Standard ECMA-107
2nd Edition - June 1995

ECMA

Standardizing Information and Communication Systems

Volume and File Structure of Disk Cartridges for Information Interchange

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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:

a) 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 inter-act 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.

b) Limitations on the number of file labels permitted on an inter-change FDC prevents the full use of the disk space if the average size of files is significantly less than, say 20 Kbytes.
   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 benevicial characteristics, in addition to those of ECMA-91.

a) Direct updating of the interchange file by an interactive application is possible.

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

The characteristics are advantageous for:

a) Interchange of sets of text files or of small files, or of multiple-part document files.

b) Interchange of any file when sender and recipient wish to carry out frequent update of the file between interchange cycles, for example files of commercial transactions..

Since the publication of the first version of this Standard, many types of high capacity Flexible Disk Cartridges (FDCs) and Optical Disk Cartridges (ODCs) have come in use. All the descriptions (except annex B) of an FDC, throughout this ECMA Standard, can be applied to an ODC as well. It is intended that existing file systems for FDCs, possibly slightly modified, are applicable to ODCs. ODC specific volume and file structure standards are, e.g., ECMA-167 and ECMA-168. This ECMA Standard is applicable to the new types of storage media because of revision at the following points:

a) Addition of the extended FDC Descriptors (clause 9) to the existing FDC Descriptors.

b) Adoption of 16-bit File Allocation Table (FAT) entries (10.2) in addition to the existing 12-bit FAT entries

c) Obsoletion of the Medium Identifier field (table 3 and subclause 9.2.9) because available values are exhausted and the field is no more used.

ECMA-107 is identical to ISO/IEC 9293.

This ECMA Standard has been adopted by the General Assembly of June 1995.

Table of contents

Section 1 - General

1 Scope

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

NOTE
All the descriptions (except those in annex B) of Flexible Disk Cartridges (FDC) can be applied to Optical Disk Cartridges (ODC) as well.

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

This ECMA Standard specifies the location of files of information on an FDC 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 location of defective recording space on the FDC;
- the attributes of the FDC and of the descriptors recorded on it.

This ECMA 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 FDCs as the medium of interchange. For this purpose it specifies the functions within systems which are intended to originate or to receive FDCs which conform to this ECMA Standard.

This ECMA Standard provides a method for the allocation of space that is independent of the number of files which 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 content and organization of the files are not specified by this ECMA Standard and are subject to agreement between the originator and the recipient of the interchanged FDC.

2 Conformance

2.1 Conformance of an FDC

An FDC shall be in conformance with this ECMA Standard when all information recorded on it conforms to the requirements of section two of this ECMA Standard.

A prerequisite to such conformance is the conformance of the FDC to the appropriate International Standard for data interchange by means of FDCs.

2.2 Conformance of an information processing system

An information processing system shall be in conformance with this ECMA Standard if it meets the set of requirements specified in section three of this ECMA 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 ECMA Standard does not require conformance with section 4.

3 References

ECMA-6:1991	7-Bit Coded Character Set for Information Interchange.
ECMA-70:1986	Data Interchange on 130 mm Flexible Disk Cartridges Using Modified Frequency Modulation Recording at 7 958 ftprad, on 40 Tracks on Each Side.
ECMA-78:1986	Data Interchange on 130 mm Flexible Disk Cartridges Using Modified Frequency Modulation Recording at 7 958 ftprad, on 80 Tracks on Each Side.

ECMA-99:1985	Data Interchange on 130 mm Flexible Disk Cartridges Using Modified Frequency Modulation Recording at 13 262 ftprad, ,on Bothe Sides; 3,8 Tracks per mm.
ECMA-100:1988	Data Interchange on 90 mm Flexible Disk Cartridges Using Modified Frequency Modulation Recording at 7 958 ftprad on 80 Tracks on Each Side - ISO type 301.
ECMA-125:1987	Data interchange on 90 mm Flexible Disk Cartridges Using Modified Frequency Modulation Recording at 15 916 ftprad, on 80 Tracks on Each Side - ISO type 302.
ECMA-147:1990	Data Interchange on 90 mm Flexible Disk Cartridges Using Modified Frequency Recording at 31 831 ftprad on 80 Tracks on Each Side - ISO type 303.
ECMA-153:1994	Information Interchange on 130 mm Optical Disk Cartridges, of the Write Once, Read Multiple WORM Type Using the Magneto-Optical Effect.
ECMA-154:1994	Data Interchange on - 90 mm Optical Disk Cartridges, Read Only and Rewritable, M.O.
ECMA-183:1992	Data Interchange on 130 mm Optical Disk Cartridges - Capacity: 1 Gigabyte per Cartridge.
ECMA-184:1992	Data Interchange on 130 mm Optical Disk Cartridges - Capacity: 1,3 Gigabytes per Cartridge.
ECMA-195:1995	Data Interchange on 130 mm Optical Disk Cartridges - Capacity: 2 Gigabytes per Cartridge.
ECMA-201:1994	Data Interchange on 90 mm Optical Disk Cartridges - Capacity: 230 Mbytes per Cartridge.
ECMA-207:1994	Data Interchange on 90 mm Flexible Disk Cartridges - 326 Tracks on Each Side - Capacity 21 Mbytes - ISO type 305.
ISO 7665:1983	Information processing - File structure and labelling of flexible disk cartridges for information interchange.
ISO/IEC 9171-1:1990	Information technology - 130 mm optical disk cartridge, write once, for information interchange. Part 1: Unrecorded optical disk cartridge.
ISO/IEC 9171-2:1990	Information technology - 130 mm optical disk cartridge, write once, for information interchange. Part 2: Recording format.
ISO/IEC 10089:1991	Information technology - 130 mm rewritable optical disk cartridge for information interchange.
ISO/IEC 13422:1995	Information technology - Data Interchange on 90 mm flexible disk cartridges 10 Mbytes capacity using sector servo tracking - ISO type 304.

4 Definitions

For the purposes of this ECMA Standard the following definitions apply.

4.1 byte

A string of binary digits operated upon as a unit. In this ECMA 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 an FDC.

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 FDC

Flexible Disk Cartridge.

NOTE
All the descriptions of an FDC (except those in annex B) can be applied to an Optical Disk Cartridge as well.

4.7 file

A named collection of information.

4.8 formatting

Writing the control information establishing the physical addresses of sectors on the surfaces of an FDC.

4.9 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.

4.10 initialization

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

4.11 ODC

Optical Disk Cartridge

4.12 originating system

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

4.13 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.

4.14 sector

That part of a track on an FDC that can be accessed independently of other parts of the track by the heads of the FDC.

4.15 physical track

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

4.16 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 4.

4.17 fixed-length record

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

4.18 record

Related data treated as a unit of information.

4.19 segment

A part of a record.

4.20 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.

4.21 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 ECMA Standard.

5.1 Decimal and hexadecimal notations

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

Numbers in hexadecimal notation are represented by hexadecimal digits, namely 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* x ip (*x*/*y*)

5.3 Capital letters

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

Section 2 - Volume and file structure/File allocation table and directories

6 Volume structure

6.1 Arrangement of data on an FDC

6.1.1 FDC parameters

For the purpose of this ECMA Standard the significant parameters of the data interchange standard are shown in table 1.

Table 1 - FDC parameters

FDC parameter	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 are given in data interchange standards (see annex B).

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 FDC is recordable on both sides) and then to track 01, side 0, etc.

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:

$LSN = SPT \times [HN + (NOS \times TN)] + SN - 1$

$SN = \text{rem}\ \{\text{rem}\ [LSN, (SPT \times NOS)], SPT\} + 1$

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

$$HN = \text{ip}\left\{\frac{\left(\text{rem}\left[LSN, \left(SPT \times NOS\right)\right]\right)}{SPT}\right\}$$

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 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 ECMA 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 in table 2. See also annex B.

Table 2 - Parameters of the Volume Structure

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

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 (Sectors per Cluster, *SC*) which shall be a power of 2, i.e. 1, 2, 4, 8, ... (See annex B). 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 *LSN*s.

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:

$LSN = [(CN - 2) \times SC] + SSA$

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 content 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 content 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 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 content 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. (See annex B).

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. Annex 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 (See annex B).

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 Root Directory Entries (*RDE*), each of which identifies a file, a Volume Label or a sub-directory, or indicates that it is not in use (see annex B).

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:

$$SSA = RSC + 2SF + \text{ceil}\left(\frac{32RDE}{SS}\right)$$

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.

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* &mult. *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:

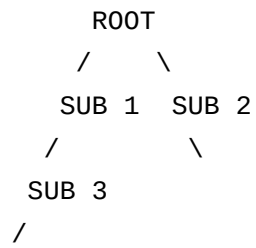
$$\text{ip}\left(\frac{1}{32}K \times SC \times SS\right)$$

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;
– if there is a file name extension, the length of the file name extension, plus 1;
– 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 Content 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
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 ECMA 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 11.5.1.

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
For example, the decimal number 72 has (00 48) as its hexadecimal representation and is 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
For example, the decimal number 305 419 896 has (12 34 56 78) as its hexadecimal representation and is 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 12-bit FAT entries.

NOTE
For example, the pair of 12-bit numbers with hexadecimal representations (123) and (456) is 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 annex 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 disk and provides information about other Descriptors in the System Area of the FDC.

This ECMA Standard defines two types of FDC descriptors:

- FDC Descriptor
- Extended FDC Descriptor

The Extended FDC Descriptor is a superset of the FDC Descriptor. Only the Extended FDC Descriptor can treat a volume with more than 65 535 sectors, and it provides additional information to be used by the recipient system

9.1 FDC Descriptor and Extended FDC Descriptor layout

Table 3a - FDC Descriptor

BP	Field Name	Acronym	Content
1 to 3	(reserved for system use)		not specified
4 to 11	Creating system Identifier		a-characters
12 and 13	Sector size	*SS*	numerical value
14	Sectors per cluster	*SC*	numerical value
15 and 16	Reserved sector count	*RSC*	numerical value
17	Number of FATs	*FN*	Number 2
18 and 19	Number of root-directory entries	*RDE*	numerical value
20 and 21	Total sectors	*TS*	numerical value
22	Medium Identifier		not specified (FD) or (F9)
23 and 24	Sectors per FAT	*SF*	numerical value
25 and 26	Sectors per track	*SPT*	numerical value
27 and 28	Number of sides	*NOS*	numerical value
29 and 30	(Reserved for future standardization)		(00)(00)
31 to 512	(Reserved for system use)		not specified

Table 3b - Extended FDC Descriptor

BP	Field Name	Acronym	Content
1 to 3	(reserved for system use)		not specified
4 to 11	Creating system Identifier		a-characters
12 and 13	Sector size	*SS*	numerical value
14	Sectors per cluster	*SC*	numerical value
15 and 16	Reserved sector count	*RSC*	numerical value
17	Number of FATs	*FN*	Number 2
18 and 19	Number of root-directory entries	*RDE*	numerical value
20 and 21	Total sectors if < 65536 0 if > 65535	*TS*	numerical value
22	Medium Identifier		not specified (FD) or (F9)
23 and 24	Sectors per FAT	*SF*	numerical value
25 and 26	Sectors per track	*SPT*	numerical value
27 and 28	Number of sides	*NOS*	numerical value
29 to 32	(Reserved for system use)		not specified
33 to 36	Total sectors if BP20 & 21 = 0 Not specified otherwise	*TS*	numerical value
37	(Reserved for system use)		not specified
38	Reserved		(00)
39	Extended Boot Record Signature		(29)
40 to 43	Volume ID Number		numerical value
44 to 54	Volume Label		d-characters
55 to 62	File System Type		d-characters
63 to 512	(Reserved for system use)		not specified

9.2 FDC Descriptor and Extended FDC Descriptor fields

9.2.1 Field reserved for system use (BP 1 to 3)

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

9.2.2 Creating System Identifier (BP 4 to 11)

This field shall specify an identification for the system that has recorded the FDC Descriptor or the Extended FDC Descriptor.

The characters in this field shall be a-characters.

9.2.3 Sector Size (BP 12 and 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 and 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 and 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 and 21)

This field shall specify the number of sectors on the FDC (including defective sectors) if the total number of sectors is not greater than 65 535. Otherwise, this field shall be recorded as ZEROs, and the total number of sectors shall be recorded in BP 33 to 36; in this case the Extended FDC Descriptor shall be used.

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

9.2.9 Medium Identifier (BP 22)

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

NOTE
The reasons why this field is not specified are that the available values for this field are exhausted and the field is no more used.

9.2.10 Sectors per FAT (BP 23 and 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 and 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 and 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 (FDC Descriptor BP 29 and 30)

This field shall be reserved for future standardization.
It shall contain only ZEROs.

9.2.14 Field reserved for system use (Extended FDC Descriptor BP 29 to 32)

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

9.2.15 Total Sectors (Extended FDC Descriptor; BP 33 to 36)

This field shall specify the number of sectors on the FDC (including defective sectors) if the field in BP 20 and 21 is recorded as ZEROs.
It shall be recorded as a 32-bit numerical value according to 8.3.

9.2.16 Field reserved for system use (Extended FDC Descriptor BP 37)

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

9.2.17 Field reserved for future standardization (Extended FDC Descriptor BP 38)

This field shall be reserved for future standardization.
It shall be recorded as ZEROs.

9.2.18 Extended Boot Record Signature (Extended FDC Descriptor BP 39)

This field shall be used to identify the descriptor type in the Extended FDC Descriptor when either BP 20 or BP 21 is not recorded as ZEROs.

This field shall be recorded as (29).

9.2.19 Volume ID Number (Extended FDC Descriptor BP 40 to 43)

This field shall specify the volume identification number. It may be used to identify the volume and to check if the disk has been changed.

It shall be recorded as a numerical value according to 8.3.

9.2.20 Volume Label (Extended FDC Descriptor BP 44 to 54)

This field shall specify the volume label.

The characters in this field shall be d-characters. The label shall be left-justified in the 11-byte field and any unused byte shall be set to (20).

9.2.21 File System Type (Extended FDC Descriptor BP 55 to 62)

This field shall specify the type of the file system.

This field can be one of the sequences of characters specified in table 4.

Table 4 - Type of file systems

Content	Meaning
FAT12	**12-bit FAT**
FAT16	**16-bit FAT**

The characters in this field shall be d-characters. The content shall be left-justified in the 8-byte field and any unused byte shall be set to (20).

9.2.22 Field reserved for system use (FDC Descriptor BP 31 to 512; Extended FDC Descriptor BP 63 to 512)

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

10 File Allocation Table

The first three (12-bit FAT case) or four (16-bit FAT case) bytes of the FAT shall be used as follows:

byte 0 shall contain the Format Identifier, bytes 1 and 2 (12-bit FAT case) or bytes 1, 2 and 3 (16-bit FAT case) 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

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

10.2 FAT entries

10.2.1 FAT entry size

The length of each FAT entry shall be 12 bits or 16 bits.

It shall be recorded as a numerical value according to 8.4 for 12-bit FAT entries, or according to 8.2 for 16-bit FAT entries.

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:

NOTE
Upper entry in the left column is for 12-bit FAT, lower entry is for 16-bit FAT.

(000) (0000)	shall mean that the corresponding cluster is not in use and may be allocated to any File Space.
(002) to *MAX* (0002) 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) *MAX*+1 to (FFF6)	are reserved for future standardization and shall not be used.
(FF7) (FFF7)	shall mean that the corresponding cluster contains a defective sector.
(FF8) to (FFF) (FFF8) to (FFFF)	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:

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

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:

$$SF = \text{ceil}\left\{\frac{\text{ip}\left[\frac{TS - RSC - SF - \text{ceil}\frac{32RDE}{SS}}{SC}\right]\times 12}{8SS}\right\}$$

where

TS is the total number of sectors on the medium;
SC is the number of sectors per clusters;
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 for example file name, attributes, data 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

Table 5 - Directory Structure

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

11.3.1 Name (BP 1 to 8)

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

11.3.2 Name Extension (BP 9 to 11)

The interpretation of this field shall depend on the entry type. The content 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 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 to 22)

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

11.3.5 Time Recorded (BP 23 and 24)

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

(2048 x hour) + (32 x minute) + ip (second / 2)

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

11.3.6 Date Recorded (BP 25 and 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) x 512] + (Month x 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 and 28)

The content 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 to 32)

The content 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 an 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 to 8)

This field shall specify the name of the file. The content 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 to 11)

This field shall specify a name extension to the name of the file. It 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 to 22)

All bytes shall be set to (00).

11.4.5 Time Recorded (BP 23 and 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 and 26)

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

11.4.7 Starting Cluster Number (BP 27 and 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 to 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 to 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 to 22)

All bytes shall be set to (00).

11.5.4 Time Recorded (BP 23 and 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 and 26)

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

11.5.6 Starting Cluster Number (BP 27 and 28)

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

11.5.7 File Length (BP 29 to 32)

The content of this field is not specified by this ECMA 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 are 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 to 8)

This field shall specify the name of the Sub-directory. The content 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 to 11)

This field shall specify a name 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 to 22)

All bytes shall be set to (00).

11.6.5 Time Recorded (BP 23 and 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 and 26)

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

11.6.7 Starting Cluster Number (BP 27 and 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 to 32)

The content of this field is not specified by this ECMA 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 to 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 to 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 to 22)

All bytes shall be set to (00).

11.7.5 Time Recorded (BP 23 and 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 and 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 and 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.

11.7.8 File Length (BP 29 to 32)

The content of this field is not specified by this ECMA 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).

A 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 to 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 to 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 to 22)

All bytes shall be set to (00).

11.8.5 Time Recorded (BP 23 and 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 and 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 and 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 to 32)

The content of this field is not specified by this ECMA Standard, it 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 to 8)

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

11.9.2 Remaining bytes (BP 9 to 32)

The values of bytes 9 to 32 are not specified by this ECMA 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 to 8)

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

11.10.2 Remaining bytes (BP 9 to 32)

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

Section 3 - System requirements

12 Requirements for the description of systems

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

An information processing system that conforms to this ECMA 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 ECMA 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 to 8
- Name Extension	File Entry BP 9 to 11
- Read-only Bit	File Entry BP 12 (bit 8)

13.3.2 The implementation shall allow the user to supply the information that is to be recorded in each of the Descriptor fields listed below, and need not record a Volume Label Entry if the user does not supply the information**.**

- Name	Volume Label Entry BP 1 to 8
- Name Extension	Volume Label Entry BP 9 to 11

13.3.3 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 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 23 and 24
- Date Recorded	Volume Label Entry BP 25 and 26
- Time Recorded	File Entry BP 23 and 24
- Date Recorded	File Entry BP 25 and 26
- Time Recorded	Sub-directory Pointer Entry BP 23 and 24
- Date Recorded	Sub-directory Pointer Entry BP 25 and 26
- Time Recorded	Sub-directory Parent Pointer Entry BP 23 and 24
- Date Recorded	Sub-directory Parent Pointer Entry BP 25 and 26
- Time Recorded	Sub-directory Identifier Entry BP 23 and 24
- Date Recorded	Sub-directory Identifier Entry BP 25 and 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 ECMA 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 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 to 8
- Name Extension	Volume Label Entry BP 9 to 11
- Name	File Entry BP 1 to 8
- Name Extension	File Entry BP 9 to 11
- Read-only Bit	File Entry BP 12 (bit 8)

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 below.

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

Section 4 - Record structure

15 Record structure

15.1 General

Section 4 of this ECMA Standard specifies a record structure for use within files that are recorded on an FDC conforming to section 2 of this ECMA 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 all of which 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 9 995.

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
The assigned maximum record length is unbounded in that this ECMA 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 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 9 994.

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
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 4

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.

Annex A
(normative)

Parameter values for other FDC formats

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

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 ECMA Standard.

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

A.1 Sectors per Cluster

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

A.2 Reserved Sector Count

The value of this parameter shall be at least 1.

A.3 Sectors per FAT

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

A.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:

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

Annex B
(informative)

Parameter values for FDCs conforming to a Standard for data interchange

B.1 Parameters defined in the Data Interchange Standard				
Standard	**ECMA-70**	**ECMA-78**	**ECMA-99**	**ECMA-100**
Description				
Diameter	130 mm	130 mm	130 mm	90 mm
Physical recording density	7 958 ftprad	7 958 ftprad	13 262 ftprad	7 958 ftprad
DC 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	1 440	2 400	1 440
B.2 Parameters Defined by this Standard				
Volume Structure Parameters				
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
B.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	2 372	714

Parameter values for FDCs conforming to a Standard for data interchange (cont'd)

B.1 Parameters defined in the Data Interchange Standard				
Standard	**ECMA-125**	**ECMA-147**	**ISO/IEC 13422**	**ECMA-207***
Description				
Diameter	90 mm	90 mm	90 mm	90 mm
Physical recording density	15916 ftprad	31831 ftprad	33157 ftprad	31831 to 47747 ftprad
DC Parameters				
Number of Tracks (NOT)	80	80	255	326
Number of Sides (NOS)	2	2	2	2
Sectors per Track (SPT)	18	36	39	56 to 84 ftprad
Sector Data Field (SS)	512	512	512	512
Total Number of Sectors (TS)	2 880	5 760	19890	41944
B.2 Parameters Defined by this Standard				
Volume Structure Parameters				
Sectors per Cluster (SC)	1	2	8	4
Reserved Sector Count (RSC)	1	1	1	1
Sectors per FAT (SF)	14	14	8	41
Root Directory Entries (RDE)	224	224	368	512
Medium Identifier			(FO)	(FO)
B.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; 0,16	00; 0,16	00; 0,10	00; 0,43
Root Directory	00; 1,12	00; 0,30	00; 0,18	00; 0,84
Data Area begins	00; 2,8	00; 1,8	00; 1,2	00; 1,32
Root Directory Sectors	14	14	23	32
Sectors per System Area(SSA)	33	33	40	115
Maximum Cluster Number (MAX)	2 848	2 864	2482	10458

* The length of a FAT entry in ECMA-207 is 16 bits.

Parameter values for ODCs conforming to a Standard for data interchange

B.1 Parameters defined in the Data Interchange Standard						
Standard	**ISO/IEC 9171**			**ISO/IEC 10089**		
Description						
Diameter	130 mm Format A**		130 mm Format B**	130 mm Format A**		130 mm Format B**
DC Parameters						
Number of Tracks (NOT)	18 744*		19980*	18 744*		19980*
Number of Sides (NOS)	2		2	2		2
Sectors per Track (SPT)	17	31	32	17	31	32
Sector Data Field (SS)	1 024	512	512	1 024	512	512
Total Number of Sectors (TS)	637 296	1 162 128	1 278 720	637 296	1 162 128	1 278 720

* This value is the number of logical tracks, i.e. the number of tracks, available for the recording of user data in the User Zone, recognized by the system.

** Format A: Continuous Composite Servo
Format B: Sample Servo.

Parameter values for ODCs conforming to a Standard for data interchange (cont'd)

B.1 Parameters defined in the Data Interchange Standard		
Standard	**ECMA-154**	**ECMA-201**
Description		
Diameter	90 mm	90 mm
DC Parameters		
Number of Tracks (NOT)	9 994*	17 930*/17 928* (embossed)
Number of Sides (NOS)	1	1
Sectors per Track (SPT)	25	25
Sector Data Field (SS)	512	512
Total Number of Sectors (TS)	249 850	448 250/448 200 (embossed)

* This value is the number of logical tracks, i.e. the number of tracks, available for the recording of user data in the User Zone, recognized by the system.

B.1 Parameters defined the ISO Data Interchange Standard				
Standard	**ECMA-153**		**ECMA-183**	
Description				
Diameter	130 mm		130 mm	
DC Parameters				
Number of Tracks (NOT)	18 744*		20 009*	20 010*
Number of Sides (NOS)	2		2	2
Sectors per Track (SPT)	17	31	17-33	31-60
Sector Data Field (SS)	1 024	512	1 024	512
Total Number of Sectors (TS)	637 296	1 162 128	1 000 450	1 820 910

* This value is the number of logical tracks, i.e. the number of tracks, available for the recording of user data in the User Zone, recognized by the system.

B.1 Parameters defined in the Data Interchange Standard				
Standard	**ECMA-184**		**ECMA-195**	
Description				
Diameter	130 mm		130 mm	
DC Parameters				
Number of Tracks (NOT)	37 594*		58 724*	55 754*
Number of Sides (NOS)	2	2	2	2
Sectors per Track (SPT)	17	31	17	31
Sector Data Field (SS)	1 024	512	1 024	512
Total Number of Sectors (TS)	1 278 196	2 330 828	1 996 616	3 456 748

* This value is the number of logical tracks, i.e. the number of tracks, available for the recording of user data in the User Zone, recognized by the system.

Annex C
(informative)

ECMA-6: International Reference Version (IRV)

Table C.1

				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 table C.1.

Table C.2

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 a-characters are those which are not shaded in table C.2.

Annex D
(informative)

Example of volume structure and file location

D.1 Sample mapping of Cluster Number to FDC 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	R	5	14	23	32	41				
	2	F									
	3	F	6	15	24	33	42				
	4	F									
	5	F	7	16	25	34	43				
	6	D									
	7	D	8	17	26	35	44				
	8	D									
	9	D	9	18	27	36	45				
SIDE 1	1	D									
	2	D	10	19	28	37	46				
	3	D									
	4	2	11	20	29	38	47				
	5										
	6	3	12	21	30	39	48				
	7										
	8	4	13	22	31	40	49				
	9										

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 content of the FAT shown is the logical content, 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	000	000	000

Cluster Numbers are shown in decimal notation. The entry indicating the end of each file is shown in hexadecimal notation (FFF),which is recorded as (FFFF) in 16-bit FAT case. The meaning of the value (FDF FFF) is explained in clause 10,which may be the value (F0FF FFFF) in 16-bit FAT case.

First File Chain = 11, 24 and 9

Second File Chain = 5, 6 and 8

Third File Chain = 17, 18, 19 and 20

Available Cluster = 2 to 4, 7, 10, 12 to 16, 21 to 23 and 25 to 356

D.3 Address mapping example

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

D.3.1 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 2 560 bytes, and the file length is 2 304 (18 x 128 = 2 304).

D.3.2 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 to 4	5 to 8	9 to 12	13 to 16	17 and 18
Cluster Number	011	011	024	024	009

It should be noted 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 release of a cluster from some other file between space allocations to this file, the order of clusters is non-ascending.

D.3.3 Logical Sector Numbers

The sectors of an FDC 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 FDC), 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

$$LSN = [(CN - 2) \times SC] + SSA$$

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

Table D.1

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

D.3.4 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. It should be noted that for other FDC 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.

Table D.2

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

It should be noted that cluster 009 contains the sectors with Logical Sector Numbers 26 and 27 which are on different sides of the FDC.

D.3.5 Summary of address mapping examples

Table D.3

Records	1 to 4	5 to 8	9 to 12	13 to 16	17 and 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	01
-Sector	4	5	3	4	9	1

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

Annex E
(informative)

Index of acronyms

BP	Byte Position
CN	Cluster Number
FAT	File Allocation Table
FDC	Flexible Disk Cartridge
HN	Side Number
LSN	Logical Sector Number
MDU	Measured Data Unit
NOS	Number of Recordable Sides
NOT	Number of Tracks per Side
ODC	Optical Disk Cartridge
RCW	Record Control Word
RDE	Number of Root Directory Entries
RSC	Reserved Sector Count
SC	Sectors per Cluster
SCW	Segment Control Word
SF	Sector 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

Annex F
(informative)

Extension to Partial ROM

ECMA-154 defines Fully Rewritable, Partially Embossed and Fully Embossed optical media. The Partially Embossed (Optical) Medium (Partial ROM) has Rewritable sectors in the lower address part of the medium and Read-Only sectors in the latter part. This annex describes the extension of the Volume and File structure of this ECMA Standard to this type of media, and how to prepare it. The following creation mechanism assumes the proper location for the System Information is rewritable and the area for the original copy is read-only, which are assured by the Standard for recording, ECMA-154.

- The System Information (FDC Descriptor, FAT and Root Directory) is recorded at the lowest address sectors (from LSN = 0) in the Rewritable zone.
- The original of the System Information should be stamped in the sectors of this excessive area at the manufacturing time and should be copied to the proper location when the medium is initialized or on the occasion the system information in the rewritable zone is destroyed.
- Other information may also be stamped in this area for copy at the same time.
- Which information to where to be copied should be described in ITB (Information Transfer Block) which is to be recorded at the last two (or more) sectors of the medium (see figure F.1).

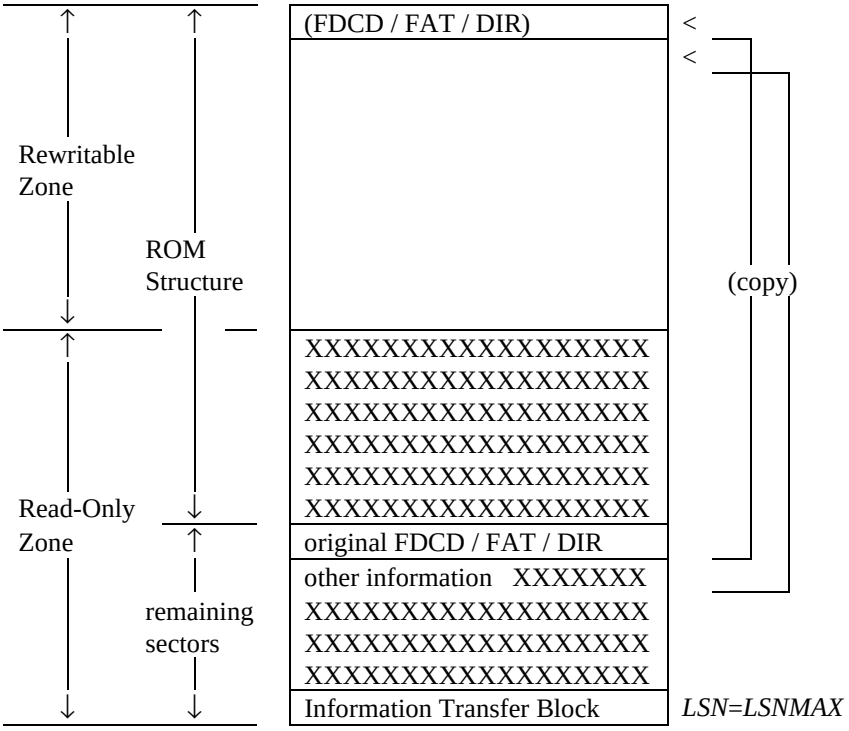


Figure F.1 - Partial ROM logical structure

F.1 Information Transfer Block (ITB)

The ITB is located on the last two sectors available on the media, LSNMAX & LSNMAX-1. LSNMAX and LSNMAX-1 are identical copies for redundancy.

If more sectors are needed they would be located in LSNMAX-2 & LSNMAX-3, LSNMAX-4 & LSNMAX-5, etc....

	Byte #	0	1	2	3	4	5	6	7	8	9	10	11
	Content	F1	F1	00	01	00	00	00	00	< No. of entries >			
	Description	ITB ID			ver.	(reserved)				*MSB* ---------- *LSB*			
(repeat)	Byte #	12	13	14	15	16	17	18	19	20	21	22	23
	Content	Transfer from starting *LSN*				Transfer to starting *LSN*				Transfer Length			
	Description	*MSB* ---------- *LSB*				*MSB* ---------- *LSB*				*MSB* ---------- *LSB*			
	Byte #	x	x+1	x+2	x+3	x+4	x+5	x+6	x+7	x+8	x+9	x+10	x+11
	Content	Transfer from starting *LSN*				Transfer to starting *LSN*				Transfer Length			
	Description	*MSB* ---------- *LSB*				*MSB* ---------- *LSB*				*MSB* ---------- *LSB*			
	Byte #	y	y+1					510	511				
	Content	FF	FF	.	.	.	.	FF	FF				
	Description												

Figure F.2 - ITB (Information Transfer Block) structure

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