ECMA

EUROPEAN COMPUTER MANUFACTURERS ASSOCIATION

STANDARD ECMA-107

VOLUME AND FILE STRUCTURE OF FLEXIBLE DISK CARTRIDGES FOR INFORMATION INTERCHANGE

December 1985

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BRIEF HISTORY

In 1979 ECMA published its first Standard ECMA-58 for file structure and labelling of 200 mm flexible disk cartridges. Further work led to the development and publication in 1984 of Standard ECMA-91 which is applicable to all flexible disk cartridges, in particular to those with FM recording on the Index Cylinder.

For many purposes this Standard ECMA-91 provides a satisfactory data interchange pathway between different types of information-processing systems. However, it imposes some restrictions on the operation of a system as follows:

i) Each individual file must be recorded on the disk in a sequential, "batch-processing" mode. After a set of files has been recorded on the disk, a file cannot be extended beyond its pre-determined length.

   It is common practice in small systems for the user to interact continuously with the system to update files. Files having a suitable structure for this purpose are not within the provisions of ECMA-91.

   It is necessary for the interchange cartridge to be created by an "export" copy process from the application's files, after the application has terminated. A similar "import" process is required in the receiving system.

ii) Limitations on the number of file labels permitted on an interchange FDC prevents the full use of the disk space if the average size of files is significantly less than, say 20 kbyte. For conventional data processing purposes this is mostly satisfactory. However, the file size typically encountered in text processing and small single-user systems are very much smaller and would lead to very inefficient use of the disk space.

In view of these requirements it was decided to develop a second standard for volume and file structures of flexible disk cartridges. Work started in 1984 and led to the issue of the present Standard the provisions of which are based on already existing practice in general use world-wide. The new Standard has the following beneficial characteristics, in addition to those of ECMA-91.

i) Interchange file will be particularly for direct updating by interactive application.

ii) There will be no limit on the number of individual files on a FDC, within the overall limitation of available space for holding files. Any file can be extended whenever required.

These characteristics are advantageous for:

- interchange of sets of text files or of small files, or of multi-part document files,
- interchange of any file when sender and recipient wish to carry out frequent update of the file between interchange cycles, e.g. files of commercial transactions.

Adopted as an ECMA Standard by the General Assembly of Dec. 12, 1985.

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SECTION I

SCOPE AND FIELD OF APPLICATION

CONFORMANCE

REFERENCES

DEFINITIONS

NOTATION

1. SCOPE AND FIELD OF APPLICATION

This ECMA Standard specifies the volume and file structure of flexible disk cartridges (FDC) for the interchange of information between users of information processing systems. It also specifies an optional record structure.

This Standard is applicable to various types of flexible disk cartridges including those identified in 3, and other types which may be the subject of ECMA Standards in the future.

This Standard specifies the placement of files of information on a flexible disk cartridge, and also specifies a set of recorded descriptors which identifies:

- the files which may be interchanged,
- the locations of the files,
- the attributes of the files,
- the location of unused space for recording on the FDC,
- the locations of defective recording space on the FDC,
- the attributes of the FDC and of the descriptors recorded on it.

This Standard also specifies requirements for the processes which are provided within information processing systems to enable information to be interchanged between different systems, utilizing recorded flexible disk cartridges as the medium of interchange. For this purpose it specifies the functions within systems which are intended to originate or to receive flexible disk cartridges which conform to this ECMA Standard.

This Standard provides a method for the allocation of space that is independent of the number of files that are recorded on the volume. It also enables the sizes of the recorded files to be expanded or contracted during processing, subject only to the availability of unused recording space when needed.

The contents and organization of the files are not specified by this Standard and are subject to agreement between the originator and the recipient of the interchanged FDC.

2. CONFORMANCE

2.1 Conformance of a Flexible Disk Cartridge

A flexible disk cartridge shall be in conformance with this Standard when all information recorded on it conforms to the requirements of Section II of this Standard.

A prerequisite to such conformance is the conformance of the flexible disk cartridge to the appropriate ECMA Standard for Data Interchange on Flexible Disk Cartridges.

2.2 Conformance of an Information Processing System

An information processing system shall be in conformance with this Standard if it meets the set of requirements specified in Section III of this Standard either for an originating system, or for a receiving system, or for both types of system. A statement of conformance shall identify which of these sets of requirements is met by the system.

Conformance with this Standard does not require conformance with Section IV.

3. REFERENCES

ECMA-6 : 7-Bit Coded Character Set for Information Interchange

ECMA-70 : Data Interchange on 130 mm Flexible Disk Cartridges Using MFM Recording at 7958 ftprad on Both Sides, 1,9 Tracks per mm

ECMA-78 : Data Interchange on 130 mm Flexible Disk Cartridges Using MFM Recording at 7958 ftprad on Both Sides, 3,8 Tracks per mm

ECMA-91 : Flexible Disk Cartridges - File Structure and Labelling for Information Interchange

ECMA-99 : Data Interchange on 130 mm Flexible Disk Cartridges Using MFM Recording at 13262 ftprad on Both Sides, 3,8 Tracks per mm

ECMA-100 : Data Interchange on 90 mm Flexible Disk Cartridges Using MFM Recording at 7958 ftprad on Both Sides, 5,33 Tracks per mm.

NOTE 1

Standards ECMA-70 and ECMA-78 will be re-issued in June 1986 with a second track format meeting the requirements of this Standard.

4. DEFINITIONS

For the purposes of this Standard the following definitions apply.

4.1 Byte

A string of binary digits operated upon as a unit. In this Standard this term designates an 8-bit byte.

4.2 Data Field of a Sector

A fixed-length field containing the data of a sector.

4.3 Data Interchange Standard

A standard which defines the physical and magnetic characteristics, the recording method, and the track format of a flexible disk cartridge.

4.4 Defective Sector

A sector which cannot be read or written without error.

4.5 Descriptor

A recorded structure containing descriptive information about the volume or a file.

4.6 File

A named collection of information.

4.7 Formatting

Writing the control information establishing the physical addresses of sectors on the surfaces of a flexible disk cartridge.

4.8 Implementation

A set of processes which enable an information processing system to behave as an originating system, or as a receiving system, or as both types of system.

4.9 Initialization

Writing descriptors initially required to be on the FDC, prior to the commencement of general processing or use.

4.10 Originating System

An information processing system which can record files on an FDC for the purpose of data interchange with another system.

4.11 Receiving System

An information processing system which can read files from an FDC which has been recorded by another system for the purpose of data interchange.

4.12 Sector

That part of a track on a flexible disk cartridge that can be accessed independently of other parts of the track by the magnetic heads of the flexible disk drive.

4.13 Track

That part of a flexible disk that can be accessed by a single magnetic head that is stationary while the disk makes a complete revolution.

4.14 User

A person or other entity (for example an application program) that causes the invocation of the services provided by an implementation.

In addition the following definitions apply specifically to Section IV.

4.15 Fixed-length Record

A record contained in a file in which all records must have the same length.

4.16 Record

Related data treated as a unit of information.

4.17 Segment

A part of a record.

4.18 Segmented Record

A record contained in a file in which the records may have different lengths and each record may consist of one or more separate segments.

4.19 Variable-length Record

A record contained in a file in which the records may have different lengths but a record must not consist of separate segments.

5. NOTATIONS

The following notations are used in this Standard.

5.1 Decimal and Hexadecimal Notations

Numbers in decimal notation are represented by decimal digits, viz. 0 to 9.

Numbers in hexadecimal notation are represented by hexadecimal digits, viz. 0 to 9 and A to F, shown in parentheses.

5.2 Other Notations

BP : Byte position within a Descriptor, starting with 1

ZERO : A single bit with the value 0

ONE : A single bit with the value 1

ip(x) : The integer part of x

ceil(x): The smallest integer that is not less than x

rem(x,y): The remainder of the integer division of x by y, that is, rem (x,y) = x-y.ip(x/y)

5.3 Capital Letters

Where a word or a group of words is used to designate a specific concept, e.g. the name of a descriptor field, it is printed with initial capital letters except for prepositions.

SECTION II

VOLUME STRUCTURE
FILE STRUCTURE
RECORDING OF NUMERICAL VALUES IN DESCRIPTOR FIELDS
FDC DESCRIPTOR
FILE ALLOCATION TABLE
FILE DIRECTORIES

6. VOLUME STRUCTURE

6.1 Arrangement of Data on a Flexible Disk Cartridge

6.1.1 FDC parameters

For the purpose of this Standard the significant parameters of the data interchange standard are:

FDC Parameters	Acronym
Number of Recordable Sides	NOS
Number of Tracks per Side	NOT
Number of Sectors per Track	SPT
Total Number of Sectors of the FDC	TS
Number of Bytes per Data Field of a Sector	SS

The values of these parameters shall be obtained from the text of an appropriate data interchange standard (see Appendix A).

6.1.2 Physical Addresses

Each sector shall be identified by a Physical Address comprising the Side Number, the Track Number, and the Sector Number. The sides shall be numbered 0 and 1, tracks shall be numbered starting with 00, and the sectors shall be numbered starting with 1 on each track.

6.1.3 Logical Sector Number

Each sector on a volume shall be identified by a Logical Sector Number. There shall be a one-to-one correspondence between Physical Address and Logical Sector Number. The Logical Sector Numbers shall be assigned in an ascending sequence, beginning with 0, starting at sector 1, track 00, side 0, continuing onto track 00, side 1 (if the FDC is recordable on both sides) and then to track 01, side 0, and so forth.

The relation between the Side Number (HN), Track Number (TN), Sector Number (SN) and the Logical Sector Number (LSN) shall be given by the formulae:

$$LSN = SPT \cdot (HN + (NOS \cdot TN)) + SN - 1$$

$$SN = rem\{rem\{LSN, (SPT \cdot NOS)\}, SPT\} + 1$$

$$TN = ip\left(\frac{LSN}{SPT \cdot NOS}\right)$$

$$HN = ip\left\{\frac{rem\{LSN,(SPT\cdot NOS)\}}{SPT}\right\}$$

6.1.4 System Area and Data Area

The space on an FDC shall be divided into a System Area and a Data Area.

The System Area shall be recorded on track 00, Side 0 and track 00, Side 1.

The System Area shall occupy sectors with the Logical Sector Numbers 0 to SSA-1, where SSA is the number of sectors in the System Area (see 6.3.4). The System Area shall contain Descriptors which specify the recording format of the FDC, describe the use of the Data Area, and provide a Directory of the files on the volume. No part of any file shall be contained in the System Area.

The Data Area shall occupy sectors with Logical Sector Numbers starting with SSA. Interchange files and supplementary Descriptors (such as Sub-directories) shall be contained in the Data Area. Files not intended for interchange may also be contained in the Data Area.

6.1.5 Parameters of the Volume Structure

This Standard specifies various types of data structure within the System Area and Data Area. The sizes of these data structures are identified by a set of numerical parameters. These parameters are listed below.

Parameter	Acroynm
Sectors per Cluster	SC
Reserved Sector Count	RSC
Sectors per FAT	SF
Root Directory Entries	RDE

The values of these parameters for each FDC type are contained in Appendix A.

6.2 Arrangement of the Data Area

6.2.1 Clusters

The Data Area shall be organized into units of allocation called clusters. Each cluster shall consist of the same number of sectors which shall be a power of 2, i.e. 1, 2, 4, 8, ... The number of sectors in each cluster (Sectors per Cluster, SC) shall be as specified in Appendix A. The data of a cluster shall be recorded in the Data Fields of its constituent sectors.

If a cluster comprises more than one sector, the set of Logical Sector Numbers (LSN) of its constituent sectors shall form a consecutive ascending sequence.

Each cluster shall be identified by a unique Cluster Number (CN). Cluster Numbers shall be integers, assigned in ascending order starting with 2. Cluster Number 2 shall be assigned to the cluster the first or only sector of which has the Logical Sector Number SSA. Each successive Cluster Number shall be assigned to the cluster the sectors of which have the next higher set of LSNs.

If the total number of sectors in the Data Area is not a multiple of SC the remaining sectors shall not be used.

The Logical Sector Number of the first sector in a cluster shall be related to the Cluster Number by the following formula:

$$LSN = ((CN - 2)\cdot SC) + SSA$$

where:

LSN is the Logical Sector Number
CN is the Cluster Number
SC is the number of sectors per cluster
SSA is the size of the System Area in number of sectors (see 6.3.4).

6.2.2 Status of Clusters

A status shall be assigned to each cluster, and shall be one of the following:

- allocated to a file,
- available for allocation,
- defective.

The status of each cluster shall be identified in the File Allocation Table (FAT) in the System Area.

6.2.2.1 Clusters allocated to a file

The clusters allocated to contain a file shall be identified in the FAT. The clusters allocated to contain a file need not have consecutive Cluster Numbers.

6.2.2.2 Clusters available for allocation

The clusters available for allocation shall be identified in the FAT. The clusters available for allocation need not have consecutive Cluster Numbers.

The contents of clusters available for allocation shall be ignored in interchange.

6.2.2.3 Defective Clusters

Clusters containing one or more defective sectors shall be marked as Defective Clusters in the FAT. The contents of Defective Clusters shall be ignored in interchange.

6.3 Arrangement of the System Area

The System Area shall contain an FDC Descriptor and space for system use, the Root Directory, and the File Allocation Table (FAT) recorded twice.

6.3.1 FDC Descriptor and space for system use

The sector with Logical Sector Number 0 shall contain the FDC Descriptor and space for system use.

The FDC Descriptor shall contain a Medium Identifier, the FDC parameters, an identifier of the system which recorded the FDC Descriptor and information about the parameters of the volume structure.

Additional sectors having successively higher Logical Sector Numbers may also be reserved for system use. The contents of such sectors shall be ignored in interchange. The number of sectors reserved for system use (RSC) shall include the sector the LSN of which is 0.

The values of the Medium Identifier and the Reserved Sectors Count for each medium type shall be as specified in Appendix A.

6.3.2 File Allocation Table (FAT)

The FAT shall contain a Format Identifier and one entry for each cluster of the Data Area of the FDC. These entries shall be numbered consecutively starting with 2 and the Entry Number shall be equal to the Cluster Number of the corresponding cluster.

Each entry in the FAT shall indicate the status of the corresponding cluster. The FAT entries shall be used to identify the set of clusters that are allocated to each file. Appendix D shows an example of a FAT.

The number of sectors of the FAT (SF) shall be dependent on the number of clusters in the Data Area and shall be as specified in Appendix A.

The FAT shall be recorded in the System Area, in a sequence of sectors starting with the Logical Sector Number equal to RSC. The second occurrence of the FAT shall be recorded in a sequence of sectors immediately following the first occurrence of the FAT.

6.3.3 Root Directory

The Root Directory shall be recorded in the System Area in a sequence of consecutive sectors immediately following the second occurrence of the FAT. It shall contain a set of entries each of which identifies a file, a Volume Label or a sub-directory, or indicates that it is not in use.

The number of these entries, the Root Directory Entries (RDE), shall be as specified in Appendix A.

6.3.4 Size of the System Area

The size of the System Area (SSA), in number of sectors, is given by the following formula:

$$SSA = RSC + 2\,SF + \mathrm{ceil}\left(\frac{32\,RDE}{SS}\right) \leqslant NOS \cdot SPT$$

where:

RSC	is the number of sectors preceding the first FAT, i.e. the Reserved Sectors Count.
SF	is the number of sectors in the FAT
RDE	is the number of Root Directory Entries
SS	is the number of bytes in the Data Field of a sector
NOS	is the number of sides available for recording
SPT	is the number of sectors per track.

6.4 Files

A file shall be an interchange file or a Sub-directory or a file not intended for interchange.

Each file shall be identified by an entry in a Directory.

6.4.1 File space

Each file shall be recorded in the Data Fields of the sectors of a set of clusters. This set shall be known as the File Space of the file. The order of the clusters within the set shall be specified by their FAT entries.

The bytes in the File Space shall be numbered consecutively. The numbering shall start with 1, which shall be assigned to the first byte of the first cluster of the File Space. The numbering shall continue through successive bytes of the first cluster, and then through successive bytes of each successive cluster (if any) of the File Space. The numbering shall end with a number equal to the number of bytes per cluster (i.e. SS.SC) multiplied by the number of clusters in the File Space.

6.4.2 Relation to Clusters

The Cluster Numbers of the clusters forming the File Space of a file shall be recorded as a chain as follows:

- The Cluster Number of the first cluster of the File Space shall be recorded in the Starting Cluster Number field of the Directory entry of the file.
- For each cluster of the File Space, except the last one, the corresponding FAT entry shall contain the Cluster Number of the next cluster of the File Space.
- For the last cluster of the File Space, the corresponding FAT entry shall contain an entry indicating that it is the last cluster of the file.

6.4.3 File length

The length of a file shall be the number of consecutive bytes in the File Space, starting from the first byte, that are intended for interchange. If this number is less than the number of bytes in the File Space then any remaining bytes in the File Space shall be ignored in interchange.

6.5 Sub-directories

In addition to the Root Directory in the System Area, additional Directories called Sub-directories may be recorded as files in the Data Area of the FDC. Sub-directories shall contain Directory entries each of which identifies a file or another Sub-Directory, or indicates that it is not used.

The number of entries in a Sub-directory shall be calculated as follows:

$$ip\left(\frac{1}{32}\ K \cdot SC \cdot SS\right)$$

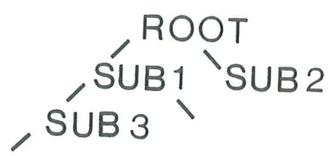
where:

K is the number of clusters allocated to the Sub-directory.

Each Sub-directory shall be identified by one entry called a Sub-directory Pointer Entry in another directory.

The Directory containing this Sub-directory Pointer Entry shall be called the Parent Directory of the Sub-directory. Each Sub-directory shall have a Parent Pointer Entry which points back to its Parent Directory. Different Sub-directories may have the same Parent Directory.

A hierarchical relationship shall exist between the Root Directory and all Sub-directories:



The hierarchy shall consist of a number of levels (level 0, level 1, ...). The Root Directory shall be the one and only directory at level 0 of the hierarchy.

If a Parent Directory is at level n of the hierarchy, its Sub-directories shall be at level (n+1). The number of levels of the hierarchy is limited only by a restriction on the length of the virtual path name which shall be calculated as follows.

The length of the virtual path name shall be the sum of:

- the length of the file name,
- the length of the file name extension,
- the length of the names of all relevant Sub-directories,
- the length of the name extensions of all relevant Sub-directories,
- the number of relevant Sub-directories,
- the number of name extensions of all relevant Sub-directories.

This sum shall not exceed 63.

7. CONTENTS OF A FILE

The information in an interchange file shall be interpreted according to the relevant international standards for the coded representation of information.

NOTE 2:

The identification of the standard to which the coding of the information content of the file conforms is assumed to be the subject of an agreement between originator and recipient of the file. This Standard makes no general provision for recording that identification on the FDC. However, some selected standards may be identified in the Name Extension Field of the File Entry of a Directory, see 11.5.2.

8. RECORDING OF DESCRIPTOR FIELDS

8.1 Numerical Values in One-byte Fields

A numerical value in a one-byte field shall be an 8-bit number recorded in binary notation.

8.2 Numerical Values in Two-byte Fields

A numerical value in a two-byte field shall be a 16-bit number the hexadecimal representation (wx yz) of which shall be recorded as (yz wx).

NOTE 3:

For example, the decimal number 72 has (00 48) as its hexadecimal representation and shall be recorded as (48 00).

8.3 Numerical Values in Four-byte Fields

A numerical value in a four-byte field shall be a 32-bit number the hexadecimal representation (st uv wx yz) of which shall be recorded as (yz wx uv st).

NOTE 4:

For example, the decimal number 305419896 has (12 34 56 78) as its hexadecimal representation and shall be recorded as (78 56 34 12).

8.4 Pairs of 12-bit Integers

A pair of 12-bit numbers the hexadecimal representations of which are (abc) and (def) shall be recorded as (bc fa de). This method shall be used for FAT entries.

NOTE 5:

For example, the pair of 12-bit numbers with hexadecimal representations (123) and (456) shall be recorded as (23 61 45).

8.5 Character Set and Coding

Unless otherwise stated, the characters in the Descriptors shall be coded according to ECMA-6 (see Appendix C).

The 37 characters in the following positions of the International Reference Version are referred to as d-characters:

3/0 to 3/9
4/1 to 5/10
5/15

The 57 characters in the following positions of the International Reference Version are referred to as a-characters:

2/0 to 2/2
2/5 to 2/15
3/0 to 3/15
4/1 to 4/15
5/0 to 5/10
5/15

8.6 Justification of Characters

In each field the content of which is specified by this ECMA Standard to be d-characters, the d-characters shall be left-justified and any remaining positions on the right shall be set to (20).

9. FDC DESCRIPTOR

The FDC Descriptor describes the format of the Flexible Disk Cartridge and provides information about other Descriptors in the System Area of the FDC.

9.1 FDC Descriptor Layout

BP	Field Name	Acronym	Content
1-3	(Reserved for system use)		not specified
4-11	Creating System Identifier		a-characters
12-13	Sector Size	SS	numerical value
14	Sectors per Cluster	SC	numerical value
15-16	Reserved Sector Count	RSC	numerical value
17	Number of FATs	FN	Number 2
18-19	Root Directory Entries	RDE	numerical value
20-21	Total Sectors	TS	numerical value

BP	Field Name	Acronym	Content
22	Medium Identifier		(FD) or (F9)
23-24	Sectors per FAT	SF	numerical value
25-26	Sectors per Track	SPT	numerical value
27-28	Number of Sides	NOS	numerical value
29-30	(Reserved for future standardization)		(00) (00)
31-512	(Reserved for system use)		not specified

9.2 FDC Descriptor Fields

9.2.1 Field Reserved for System Use (BP 1-3)

This field shall be reserved for system use. Its content is not specified by this Standard and shall be ignored in interchange.

9.2.2 Creating System Identifier (BP 4-11)

This field shall specify an identification for the system that has recorded the FDC Descriptors.

The characters in this field shall be a-characters.

9.2.3 Sector Size (BP 12-13)

This field shall specify the size of the Data Field of a sector.

It shall be recorded as a numerical value according to 8.2.

9.2.4 Sectors Per Cluster (BP 14)

This field shall specify the number of sectors per cluster.

It shall be recorded as a numerical value according to 8.1.

9.2.5 Reserved Sector Count (BP 15-16)

This field shall specify the number of sectors reserved for system use.

It shall be recorded as a numerical value according to 8.2.

9.2.6 Number of FATs (BP 17)

This field shall specify the number 2.

It shall be recorded as a numerical value according to 8.1.

9.2.7 Root Directory Entries (BP 18-19)

This field shall specify the number of entries in the Root Directory.

It shall be recorded as a numerical value according to 8.2.

9.2.8 Total Sectors (BP 20-21)

This field shall specify the total number of sectors on the FDC (including defective sectors).

It shall be recorded as a numerical value according to 8.2.

9.2.9 Medium Identifier (BP 22)

This field shall specify an identification of the medium.

It shall be recorded as a single byte. Its value shall be as specified in Appendix A.

9.2.10 Sectors per FAT (BP 23-24)

This field shall specify the number of sectors occupied by each occurrence of the FAT.

It shall be recorded as a numerical value according to 8.2.

9.2.11 Sectors per Track (BP 25-26)

This field shall specify the number of sectors in each track.

It shall be recorded as a numerical value according to 8.2.

9.2.12 Number of Sides (BP 27-28)

This field shall specify the number of recordable sides.

It shall be recorded as a numerical value according to 8.2.

9.2.13 Field Reserved for future Standardization (BP 29-30)

This field shall be reserved for future standardization.

It shall contain only ZEROs.

9.2.14 Field reserved for system use (BP 31-512)

This field shall be reserved for system use.

Its contents are not specified by this Standard and shall be ignored in interchange.

10. FILE ALLOCATION TABLE

The first three bytes of the FAT shall be used as follows:

byte 0 shall contain the Format Identifier, bytes 1 and 2 shall each contain (FF).

The remaining bytes of the FAT shall contain FAT entries each of which shall indicate the status of the cluster associated with it. FAT entries shall be numbered starting with 2.

10.1 Format Identifier

This field shall specify an identification for the source of the volume structure parameters.

(F9) shall mean that these parameters are recorded in the FDC Descriptor .

(FD) shall mean that these parameters shall be as specified in Appendix A for Standard ECMA-70.

All other values are prohibited from future use.

10.2 FAT Entries

10.2.1 FAT Entry Size

The length of each FAT entry shall be twelve bits.

10.2.2 Number of FAT Entries

The number of entries in the FAT shall be equal to the number of clusters.

10.2.3 FAT Entry Values

The values for FAT Entries shall be:

(000)	shall mean that the corresponding cluster is not in use and may be allocated to any File Space.
(002) to MAX	shall mean that the corresponding cluster is in use; the entry value shall be the cluster number of the next cluster allocated in the File Space. MAX shall be the Maximum Cluster Number (see 10.2.4).
MAX+1 to (FF6)	are reserved for future standardization and shall not be used.
(FF7)	shall mean that the corresponding cluster contains a defective sector.
(FF8) to (FFF)	shall mean that the corresponding cluster is in use and is the last cluster of a File Space.

10.2.4 Maximum Cluster Number (MAX)

The value for Maximum Cluster Number shall be calculated as follows:

$$MAX = ip\left(\frac{TS - SSA}{SC}\right) + 1$$

where:

TS	is the total number of sectors on the medium
SSA	is the number of sectors in the System Area
SC	is the number of sectors per cluster

10.3 Number of Sectors in each FAT

Each FAT shall occupy one or more sectors. The number of sectors per FAT (SF) shall be calculated by iteration from:

$$SF = \text{ceil}\left\{\frac{\text{ip}\left(\frac{TS - RSC - SF - \text{ceil}\left(\frac{32\,RDE}{SS}\right)}{SC}\right) \cdot 12}{8\,SS}\right\}$$

where:

TS is the total number of sectors on the medium
SC is the number of sectors per cluster
SS is the sector data field size
RSC is the Reserved Sector Count
RDE is the number of entries in the Root Directory

10.4 Recorded Form of the FAT

The recorded form of the FAT shall be a sequence of 3-byte fields. The first field shall contain the Format Identifier followed by two (FF) bytes. Successive 3-byte fields shall contain consecutive pairs of FAT entries (FAT entries with number n and n+1, where n is even, form a pair). Each pair of FAT entries shall be recorded according to 8.4.

A pair of FAT entries may be split between successive sectors of the FAT. Bytes at the end of the Data Field of the last FAT sector which are not used for FAT entries shall be ignored in interchange.

11. FILE DIRECTORIES

11.1 Characteristics

A Directory is a Descriptor that shall contain a set of consecutive 32-byte Directory entries each of which identifies a file, a Volume Label, another Directory or is unused.

There are two types of Directories: Root Directory and Sub-Directory. Directory entries shall be recorded starting with the first byte of the space in which the Directory is recorded.

11.2 Directory Entry Types

A Directory entry shall have one of two states: Used or Unused.

Used Directory entries shall contain descriptive information about the files recorded on the FDC, e.g. file name, attributes, date and time of creation, location and length. There are five types of used entries:

- File Entry
- Volume Label Entry
- Sub-directory Pointer Entry
- Sub-directory Identifier Entry
- Sub-directory Parent Pointer Entry

There are two types of unused entries:

- Not-currently-in-use Entry
- Never-used Entry

11.3 General Definition of Directory Entry Fields

BP	Field Name	Contents
1-8	Name	depend on entry type
9-11	Name Extension	d-characters
12	Attributes	eight bits
13-22	Reserved Field	all (00) or (FF)
23-24	Time Recorded	numerical value
25-26	Date Recorded	numerical value
27-28	Starting Cluster Number	numerical value
29-32	File Length	numerical value

11.3.1 Name (BP 1-8)

The contents and the interpretation of this field shall depend on the entry type.

11.3.2 Name Extension (BP 9-11)

The interpretation of this field shall depend on the entry type. The contents of this field shall be d-characters.

11.3.3 Attributes (BP 12)

The bits of this field shall be numbered from 1 for the most significant bit to 8 for the least significant bit.

11.3.3.1 Bits 1 and 2

These bits shall be reserved for system use and shall be ignored in interchange.

11.3.3.2 Archive Bit (Bit 3)

This bit shall specify whether a copy of the file exists.

ZERO shall mean that a copy of the file exists on this or another medium.

ONE shall mean that a copy of the file need not to exist.

11.3.3.3 Sub-directory Entry Bit (Bit 4)

This bit shall specify whether the entry is a Sub-directory entry.

ZERO shall mean that the entry is not a Sub-directory entry.

ONE shall mean that the entry is a Sub-directory entry.

11.3.3.4 Volume Label Bit (Bit 5)

This bit shall specify whether the entry is a Volume Label entry.

ZERO shall mean that the entry is not a Volume Label entry.

ONE shall mean that the entry is a Volume Label entry.

11.3.3.5 Bits 6 and 7

These bits shall be set to ZERO for interchange files.

If either bit is set to ONE, the file shall be ignored in interchange.

11.3.3.6 Read-only Bit (Bit 8)

This bit shall specify whether the file may be modified by the recipient.

ZERO shall mean that the file may be modified by the recipient.

ONE shall mean that the file shall not be modified by the recipient.

This attribute shall not apply to other than File Entries.

11.3.4 Reserved Field (BP 13-22)

The contents of this field shall depend on the entry type (see 11.4 to 11.10).

11.3.5 Time Recorded (BP 23-24)

This field shall contain a 16-bit integer representing a time. The time shall be expressed in terms of hour (0-23), minute (0-59), and second (0-59). The value of this integer shall be computed by the formula:

(2048 . Hour) + (32 . Minute) + ip(Second/2)

The value shall be recorded as a numerical value according to 8.2.

11.3.6 Date Recorded (BP 25-26)

This field shall contain a 16-bit integer representing a date. The date shall be expressed in terms of year (1980 to 2107), month (1 to 12), and day (1 to 31). The value of this integer shall be computed by the formula:

((Year-1980) . 512) + (Month . 32) + Day

The value shall be recorded as a numerical value according to 8.2.

If the value is 0, it shall mean that the date is not specified.

11.3.7 Starting Cluster Number (BP 27-28)

The contents of this field shall depend on the entry type.

This field shall be recorded as a numerical value according to 8.2.

11.3.8 File Length (BP 29-32)

The contents of this field shall depend on the entry type.

This field shall be recorded as a numerical value according to 8.3.

11.4 File Entry

A Directory entry shall be a File Entry if both the Volume Label and the Sub-directory Attributes bits are set to ZERO and if the first byte of the Name field contains a d-character.

A File Entry may appear in any entry position of any Directory, other than the first or second entry in any Sub-directory. Each File Entry of a Directory shall contain a File Name (Name concatenated with Name Extension) that shall not be duplicated within that Directory.

11.4.1 Name (BP 1-8)

This field shall specify the name of the file. The contents of this field shall be a left-justified string of d-characters. Any unused bytes shall be set to (20).

11.4.2 Name Extension (BP 9-11)

This field shall specify a name extension to the name of the file.

The field shall be recorded according to 11.3.2.

11.4.3 Attributes (BP 12)

The Volume Label Bit and the Sub-directory Bit shall be set to ZERO. Other bits shall be interpreted according to 11.3.3.

11.4.4 Reserved Field (BP 13-22)

All bytes shall be set to (00).

11.4.5 Time Recorded (BP 23-24)

This field shall specify the time at which the file was recorded. It shall be recorded according to 11.3.5.

11.4.6 Date Recorded (BP 25-26)

This field shall specify on which date the file was recorded. It shall be recorded according to 11.3.6.

11.4.7 Starting Cluster Number (BP 27-28)

This field shall specify the Cluster Number of the first cluster allocated to the file. It shall be recorded according to 8.2.

11.4.8 File Length (BP 29-32)

This field shall specify the length of the file in bytes. It shall be recorded according to 8.3.

11.5 Volume Label Entry

A Volume Label Entry is optional. If present it may appear in any Directory position in the Root Directory.

A Directory entry shall be a Volume Label Entry if the Volume Label Attribute Bit is set to ONE and the Sub-directory Attribute Bit is set to ZERO.

11.5.1 Name and Name Extension (BP 1-11)

The Name and the Name Extension fields are treated as one single 11-character Volume Name. The characters shall be d-characters. The name shall be left-justified in the 11-byte field and any unused byte shall be set to (20).

The volume name does not participate in the identification of interchange files except as agreed upon by originator and recipient.

11.5.2 Attributes (BP 12)

The Volume Label Attribute Bit shall be set to ONE. All other Attribute bits shall be set to ZERO.

11.5.3 Reserved Field (BP 13-22)

All bytes shall be set to (00).

11.5.4 Time Recorded (BP 23-24)

This field shall specify the time at which the Volume Label Entry was recorded. This time shall be recorded according to 11.3.5.

11.5.5 Date Recorded (BP 25-26)

This field shall specify the date on which the Volume Label Entry was recorded. This date shall be recorded according to 11.3.6.

11.5.6 Starting Cluster Number (BP 27-28)

The content of this field is not specified by this Standard, it shall be ignored in interchange.

11.5.7 File Length (BP 29-32)

The content of this field is not specified by this Standard, it shall be ignored in interchange.

11.6 Sub-directory Pointer Entry

A Directory entry shall be a Sub-directory Pointer Entry if the Sub-directory Attribute Bit is set to ONE and the first byte of the Name field contains a d-character. Sub-directory Pointer Entries shall be optional. If present a Sub-directory Pointer Entry may appear in any entry position of its Parent Directory, other than in the first or second entry.

Within a Directory, each Sub-directory Pointer Entry shall have a unique concatenated Name and Name Extension field.

11.6.1 Name (BP 1-8)

This field shall specify the name of the Sub-directory. The contents of this field shall be a left-justified string of d-characters. Any unused bytes shall be set to (20).

11.6.2 Name Extension (BP 9-11)

This field shall specify an extension to the name of the Sub-directory. It shall be recorded according to 11.3.2.

11.6.3 Attributes (BP 12)

The Sub-directory Attribute Bit shall be set to ONE. The Volume Label Bit shall be set to ZERO. Other Attribute bits shall be interpreted according to 11.3.3.

11.6.4 Reserved Field (BP 13-22)

All bytes shall be set to (00).

11.6.5 Time Recorded (BP 23-24)

This field shall specify the time at which the Sub-directory Pointer Entry was recorded. It shall be recorded according to 11.3.5.

11.6.6 Date Recorded (BP 25-26)

This field shall specify the date on which the Subdirectory Pointer Entry was recorded. It shall be recorded according to 11.3.6.

11.6.7 Starting Cluster Number (BP 27-28)

This field shall specify the Cluster Number of the first cluster allocated to the Sub-directory. It shall be recorded as a numerical value according to 8.2.

11.6.8 File Length (BP 29-32)

The content of this field is not specified by this Standard, it shall be ignored in interchange.

11.7 Sub-directory Identifier Entry

A Directory entry shall be a Sub-directory Identifier Entry if it occurs as the first entry in a Sub-directory, if the Sub-directory Attribute Bit is set to ONE, if the first byte of the Name field is set to (2E) and if the remaining seven bytes of the Name field are set to (20).

A Sub-directory Identifier Entry identifies a file as a Sub-directory. Sub-directories are optional, if present, they shall have a Sub-directory Identifier Entry as their first Directory entry. A Sub-directory Identifier Entry shall not appear in the Root Directory.

11.7.1 Name (BP 1-8)

The first byte of this field shall be set to (2E), the remaining seven bytes shall be set to (20).

11.7.2 Name Extension (BP 9-11)

All bytes shall be set to (20).

11.7.3 Attributes (BP 12)

The Sub-directory Attribute Bit shall be set to ONE. The Volume Label Bit shall be set to ZERO. The value of the other Attribute bits shall be ignored in interchange.

11.7.4 Reserved Field (BP 13-22)

All bytes shall be set to (00).

11.7.5 Time Recorded (BP 23-24)

This field shall specify the time at which the Sub-directory Identifier Entry was recorded. It shall be recorded according to 11.3.5.

11.7.6 Date Recorded (BP 25-26)

This field shall specify the date on which the Sub-directory Identifier Entry was recorded. It shall be recorded according to 11.3.6.

11.7.7 Starting Cluster Number (BP 27-28)

This field shall specify the cluster number of the first cluster allocated to the Sub-directory. It shall be recorded according to 8.2.

11.7.8 File Length (BP 29-32)

The content of this field is not specified by this Standard. It shall be ignored in interchange.

11.8 Sub-directory Parent Pointer Entry

A Directory entry shall be a Sub-directory Parent Pointer Entry if it occurs as the second entry in a Sub-directory, if the Sub-directory Attribute Bit is set to ONE, if the first two bytes of the Name field are set to (2E) and if the remaining six bytes of the Name field are set to (20).

The Sub-directory Parent Pointer Entry shall specify the location of the Directory which contains a Sub-directory Pointer Entry which points to the associated Sub-directory. Sub-directories are optional, if present, they shall have a Sub-directory Parent Pointer Entry as their second Directory entry.

A Sub-directory Parent Pointer Entry shall not appear in the Root Directory.

11.8.1 Name (BP 1-8)

The first two bytes of this field shall be set to (2E), the remaining six bytes shall be set to (20).

11.8.2 Name Extension (BP 9-11)

All bytes shall be set to (20).

11.8.3 Attributes (BP 12)

The Sub-directory Attribute Bit shall be set to ONE. The Volume Label Bit shall be set to ZERO. The value of the other Attribute bits shall be ignored in interchange.

11.8.4 Reserved Field (BP 13-22)

All bytes shall be set to (00).

11.8.5 Time Recorded (BP 23-24)

This field shall specify the time at which the Sub-directory Parent Pointer Entry was recorded. It shall be recorded according to 11.3.5.

11.8.6 Date Recorded (BP 25-26)

This field shall specify the date on which the Sub-directory Parent Pointer Entry was recorded. It shall be recorded according to 11.3.6.

11.8.7 Starting Cluster Number (BP 27-28)

This field shall specify the cluster number of the first cluster of the Parent Directory.

If the Parent Directory is a Sub-directory, the cluster number of the first cluster allocated to it shall be recorded according to 8.2.

If the Parent Directory is the Root Directory, then the value (0000) shall be recorded.

11.8.8 File Length (BP 29-32)

The content of this field is not specified by this Standard and shall be ignored in interchange.

11.9 Not-Currently-Used Entry

A Directory entry shall be a Not-Currently-Used Entry if the first byte is set to (E5). A Not-Currently-Used Entry indicates available Directory space which can subsequently be used to record other entries.

A Not-Currently-Used Entry shall not appear as the first or second entry in a Sub-directory.

11.9.1 Name Field (BP 1-8)

The first byte of this field shall be set to (E5). The value of the remaining bytes is not specified by this Standard and shall be ignored in interchange.

11.9.2 Remaining Bytes (BP 9-32)

The values of bytes 9 to 32 are not specified by this Standard and shall be ignored in interchange.

11.10 Never-Used Entry

A Directory entry shall be a Never-Used Entry if the first byte is set to (00). A Never-Used Entry indicates available Directory space which has not been used before, and which can subsequently be used to record other entries.

A Never-Used Entry shall not appear as the first or second entry in any Sub-directory. Never-Used Entries shall not appear before any other type of Directory entry, i.e. all Never-Used Entries shall appear at the end of a Directory.

11.10.1 Name Field (BP 1-8)

The first byte of this field shall be set to (00). The values of the remaining bytes are not specified by this Standard and shall be ignored in interchange.

11.10.2 Remaining Bytes (BP 9-32)

The contents of the remaining bytes 9 to 32 are not specified by this Standard and shall be ignored in interchange.

SECTION III

REQUIREMENTS FOR THE DESCRIPTION OF SYSTEMS
REQUIREMENTS FOR AN ORIGINATING SYSTEM
REQUIREMENTS FOR A RECEIVING SYSTEM

12. REQUIREMENTS FOR THE DESCRIPTION OF SYSTEMS

Clauses 13 and 14 of this Standard specify that certain information shall be communicated between a user and an implementation.

An information processing system that conforms to this Standard shall be the subject of a description which identifies the means by which the user may supply such information, or may obtain it when it is made available, as specified in these clauses.

13. REQUIREMENTS FOR AN ORIGINATING SYSTEM

13.1 General

The implementation in an originating system shall be capable of recording an FDC that conforms to this Standard.

13.2 Files

The implementation shall obtain from the user the information that constitutes the interchange files to be recorded.

13.3 Descriptors

13.3.1 The implementation shall allow the user to supply the information that is to be recorded in each of the Descriptor fields listed below, and shall supply the information for a field if the user does not supply it.

- Name	File Entry BP 1-8
- Name Extension	File Entry BP 9-11
- Read-only Bit	File Entry BP 12 (Bit 0)

13.3.2 If the implementation allows the user to supply the information that is to be recorded in any of the Descriptor fields listed below, then the implementation shall record such information as supplied by the user, and shall supply the information if the user does not supply it.

- Time Recorded	Volume Label Entry BP 22-23
- Date Recorded	Volume Label Entry BP 24-25
- Time Recorded	File Entry BP 22-23
- Date Recorded	File Entry BP 24-25
- Time Recorded	Sub-directory Pointer Entry BP 22-23
- Date Recorded	Sub-directory Pointer Entry BP 24-25
- Time Recorded	Sub-directory Parent Pointer Entry BP
- Date Recorded	Sub-directory Parent Pointer Entry BP 24-25
- Time Recorded	Sub-directory Identifier Entry BP 23-24
- Date Recorded	Sub-directory Identifier Entry BP 25-26

14. REQUIREMENTS FOR A RECEIVING SYSTEM

14.1 General

The implementation in a receiving system shall be capable of reading all interchange files from an FDC that conforms to this Standard.

14.2 Files

The implementation shall make available to the user the information that constitutes the interchange files of the volume.

14.3 Descriptors

14.3.1 The implementation shall allow the user to supply information sufficient to enable the implementation to locate the files required by the user, and to locate the FDCs on which these files are recorded.

14.3.2 The implementation shall make available to the user the information that is recorded in each of the Descriptor fields listed below.

- Name	Volume Label Entry BP 1-8
- Name Extension	Volume Label Entry BP 9-11
- Name	File Entry BP 1-8
- Name Extension	File Entry BP 9-11
- Read-only Bit	File Entry BP 12 (Bit 0)

14.3.3 The implementation shall not be required to make available to the user the information that is recorded in each of the Descriptor fields listed below.

- Time Recorded	Volume Label Entry BP 23-24
- Date Recorded	Volume Label Entry BP 25-26
- Time Recorded	File Entry BP 23-24
- Date Recorded	File Entry BP 25-26
- Time Recorded	Sub-directory Pointer Entry BP 23-24
- Date Recorded	Sub-directory Pointer Entry BP 25-26
- Time Recorded	Sub-directory Parent Pointer Entry BP 23-24
- Date Recorded	Sub-directory Parent Pointer Entry BP 24-26
- Time Recorded	Sub-directory Identifier Entry BP 23-24
- Date Recorded	Sub-directory Identifier Entry BP 25-26

SECTION IV

RECORD STRUCTURE

RECORD STRUCTURE

15. RECORD STRUCTURE

15.1 General

This Section IV of this ECMA Standard specifies a record structure for use within files that are recorded on an FDC conforming to Section II of this Standard.

This record structure may be used in the input or output data streams of an application program when such data streams are required to be organized as a set of records. The use of this record structure may require additional user-supplied program statements in an application expressed in a programming language. Alternatively, utility programs may have to be developed to transform between these record structures and those supported by the originating or receiving system.

15.2 Records

15.2.1 Characteristics

A record shall be a sequence of bytes consisting of the coded representation of a part of the information in a file.

The length of a record shall be the number of bytes in the record.

A record shall either be a fixed-length record, or a variable-length record, or a segmented record.

15.2.2 Measured Data Units

A Measured Data Unit (MDU) shall contain either a fixed-length record, or a variable-length record or a record segment.

Each MDU shall be recorded in successive bytes of the File Space. The first or only MDU shall begin at the first byte of the File Space. Each successive MDU shall begin at the byte in the File Space immediately following the last byte of the preceding MDU.

15.2.3 Fixed-length Records

A fixed-length record shall be a record contained in a file that is assigned to contain records that all must have the same length. The format of the records in the file shall be fixed-length format.

A fixed-length record shall be contained in an MDU that consists only of that record.

The minimum assigned length of a fixed-length record shall be 1.

15.2.4 Variable-length Records

A variable-length record shall be a record contained in a file that is assigned to contain records that may have different lengths. The format of the records in the file shall be variable-length format.

A variable-length record shall be contained in an MDU. The MDU shall consist of a Record Control Word (RCW), followed immediately by the variable-length record. The RCW shall consist of four characters which shall be coded according to ECMA-6 and shall express the sum of the lengths of the record and of the RCW as a four-digit decimal number.

A maximum record length shall be assigned for a file. The length of any record in the file shall not exceed this value. The assigned maximum record length shall not be 0 and shall not exceed 9995.

The minimum length of a variable-length record shall be 0.

15.2.5 Segmented Records

A segmented record shall be a record contained in a file that is assigned to contain records that may have different lengths and that may be recorded entirely in one MDU or over more than one MDU. The format of the records in the file shall be segmented format.

That part of a segmented record that is recorded in one MDU is a record segment.

Successive segments of the same record within the same file shall be recorded in successive MDUs.

Different segments of the same record shall only be recorded on different FDCs if one of the segments is contained within the last MDU recorded in a File Space on one FDC, and the next segment of the record is contained within the first MDU recorded in a File Space on another FDC.

A maximum record length shall be assigned for a file. The length of any record in the file shall not exceed this value. The assigned maximum record length shall not be 0.

NOTE 6:

The assigned maximum record length is unbounded in that this Standard specifies no limit to the number of record segments in a record.

A record segment shall be contained in an MDU. The MDU shall consist of a Segment Control Word (SCW), followed immediately by the record segment. The SCW shall consist of five characters which shall be coded according to ECMA-6.

The first character of the SCW is called the Segment Indicator. This character shall have one of the values 0, 1, 2 or 3 with the following meaning.

0 shall mean that the record begins and ends in this record segment.

1 shall mean that the record begins but does not end in this record segment.

2 shall mean that the record neither begins nor ends in this record segment.

3 shall mean that the record ends but does not begin in this record segment.

The last four characters of the SCW shall express as a decimal number the sum of the lengths of the record segment and the SCW.

The maximum length of a record segment shall be 9994.

The minimum length of a record segment shall be 0.

15.3 Attributes of Record-structured Files

The following information shall be regarded as a set of attributes of a record-structured file:

- The format of the records in the file;
- the record length, if the format of the records is fixed-length;
- the maximum record length, if the format of the records is either variable-length or segmented.

NOTE 7:

The attributes of a record-structured file are assumed to be the subject of an agreement between originator and recipient of the FDC on which the file is recorded.

15.4 Requirements for Systems Implementing Section IV

15.4.1 Originating Systems

The implementation shall obtain from the user the length of each record of the file.

If the records of a file are segmented records the implementation may impose a limit on the maximum record length.

15.4.2 Receiving Systems

The implementation shall make available to the user the length of each record in the file.

If the records are segmented records the implementation may impose a limit on the length of a record in the file.

The implementation is not required to make available to the user any byte beyond the first n bytes of the record, where n is the value of the imposed limit.

SECTION V

APPENDICES

APPENDIX A

PARAMETER VALUES FOR FDCs CONFORMING TO AN ECMA STANDARD FOR DATA INTERCHANGE

A.1 Parameters Defined in an ECMA Data Interchange Standard

ECMA Standard	ECMA-70	ECMA-78	ECMA-99	ECMA-100
Description				
Diameter	130	130	130	90
ftprad	7958	7958	13262	7958
FDC Parameters				
Number of Tracks (NOT)	40	80	80	80
Number of Sides (NOS)	2	2	2	2
Sectors per Track (SPT)	9	9	15	9
Sector Data Field (SS)	512	512	512	512
Total Number of Sectors (TS)	720	1440	2400	1440

A.2 Parameters Defined by this Standard

Volume Structure Parameters				
Medium Identifier	(FD)	(F9)	(F9)	(F9)
Sectors per Cluster (SC)	2	2	1	2
Reserved Sector Count (RSC)	1	1	1	1
Sectors per FAT (SF)	2	3	7	3
Root Directory Entries (RDE)	112	176	224	112

A.3 Variables Calculated from the Above Parameters

Medium Map Summary - Track, Side, Sector Number				
System Area begins	00;0,1	00;0,1	00;0,1	00;0,1
FDC Descriptor	00;0,1	00;0,1	00;0,1	00;0,1
1st FAT	00;0,2	00;0,2	00;0,2	00;0,2
2nd FAT	00;0,4	00;0,5	00;0,9	00;0,5
Root Directory	00;0,6	00;0,8	00;1,1	00;0,8
Data Area begins	00;1,4	01;0,1	00;1,15	00;1,6
Root Directory Sectors	7	11	14	7
Sectors per System Area (SSA)	12	18	29	14
Maximum Cluster Number (MAX)	355	712	2372	714

APPENDIX B

PARAMETER VALUES FOR OTHER FDC FORMATS

If ECMA Standards become available in future for other types of FDC not shown in Appendix A, the requirements of this ECMA Standard may be applied to such types of FDC as specified in this Appendix B.

For each such type of FDC it is a prerequisite that the FDC can be described in terms of the parameters in 6.1.1 of this Standard.

The value of the Format Identifier (see 10.1) shall be (F9).

The values of the Volume Structure Parameters (see 6.1.5), shall be derived as follows.

B.1 Sectors per Cluster

The value of this parameter shall be chosen by the implementation that records the FDC Descriptor.

B.2 Reserved Sector Count

The value of this parameter shall be at least 1.

B.3 Sectors per FAT

The value of this parameter shall be given by the formula in 10.3.

B.4 Root Directory Entries

The implementation that records the FDC Descriptor shall select the number of sectors to be allocated to the Root Directory. The number RDE of Root Directory Entries is then given by the formula:

$$RDE = ip\left(\frac{(\text{Number of sectors in Root Directory}) \cdot SS}{32}\right)$$

APPENDIX C

STANDARD ECMA-6: INTERNATIONAL REFERENCE VERSION (IRV)

b7	0	0	0	0	1	1	1	1
b6	0	0	1	1	0	0	1	1
b5	0	1	0	1	0	1	0	1
b4 b3 b2 b1	0	1	2	3	4	5	6	7
0 0 0 0 0	NUL	DLE	SP	0	@	P	`	p
0 0 0 1 1	SOH	DC1	!	1	A	Q	a	q
0 0 1 0 2	STX	DC2	"	2	B	R	b	r
0 0 1 1 3	ETX	DC3	#	3	C	S	c	s
0 1 0 0 4	EOT	DC4	¤	4	D	T	d	t
0 1 0 1 5	ENQ	NAK	%	5	E	U	e	u
0 1 1 0 6	ACK	SYN	&	6	F	V	f	v
0 1 1 1 7	BEL	ETB	'	7	G	W	g	w
1 0 0 0 8	BS	CAN	(	8	H	X	h	x
1 0 0 1 9	HT	EM	)	9	I	Y	i	y
1 0 1 0 10	LF	SUB	*	:	J	Z	j	z
1 0 1 1 11	VT	ESC	+	;	K	[	k	{
1 1 0 0 12	FF	IS4	,	<	L	\	l	|
1 1 0 1 13	CR	IS3	-	=	M	]	m	}
1 1 1 0 14	SO	IS2	.	>	N	^	n	~
1 1 1 1 15	SI	IS1	/	?	O	_	o	DEL

The d-characters are those which are not shaded in the above table.

b7	0	0	0	0	1	1	1	1
b6	0	0	1	1	0	0	1	1
b5	0	1	0	1	0	1	0	1
b4 b3 b2 b1	0	1	2	3	4	5	6	7
0 0 0 0 0	NUL	DLE	SP	0	@	P	`	p
0 0 0 1 1	SOH	DC1	!	1	A	Q	a	q
0 0 1 0 2	STX	DC2	"	2	B	R	b	r
0 0 1 1 3	ETX	DC3	#	3	C	S	c	s
0 1 0 0 4	EOT	DC4	¤	4	D	T	d	t
0 1 0 1 5	ENQ	NAK	%	5	E	U	e	u
0 1 1 0 6	ACK	SYN	&	6	F	V	f	v
0 1 1 1 7	BEL	ETB	'	7	G	W	g	w
1 0 0 0 8	BS	CAN	(	8	H	X	h	x
1 0 0 1 9	HT	EM	)	9	I	Y	i	y
1 0 1 0 10	LF	SUB	*	:	J	Z	j	z
1 0 1 1 11	VT	ESC	+	;	K	Ä	k	ä
1 1 0 0 12	FF	IS4	,	<	L	Ö	l	ö
1 1 0 1 13	CR	IS3	-	=	M	Å	m	å
1 1 1 0 14	SO	IS2	.	>	N	Ü	n	ü
1 1 1 1 15	SI	IS1	/	?	O	_	o	DEL

The a-characters are those which are not shaded in the above table.

APPENDIX D

EXAMPLE OF VOLUME STRUCTURES AND FILE PLACEMENT

D.1 Sample Mapping of Cluster Number to Flexible Disk Cartridge Sectors

This sample mapping assumes: NOS = 2, SPT = 9, NOT = 40, SC = 2, RSC = 1, SF = 2 and RDE = 112.

		TRACKS									
	SECTORS	00	01	02	03	04	05	06	07	08	09
SIDE 0	1 2	R F	5	14	23	32	41				
	3 4	F F	6	15	24	33	42				
	5 6	F D	7	16	25	34	43				
	7 8	D D	8	17	26	35	44				
SIDE 1	9 1	D D	9	18	27	36	45				
	2 3	D D	10	19	28	37	46				
	4 5	2	11	20	29	38	47				
	6 7	3	12	21	30	39	48				
	8 9	4	13	22	31	40	49				

R = Reserved Sector
F = FAT Sector
D = Root Directory Sector

Each entry of the table other than R, F, D is a cluster number. For example, Cluster Number 11 contains sectors 4 and 5 of track 01, side 1.

D.2 A Sample File Allocation Table (FAT)

This example assumes three files; the FAT is shown below. The contents of the FAT shown are the logical contents, not the recorded format.

	00	01	02	03	04	05	06	07	08	09
00	(FDF	FFF)	000	000	000	006	008	000	(FFF)	(FFF)
10	000	024	000	000	000	000	000	018	019	020
20	(FFF)	000	000	000	009	000	000	000	000	000
30	000	000	000	000	000	000	000	000	000	000
40	000	000	000	000	000	000	000	000	000	000
.	.	.	.	.	.	.	.	.	.	.
.	.	.	.	.	.	.	.	.	.	.
.	.	.	.	.	.	.	.	.	.	.
340	000	000	000	000	000	000	000	000	000	000
350	000	000	000	000	000	000	000			

Cluster Numbers are shown in decimal notation. The entry indicating the end of each file is shown in hexadecimal notation (FFF). The meaning of the value (FDF FFF) is explained in 10.

First File Chain = 11, 24 and 9
Second File Chain = 5, 6 and 8
Third File Chain = 17, 18, 19 and 20
Available Clusters = 2-4, 7, 10, 12-16, 21-23 and 25-356

D.3 Address Mapping Example

This example uses the parameter values as in D.1 and D.2.

D.3.1 The File Space

This example assumes that a file contains a sequence of eighteen 128-byte fixed-length records.

The File Space is composed of the ordered set of 2560 bytes, and the file length is 2304 (18 x 128 = 2304).

D.3.2 The Cluster Space

Since any available clusters may be allocated, and the existence of available clusters is dependent on the previous use history of the clusters, it is probable that the available clusters will not have consecutive cluster numbers.

Records	1-4	5-8	9-12	13-16	17-18
Cluster Number	011	011	024	024	009

Note that since there are two sectors per cluster, each group of eight records occupies only one cluster. The second sector in cluster 009 is not used in this example; it is available for extension of the file at some later time. Due to the freeing of a cluster from some other file between space allocations to this file, the order of clusters is non-ascending.

D.3.3 The Logical Sector Numbers

The sectors of a flexible disk cartridge are logically numbered starting with 0; this corresponds to side 0, track 00, sector 1. Logical Sector Number 1 corresponds to side 0, track 00, sector 2; etc. This numbering continues consecutively through side 0 of a track, then proceeds with side 1 of the same track (if it is a two-sided flexible disk cartridge), then to the next higher numbered track, etc.

Cluster Numbers can be converted to Logical Sector Numbers by the following calculation: Logical Sector Number equals the product of the Cluster Number minus 2 times the number of sectors per cluster added to the number of sectors in the systems area.

$$LSN = ((CN - 2) \cdot SC) + SSA$$

For this example there are two sectors per cluster (SC), and twelve sectors in the system area (SSA), therefore:

Cluster Number (Decimal)	Logical Sector Numbers
002	12, 13
011	30, 31
024	56, 57
009	26, 27

D.3.4 The Physical Address Space

To convert a Logical Sector Number to a Physical Address divide the Logical Sector Number by 9 (the number of sectors per track) and then by 2 (the number of recordable sides). The quotient is the Track Number; then divide the remainder by 9, the second quotient is the Side Number, and the second remainder plus 1 is the Sector Number. Note that for other flexible disk cartridge formats, all occurrences of the values 9 and 2 should be replaced by the number of sectors per track and the number of recordable sides, respectively.

Logical Sector Number	Physical Address		
	Side	Track	Sector
30	1	01	4
31	1	01	5
56	0	03	3
57	0	03	4
26	0	01	9
27	1	01	1

Note that cluster 009 contains the sectors with Logical Sector Numbers 26 and 27 which are on different sides of the flexible disk cartridge.

D.3.5 Summary of Address Mapping Examples

Records	1-4	5-8	9-12	13-16	17-18	*
Cluster Number	011	011	024	024	009	009
Sector of Cluster	1	2	1	2	1	2
Logical Sector Number	30	31	56	57	26	27
Physical Address - Side	1	1	0	0	0	1
- Track	01	01	03	03	01	02
- Sector	4	5	3	4	9	1

* The second sector of the cluster is available for subsequent use in this file.

APPENDIX E

INDEX OF ACRONYMS

CN	Cluster Number
HN	Side Number
FAT	File Allocation Table
LSN	Logical Sector Number
NOS	Number of Recordable Sides
NOT	Number of Tracks per Side
RDE	Number of Root Directory Entries
RSC	Reserved Sector Count
SC	Sectors per Cluster
SF	Sectors per FAT
SN	Sector Number
SPT	Number of Sectors per Track
SS	Number of Bytes in the Data Field of a Sector
SSA	Size of the System Area (in number of sectors)
TN	Track Number
TS	Total Number of Sectors of the FDC