with the Volume Label or Subdirectory flag set should have a size of 0.

Clusters are numbered from a cluster offset as defined above and the file_start_cluster is in 0x1a. This means the first data segment can be calculated:

- For FAT16/12:

  File start sector = reserved sectors + (no of FAT * sectors per FAT) +
  (max root entry * 32 / bytes per sector) +
  ((file start cluster − 2) * sectors per cluster)

- For FAT32

  File start sector = reserved sectors + (no of FAT * sectors per FAT) +
  ((file start cluster − 2) * Sectors per cluster)

10.6.5 Position of the Structures in a DOS Partition

- The position of the **Boot Sector** P_{BS}(the beginning of a logical partition) is directly given in the **Master Boot Record** or in an **Extended Master Boot Record**
- The position of the first **FAT** P_{FAT1} is equal to the position of the **boot sector** plus the number of reserved sector:
  $P_{FAT1} = P_{BS} + RES$
- The position of the second **FAT** P_{FAT2} is equal to the position of the P_{FAT1} plus the size of the **FAT**:
  $P_{FAT2} = P_{FAT1} + SPF$
- The position of the **Root Directory** P_{RD} is equal to the position of P_{FAT2} plus the size of the **FAT**:
  $P_{RD} = P_{FAT2} + SPF$
- The position of the first data cluster P_{DATA} is equal to the position of the **Root Directory** plus the size of the **Root Directory**:
  $P_{DATA} = P_{RD} + NDIRS * (32/512)$

The Size of the data region = Number of Clusters * Sectors per Cluster

10.6.6 DOS/FAT Long file names

Long File Names (LFN) are stored on a FAT file system using a trick—adding (possibly multiple) additional entries into the directory before the normal file entry. When using LFN the DOS/FAT file system is often referred as **DOS/VFAT** file system. The additional entries are marked with the Volume Label, System, Hidden, and Read Only attributes (yielding 0x0F attribute), which is a combination that is not expected in the MS-DOS environment, and therefore ignored by MS-DOS programs and third-party utilities. Notably, a directory containing only volume labels is considered as empty and is allowed to be deleted; such a situation appears if files created with long names are deleted from plain DOS. Older versions of PC-DOS mistake LFN names in the root directory for the volume label, and are likely to display an incorrect label.

Each fake entry can contain up to 13 UTF-16 characters (26 bytes) by using fields in the record which contain file size or time stamps (but not the starting cluster field, for compatibility with disk utilities, the starting cluster field is set to a value of 0. See 8.3 filename for additional explanations). Up to 20 of these 13-character entries may be chained, supporting a maximum length of 255 UTF-16 characters. After the last UTF-16 character, a 0x00 0x00 is added. Other not used characters are filled with 0xFF 0xFF.

LFN entries use the following format:

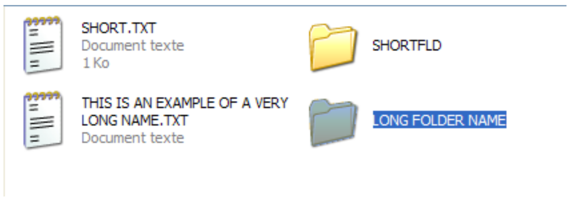
Byte Offset	Length	Description
0x00	1	Sequence Number
0x01	10	Name characters (five UTF-16 characters)
0x0b	1	Attributes (always 0x0F)
0x0c	1	Reserved (always 0x00)
0x0d	1	Checksum of DOS file name
0x0e	12	Name characters (six UTF-16 characters)
0x1a	2	First cluster (always 0x0000)
0x1c	4	Name characters (two UTF-16 characters)

If there are multiple LFN entries, required to represent a file name, firstly comes the last LFN entry (the last part of the filename). The sequence number here also has bit 7 (0x40) checked (this means the last LFN entry. However it's the first entry got when reading the directory file). The last LFN entry has the biggest sequence number which decreases in following entries. The first LFN entry has sequence number 1. Bit 8 (0x80) of the sequence number is used to indicate that the entry is deleted.

For example if we have filename "File with very long filename.ext" it would be formatted like this:

Sequence number	Entry data
0x43	"me.ext"
0x02	"y long filena"
0x01	"File with ver"
???	Normal 8.3 entry

Here a Practical example of a disk with only 4 entries:


SHORT.TXT
Document texte
1 Ko

SHORTFLD

THIS IS AN EXAMPLE OF A VERY LONG NAME.TXT
Document texte

LONG FOLDER NAME

Dump of the directory table:

```
Offset      0  1  2  3  4  5  6  7   8  9  A  B  C  D  E  F
0002A000   53 48 4F 52 54 20 20 20  54 58 54 20 00 0F 9B 81   SHORT   TXT ..›□
0002A010   8D 3B 8D 3B 00 00 A0 8C  8C 3B 02 00 0E 00 00 00   □;□;.. ŒŒ;......
0002A020   44 54 00 58 00 54 00 00  00 FF FF 0F 00 43 FF FF   DT.X.T...ÿÿ..Cÿÿ
0002A030   FF FF FF FF FF FF FF FF  FF FF 00 00 FF FF FF FF   ÿÿÿÿÿÿÿÿÿÿ..ÿÿÿÿ
0002A040   03 52 00 59 00 20 00 4C  00 4F 00 0F 00 43 4E 00   .R.Y. .L.O...CN.
0002A050   47 00 20 00 4E 00 41 00  4D 00 00 00 45 00 2E 00   G. .N.A.M...E...
0002A060   02 41 00 4D 00 50 00 4C  00 45 00 0F 00 43 20 00   .A.M.P.L.E...C .
0002A070   4F 00 46 00 20 00 41 00  20 00 00 00 56 00 45 00   O.F. .A. ...V.E.
0002A080   01 54 00 48 00 49 00 53  00 20 00 0F 00 43 49 00   .T.H.I.S. ...CI.
0002A090   53 00 20 00 41 00 4E 00  20 00 00 00 45 00 58 00   S. .A.N. ...E.X.
0002A020   54 48 49 53 49 53 7E 31  54 58 54 20 00 92 9D 81   THISIS~1TXT .’□□
0002A0B0   8D 3B 8D 3B 00 00 A0 8C  8C 3B 03 00 0E 00 00 00   □;□;.. ŒŒ;......
0002A0C0   53 48 4F 52 54 46 4C 44  20 20 20 10 00 72 A3 81   SHORTFLD   ..r£□
0002A0D0   8D 3B 8D 3B 00 00 A4 81  8D 3B 04 00 00 00 00 00   □;□;..¤□□;......
0002A0E0   42 41 00 4D 00 45 00 00  00 FF FF 0F 00 68 FF FF   BA.M.E...ÿÿ..hÿÿ
0002A0F0   FF FF FF FF FF FF FF FF  FF FF 00 00 FF FF FF FF   ÿÿÿÿÿÿÿÿÿÿ..ÿÿÿÿ
0002A100   01 4C 00 4F 00 4E 00 47  00 20 00 0F 00 68 46 00   .L.O.N.G. ...hF.
0002A110   4F 00 4C 00 44 00 45 00  52 00 00 00 20 00 4E 00   O.L.D.E.R... .N.
0002A120   4C 4F 4E 47 46 4F 7E 31  20 20 20 10 00 4E A7 81   LONGFO~1   ..N§□
0002A130   8D 3B 8D 3B 00 00 A8 81  8D 3B 05 00 00 00 00 00   □;□;..¨□□;......
0002A140   00 00 00 00 00 00 00 00  00 00 00 00 00 00 00 00   ................
```

Relevant information:

- Entry 1 at 0x2A000 is a file entry (FA at 0x2A00B = 0x20 – Archive bit). As the file has a short name it is entered directly in the DOS file name field. In this case “SHORT.TXT”
- Entries 2 to 5 starting at 0x2A020 are dummy LFN entries (FA at 0x2A02B = 0x0F – RO + Hidden + System + Volume). This is where the long name is coded using UTF-16 Format. The name is scattered in each record (shown in blue above). The first byte of each entry is the sequence number.
- Entry 6 starting at 0x2A020 is the actual descriptor for the file (FA at 0x2A02B = 20) with the long file name. The name field contains a short (and unique) 8.3 equivalent of the long name. In this case “THISIS~1.TXT”.

If we now remove the first file with the long file name, the directory table is modified as follow:

```
Offset      0  1  2  3  4  5  6  7   8  9  A  B  C  D  E  F
0002A020   E5 54 00 58 00 54 00 00  00 FF FF 0F 00 43 FF FF   åT.X.T...ÿÿ..Cÿÿ
0002A030   FF FF FF FF FF FF FF FF  FF FF 00 00 FF FF FF FF   ÿÿÿÿÿÿÿÿÿÿ..ÿÿÿÿ
0002A040   E5 52 00 59 00 20 00 4C  00 4F 00 0F 00 43 4E 00   åR.Y. .L.O...CN.
0002A050   47 00 20 00 4E 00 41 00  4D 00 00 00 45 00 2E 00   G. .N.A.M...E...
0002A060   E5 41 00 4D 00 50 00 4C  00 45 00 0F 00 43 20 00   åA.M.P.L.E...C .
0002A070   4F 00 46 00 20 00 41 00  20 00 00 00 56 00 45 00   O.F. .A. ...V.E.
0002A080   E5 54 00 48 00 49 00 53  00 20 00 0F 00 43 49 00   åT.H.I.S. ...CI.
0002A090   53 00 20 00 41 00 4E 00  20 00 00 00 45 00 58 00   S. .A.N. ...E.X.
0002A0A0   E5 48 49 53 49 53 7E 31  54 58 54 20 00 92 9D 81   åHISIS~1TXT .’□□
0002A0B0   8D 3B 8D 3B 00 00 A0 8C  8C 3B 03 00 0E 00 00 00   □;□;.. ŒŒ;......
```

We can see that not only the entry for the actual file at 0x2A0A0 is marked as erased (0xE5) but all the dummy LFN entries (0x2A020, 0x2A040, 0x2A060, 0x2A080) are also marked as erased.

10.7 DOS/Windows Boot Sequence

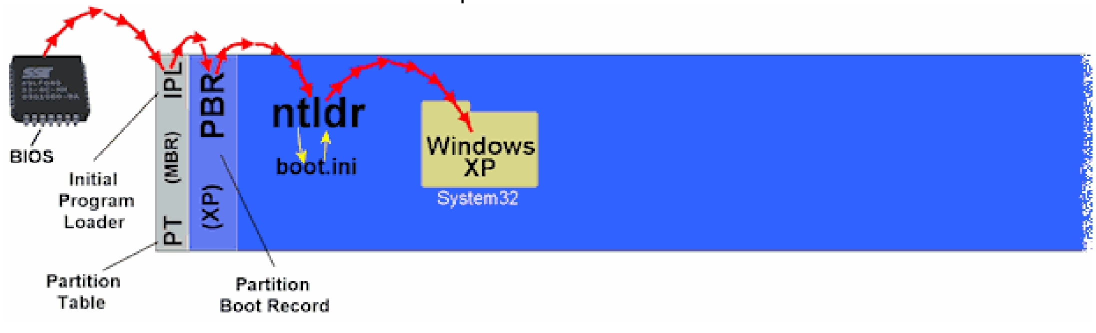
The first program executed in the boot sequence is built into your computer's motherboard. This program is called the BIOS. The BIOS search for the next program to execute. It will look in the place you want it to – Floppy, CD, hard drive, etc.

If you are booting an OS from a hard drive then the next program is, unsurprisingly, on the hard drive. It is always right at the very beginning of the drive, starting on the very first byte of the very first sector. This program is commonly called the MBR (Master Boot Record), but this is misleading because the MBR contains the boot-program and the partition table. The most common name for the boot-program part of the MBR is the **Initial Program Loader** (IPL). Just like the BIOS program the IPL is not usually specific to any OS. The Microsoft IPL is very small and quite limited and its main job is just to find and start that next program in the chain. It looks at the partition table to see if any of the entries there has a flag to indicate an active partition. If it found one then it goes to the very first byte of that partition and starts the little program that it finds there.

The third little program in the chain is at the very beginning of the partition. This one is called the **Partition Boot Record** (PBR). Now the PBR will do its job and then start the next program. However, unlike the BIOS and IPL, the PBR is operating system specific and needs to know the name and location of the file it has to start. This next file will be different for various operating systems, so during the install of an OS the PBR will be written with the information necessary to find the correct file. For WinNT before Vista this will be **ntldr**, which will always just be in the root of the partition. That is it will not be inside any folder or directory, but just right there on its own, next to the Windows and Program Files folders.

For all WinNT before Vista the **ntldr** will be the 4th and last program in the boot sequence chain. It's called the boot-loader and it is the one that does the actual job of starting Windows from the System32 folder.

For Win 2K/XP etc. the boot sequence is: - BIOS - IPL - PBR - ntldr - Windows



In these graphic the MBR is shown as a separate section at the very start of the hard drive. It is indeed separate and not connected in any way to the following partitions. Convention is to reserve a small section of the drive specifically for the MBR to reside on. I've shown the PBR as a separate section but it is actually a part of the partition it is in. Windows reserves the first 16 sectors of its partition to be used exclusively for the partition boot record.

Chapter 11. Information about TOS&DOS Partitions

There is no standard for TOS&DOS partitions. They are only available with the PPDRIVER and HDDRIVER hard disk driver but with different implementation. In this chapter we will detailed the technique used by these two drivers.

Most of the problems of compatibility between the TOS and FAT file systems are located in the **BPB** area of the **Boot Sector**. Following is a description of the critical parameters of the BPB:

- Two important parameters in the BPB are the number of bytes per sector (**BPS**) and the number of sectors per cluster (**SPC**). They are interpreted differently by TOS and DOS/FAT but together they define the notion of **Logical Sectors**[19]. On a TOS file system a logical sector can range from 512 to 8192[20] bytes (**BPS** from 512 to 8192) with **SPC** always equal to 2. On a DOS/FAT file system the **BPS** is always 512 bytes but the **SPC** can range from 1 to 128 leading to logical sector of 1024 to 65536. Therefore we can see that the two file systems use a different scheme to define *logical sectors* bigger than 512 bytes. For example a logical sector of 8192 bytes is achieved with a BPS of 8192 and a SPC of 2 on the TOS file system. The same 8192 bytes logical sector is achieved with a BPS of 512 and a SPC of 16 on the DOS file system.
- Another important parameter in the BPB is the total number of sectors. On a TOS file system this number is stored as a 16-bit quantity (**NSECTS** parameter). This results in a maximum size of 512MB (2^16 * 8192 bytes) for a TOS partition[21]. On DOS/FAT file system the number of sectors can be stored as a 32-bit quantity (**HSECTS** parameter) allowing definition of partitions up to 2TB.

For more details look at TOS Boot sector and DOS/FAT Boot sector

Therefore because of the fact that the GEMDOS part of TOS does not handle correctly some of the DOS BPS it seems that it is only possible to use partitions of up to 32MB (FAT16A) on an Atari system (unless we use BigDOS as a replacement to GEMDOS).

To overcome this limitation the HDDRIVER and PPTDRIVER hard disk driver have defined a new type of partitions called the TOS&DOS partitions. Both drivers use similar technique but **different** implementations. Basically the idea is that a TOS&DOS partition is seen as a TOS partition, with its own TOS boot sector, when used on an Atari machine running TOS. The same partition is seen as a DOS partition, with its own DOS boot sector, when accessed on a PC running DOS/Windows. This implies that a TOS&DOS partition **has two boot sectors**: one boot sector for TOS and one boot sector for DOS.

Therefore the limitations of a TOS&DOS partition follow the same limitations that a TOS partition (the most constraining one). The maximum size of a partition depends on the TOS version, the Hard Disk drivers, and the capability of the host adapter. With recent hard disk drivers and host adapters, that support the ICD extended command set, the maximum partition size is:

- Up to 256 megabytes for TOS < 1.04,
- Up to 512 megabytes with TOS ≥ 1.4, and
- Up to 2GB with TOS ≥ 4.0 (Falcon).

11.1 TOS&DOS Hard Disk Layout

Partitioning and Initialization of the disk write information that defines the layout of the disk:

- The Master Boot Record (MBR) defines the number of partitions and their positions on the disk.
- The Reserved Sectors is optional. However, for historical reason, a partition on a TOS&DOS file system is aligned on a cylinder boundary (Cylinder 0, head 1, Sector 1 in CHS notation). The 62 (usual value) sectors gap between them is left unused. This is not required with LBA drives, but we need to follow this rule in order to make happy old software (MS-DOS for example).
- One or several partitions.

There are two types of partitions: *primary* partitions and *extended partitions*:

- A *primary partition* contains a number of control structures, necessary to describe the partitions, but most of its content is the actual data.
- An *extended partition* is a special kind of partition which itself is subdivided into *primary partitions*.

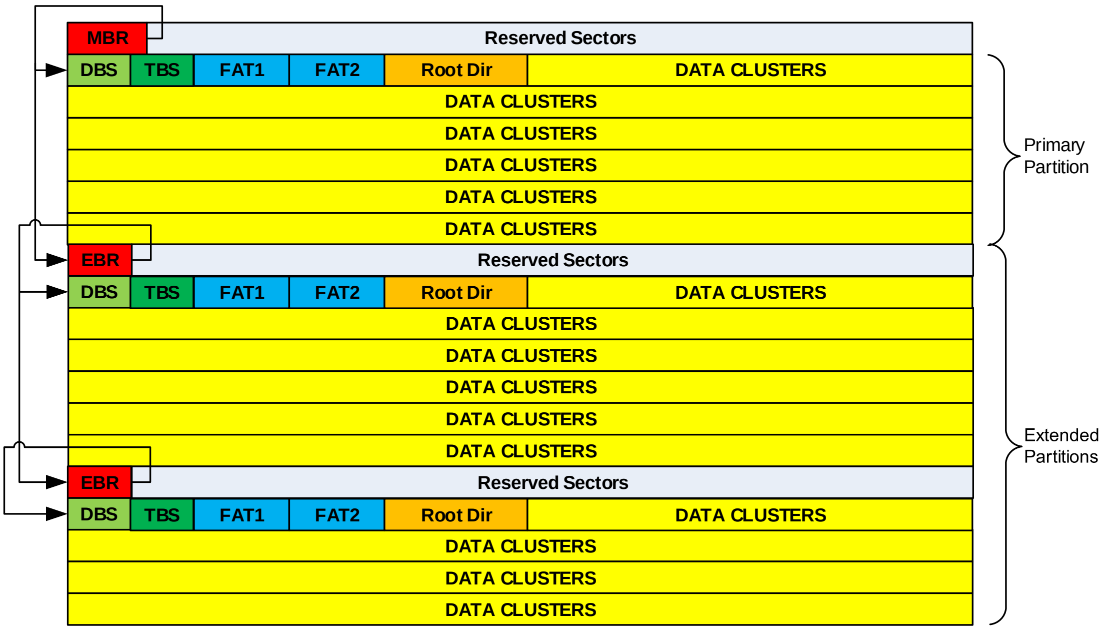
[19] Note that the term *logical sector* is used differently on Atari and PC platforms.
[20] 32768 for TOS4.0 on Falcon (officially supported 16384)
[21] For TOS < 1.04 max partition size = 256MB (2^{15} * 8192), and for TOS 4.x max partition size = 2GB (2^{16} * 32768).

11.2 TOS&DOS MBR / EMBR

The Master Boot Records created by HDDRIVER and PPDRIVER hard disk drivers are different.

They have in common that when multiple partitions are defined the first partition is a primary partition, and the following partitions are extended partitions that each contains a unique primary partition.

Therefore we have the following structure for multiple partitions



Note that at the beginning of each partition we have a normal Dos Boot Sector (DBS) that is followed by a TOS Boot Sector (TBS). This will be detailed in TOS&DOS Partition Structure.

11.2.1 PPDRIVER 1.0 MBR / EMBR

For TOS&DOS partitions PPDRIVER hard disk driver uses fully Windows compatible MBR and EMBR. The format of the MBR and EMBR follows exactly the DOS standard and therefore it is interpreted normally by Windows and DOS utilities. Please refer to DOS/FAT Master Boot Record for more details about this format.

Here is an example of a MBR created by PPDRIVER hard disk driver partitioning utility:

```
Offset      0  1  2  3  4  5  6  7   8  9  A  B  C  D  E  F
000001B0   00 00 00 00 00 00 00 00  6D 0D 0E 4E B1 A5 00 01   ........m..N±¥..
000001C0   01 00 06 40 2F 10 3F 00  00 00 BF FB 03 00 00 00   ...@/.?...¿û....
000001D0   00 00 00 00 00 00 00 00  00 00 00 00 00 00 00 00   ................
000001E0   00 00 00 00 00 00 00 00  00 00 00 00 00 00 00 00   ................
000001F0   00 00 00 00 00 00 00 00  00 00 00 00 00 00 55 AA   ..............Uª
```

As we can see it follows exactly the DOS standard.

However it is interesting to note that:

- At location 0x01B8 a random disk signature is correctly created.
- As we have seen in section 9.2 a **Root Sector** checksum must be equal to the *magic number* $1234 to be executable by TOS. In a standard TOS partition this is achieved by adjusting the word at location 0x01FE. However it is not possible to change this value in a TOS&DOS partition as this word is used as a DOS signature by (0xAA55 in big-endian). Therefore PPDRIVER uses the word at location 0x01BC in the MBR to “evening out” the sector checksum.

11.2.2 HDDRIVER 9.02 MBR / EMBR

For TOS&DOS partitions HDDRIVER hard disk driver uses a **non-standard format** for MBR / EMBRs. The format used is a combination of DOS MBR and TOS RS formats. Yet it is designed to be interpreted normally by Windows and DOS utilities. The format is the following

Offset	Length	Description
0x0000	440	Boot loader code. Filled with zero if disk is not bootable.
0x01B8	4	Disk signature
0x01BC	2	Checksum to render MRB bootable on Atari?
0x01BE	1	State: 0x80 = bootable, 0x00 = non-bootable
0x01BF	3	CHS address of first block in partition described in the next 3 bytes. ■ Head (0-254) ■ Sector is in bits 5–0; bits 9–8 of Cylinder are in bits 7–6 ■ bits 7–0 of Cylinder
0x01C2	1	■ partition type
0x01C3	3	CHS address of last block in partition described in the next 3 bytes. ■ Head (0-254) ■ Sector is in bits 5–0; bits 9–8 of Cylinder are in bits 7–6 ■ bits 7–0 of Cylinder
0x01C6	4	LBA of first sector in the partition in little-endian format
0x01CA	4	number of blocks in partition, in little-endian format
0x01CE	*1*	*State = 00*
0x01CF	*3*	*Not used*
0x01D2	*1*	*partition type 05 = extended or 00 = end-of-chain*
0x01D3	*3*	*Not used*
0x01D6	*4*	*LBA relative address of next EMBR.*
0x01DA	*4*	*number of blocks for next logical partition*
0x01DE	1	State: indicate the state of the partition ■ bit 0 when set partition *exist*, ■ bit 7 when set partition *bootable*
0x01DF	3	ID Name: a 3-bytes ASCII field that identifies the type of partition ■ GEM for regular (< 32MB) partition ■ BGM for big (≥ 32MB) partition
0x01E2	4	Offset to the beginning of the partition from the beginning of the hard disk.
0x01E6	4	Size of the partition in number of physical (512 bytes) sectors
0x01EA	*1*	*State = 01*
0x01EB	*3*	*ID = XGM must be used*
0x01EE	*4*	*Offset to the beginning of the next subdivision from the beginning of the entire extended partition. In number of physical (512 bytes) sectors*
0x01F2	*4*	*Size of the partition in number of physical (512 bytes) sectors*
0x01F6	8	Not used set to 0
0x01FE	2	Signature = 0x55AA

In the table abos the color is used as follow: DOS interpreted, TOS interpreted.

This MBR is interpreted as follow by the DOS/FAT file system on a PC platform:

- The first partition entry at location 0x01BE is a standard DOS partition entry. Therefore DOS will find the type of partition at 0x01C2 and the location and size of the primary partition using the LBA of first block and the length of the partition (alternatively for very old version of DOS it can use the CHS address of first and last block).
- The second partition entry at location 0x01CE is used to eventually chain multiple partitions. So the type is set to 00 when no other partition follow or 05 to point to a next EMBR.
- The third entry at location 0x01DE and the fourth entry at location 0x01EE are ignored by DOS because the partition type = 0 at location 0x01E2 and 0x01F2. However the other bytes of this partition entries contains values that, as we will see later, are used by HDDRIVER on the Atari.

The same MBR is interpreted differently by the HDDRIVER on the Atari platform:

- The content of the MBR is ignored until 0x01DE and from this point the MBR is interpreted as TOS partition
- The first entry is at location 0x01DE:
  - The first byte at location 0x01DE is interpreted as the state of the partition and is set to 0x01 for a non-bootable partition and to 0x81 for a bootable partition.
  - The next three bytes contains the ID: GEM for partition < 32MB and BGM for partition ≥ 32 MB
  - The next 4 bytes indicate the location of the partition
  - The next 4 bytes indicate the size of the partition.
- The second entry is at location 0x01EA:
  - The first byte at location 0x01DE is the state and is set to 0x01
  - The next three bytes contains the ID: should be XGM
  - The next 4 bytes indicate the location of the next partition
  - The next 4 bytes indicate the size of the next partition.

Here is an example:

```
Offset      0  1  2  3  4  5  6  7   8  9  A  B  C  D  E  F
000001B0   00 00 00 00 00 00 00 00  00 00 00 00 21 B0 00 01               !°
000001C0   01 00 06 3B 3F FD 3F 00  00 00 39 A6 0E 00 00 00       ;?ý?    9¦
000001D0   01 FE 05 3B FF F6 78 A6  0E 00 A4 E4 2B 00 81 42     þ ;ÿöx¦   ¤ä+  B
000001E0   47 4D 00 00 00 40 00 0E  A6 38 01 58 47 4D 00 0E    GM    @   ¦8 XGM
000001F0   A6 78 00 2B E4 A4 00 00  00 00 00 00 00 00 55 AA    ¦x +ä¤          Uª
```

Beyond what we just explained about the interpretation of the MBR by DOS and HDDRIVER we can also see several particularities in the above example:

- The position of the partition as interpreted by DOS is given at location 0x01C6 and is equal to 63 (0x3F in little-endian format). The size is given at location 0x01CA and is equal to 96057 (0x0EA639) sectors.
- The position of the partition as interpreted by HDDRIVER is given at location 0x01E0 and is equal to 64 (0x40 in big-endian format). The size is given at location 0x1E6 and is equal to 96056 (0x0EA638) or sectors (one less sector).

If we remember that the first logical record of a partition is the Boot Sector, we can see that DOS will see the Boot Sector at position 63 and TOS will see the Boot Sector at position 64. We will see later that these two boot sector point to the same FAT, Root Directory and data.

The technique used by HDDRIVER has few problems in term of compatibilities with DOS/FAT:

- The MBR does not follow the standard DOS rules: in the third and fourth entries there are some values used by HDDRIVER instead of null bytes. Windows and other DOS utilities do not like to see invalid values in null partition entries. Therefore in the best case they offer to fix it and in worst case they **fix it silently** rendering the partition unusable by HDDRIVER.

Therefore watch out for these problems when using HDDRIVER TOS&DOS partition. Note that this is further exacerbated with Windows 7 & 8.

11.3 TOS&DOS Partition Structure

11.3.1 TOS&DOS Boot Sector

DOS&TOS partitions contain two Boot Sectors: one for DOS and one for TOS.

11.3.1.1 HDDRIVER

As we have seen in previous section HDDRIVER have the first partition entry in the MRB pointing to a DOS Boot Sector at location 0x07E00. This boot sector follows the DOS standard and you can go to DOS/FAT Boot sector section for more information.

Example of DOS boot sector created by HDDRIVER:

```
  Offset      0  1  2  3  4  5  6  7   8  9  A  B  C  D  E  F
  00007E00   EB 3C 90 4D 53 44 4F 53  35 2E 30 00 02 20 11 00   ë< MSDOS5.0
  00007E10   02 00 02 00 00 F8 80 00  3F 00 3C 00 3F 00 00 00        ø€ ? < ?
  00007E20   38 A6 0E 00 80 00 29 CC  56 37 61 4E 4F 20 4E 41   8¦  € )ÌV7aNO NA
  00007E30   4D 45 20 20 20 20 46 41  54 31 36 20 20 20 00 00   ME     FAT16
```

Few things to note:

- As we can see the BPS at location 0x7E0B is 512 (0x0200) and the SPC is 32 (0x08). This gives a logical cluster size of 16384 (512 * 32)
- The reserved sector count at location 0x800E is 17 (0x0011). Therefore the position of the first FAT is at logical sector 17 (relative to the DOS partition).
- As this is a large DOS partition, the number of sectors is 960056 specified at 0x07E20. This gives a partition size of 491548672 (960056 * 512)

The third partition entry in the MBR is pointing to the TOS boot sector at location 0x08000. This boot sector follows the TOS standard and you can go to TOS Boot sector section for more information.

Example of TOS boot sector created by HDDRIVER:

```
  Offset      0  1  2  3  4  5  6  7   8  9  A  B  C  D  E  F
  00008000   60 32 90 4D 53 44 4F 53  35 2E 30 00 20 02 01 00   `2 MSDOS5.0
  00008010   02 00 02 63 EA F8 08 00  3F 00 3C 00 40 00 00 00       cêø  ? < @
  00008020   00 00 00 00 80 00 29 CB  56 37 61 4E 4F 20 4E 41       € )ËV7aNO NA
  00008030   4D 45 20 20 48 78 FF FF  3F 3C 00 48 4E 41 5C 8F   ME  Hxÿÿ?< HNA\
```

Few things to note:

- As we can see the BPS at location 0x800B is 8192 (0x0800) and the SPC is 2. This gives a logical cluster size of 16384 (8192 * 2)
- The reserved sector count at location 0x800E is 0x0001. Therefore the position of the first FAT is at logical sector 1 * 8192/512 = 16 (relative to the TOS partition).
- The number of logical sectors is 60003 (0xEA63) specified at location 0x8013. This gives a partition size of 491544576 (60003 * 8192).

As we can see both Boot Sector points to the same FAT, Root Directory, and data segment.

11.3.1.2 PPDRIVER

PPDRIVER uses a standard first partition entry in the MRB pointing to a DOS Boot Sector at location 0x07E00. This boot sector follows the DOS standard and you can go to DOS/FAT Boot sector section for more information.

Example of DOS boot sector created by HDDRIVER:

```
  Offset      0  1  2  3  4  5  6  7   8  9  A  B  C  D  E  F
  00007E00   EB 3C 90 50 50 47 44 4F  44 42 43 00 02 08 05 00   ë<.PPGDODBC.....
  00007E10   02 00 02 00 00 F8 84 00  00 00 00 00 00 00 00 00   .....ø„.........
  00007E20   BC FB 03 00 00 00 00 00  00 00 00 00 00 00 00 00   ¼û..............
```

Few things to note:

- As we can see the BPS at location 0x7E0B is 512 (0x0200) and the SPC is 8. This gives a logical cluster size of 4096 (512 * 8)
- The reserved sector count at location 0x7E0E is 0x0005. Therefore the position of the first FAT is at logical sector 5 (relative to the DOS partition).
- As this is a large DOS partition, the number of sectors is 261052 (0x00 03 FB BC) specified at location 0x08020. This gives a partition size of 133658624 bytes. For a small partition this field would have been set to 0 and the size would have been specified at location 0x8013.
- PPTOS does not fill the FAT16 extended BPS (location 0x08024-0x0802D)

The sector following the DOS/FAT boot sector is the TOS boot sector at location 0x08000. This boot sector follows the TOS standard and you can go to TOS Boot sector section for more information.

Example of TOS boot sector created by PPDRIVER:

```
Offset      0  1  2  3  4  5  6  7   8  9  A  B  C  D  E  F
00008000   EB 3C 90 50 50 47 44 4F  44 42 43 00 08 02 01 00   ë<.PPGDODBC.....
00008010   02 00 02 EF FE F8 21 00  00 00 00 00 00 00 00 00   ...ïþø!.........
00008020   BC FB 03 00 00 00 00 00  00 00 00 00 00 00 00 00   ¼û..............
```

Few things to note:

- As we can see the BPS at location 0x802B is 2048 (0x0800) and the SPC is 2. This gives a logical cluster size of 4096 (2048 * 2)
- The reserved sector count at location 0x800E is 0x0001. Therefore the position of the first FAT is at logical sector 1 * 2048/512 = 4 (relative to the TOS partition).
- The number of logical sectors is 65263 (0xFEEF) specified at location 0x8013. This gives a partition size of 133658624.

As we can see both Boot Sector points to the same FAT, Root Directory, and data segment.

11.3.2 TOS&DOS FAT, Directory Table, and Boot Sequence

Follow the standard DOS FAT. Please refer to DOS/FAT File Allocation Table.

Follow the standard DOS Directory Table. Please refer to DOS/FAT Directory Table.

Follow the standard TOS boot sequence. Please refer to TOS Boot Sequence

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History

V1.2 September 2014. Added description for HDDRIVER 9.x (with multi TOS&DOS partitions) and PPDRIVER 1.x packages. Removed information about HDDRIVER 8.x and 7.x (please refer to version 1.1 document if you need information about these versions). Added information about accessing multiple partitions from an USB stick. Lots of correction, cleanup, and additions have been made especially in Chapter 9-11. Chapter 12 about analysis has removed in this version because it needs a lot of work. It may be reincorporated in next revision of the document.

V1.1 January 2010: This is a major new release of the document. The Atari HD Partitioning Technical information and User's Guide have been merged into one document and title has been changed. A lot of corrections have been done based on new tests. Major additions are: Added section Fat File System General Information, FAT32 Information, Long file names, TOS&DOS information in many places, common problems and solutions…

V1.0 November 2009: Initial Publication