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Information technology — Volume and file structure of disk cartridges for information interchange

Technologies de l'information — Volume et structure des fichiers des cartouches à disquette pour l'échange d'information

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Foreword

ISO (the International Organization for Standardization) and IEC (the International Electrotechnical Commission) form the specialized system for worldwide standardization. National bodies that are members of ISO or IEC participate in the development of International Standards through technical committees established by the respective organization to deal with particular fields of technical activity. ISO and IEC technical committees collaborate in fields of mutual interest. Other international organizations, governmental and non-governmental, in liaison with ISO and IEC, also take part in the work.

In the field of information technology, ISO and IEC have established a joint technical committee, ISO/IEC JTC 1. Draft International Standards adopted by the joint technical committee are circulated to national bodies for voting. Publication as an International Standard requires approval by at least 75 % of the national bodies casting a vote.

The first edition of International Standard ISO/IEC 9293 was prepared by the ECMA (as Standard ECMA-107) and was adopted, under a special "fast-track procedure", by Joint Technical Committee ISO/IEC JTC 1, *Information technology*, in parallel with its approval by national bodies of ISO and IEC.

This second edition cancels and replaces the first edition (ISO 9293:1987); it incorporates the capabilities of new disk cartridges (both optical and magnetic).

Annex A forms an integral part of this International Standard. Annexes B to F are for information only.

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Introduction

For many purposes ISO 7665 provides a satisfactory data interchange 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 interact continuously with the system to update files. Files having a suitable structure for this purposes are not within the provision of ISO 7665.

The interchange cartridge has 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 interchange disk cartridge prevent 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 such an average file size is usually satisfactory. However, the file sizes 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 structure of disk cartridges, the provisions of which were to be based on already existing practice in general use world-wide. Hence this International Standard has the following beneficial characteristics, in addition to those of ISO 7665:

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 International 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 International 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., ISO/IEC 13346 and ISO/IEC 13490. This International 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.

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Information technology - Volume and file structure of disk cartridges for information interchange

Section 1 - General

1 Scope

This International 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 International 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 International 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 International 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 International Standard.

This International 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 International 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 International Standard when all information recorded on it conforms to the requirements of section two of this International 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 International Standard if it meets the set of requirements specified in section three of this International 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 International Standard does not require conformance with section 4.

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3 Normative references

The following standards contain provisions which, through reference in this text, constitute provisions of this International Standard. At the time of publication, the edition indicated was valid. All standards are subject to revision, and parties to agreements based on this International Standard are encouraged to investigate the possibility of applying the most recent edition of the standards listed below. Members of IEC and ISO maintain registers of currently valid International Standards.

ISO/IEC 646:1991, *Information technology - ISO 7-bit coded character set for information interchange.*

ISO 7487-1:1993, *Information technology - Data interchange on 130 mm (5,25 in) flexible disk cartridges using modified frequency modulation recording at 7 958 ftprad, 1,9 tpmm (48 tpi), on both sides*
Part 1: Dimensional, physical and magnetic chaacteristics.

ISO 7487-3:1986, *Information processing - Data interchange on 130 mm (5,25 in) flexible disk cartridges using modified frequency modulation recording at 7 958 ftprad, 1,9 tpmm (48 tpi), on both sides*
Part 3: Track format B.

ISO 7665:1983, *Information processing - File structure and labelling of flexible disk cartridges for information interchange.*

ISO 8378-1:1986, *Information processing - Data interchange on 130 mm (5,25 in) flexible disk cartridges using modified frequency modulation recording at 7 958 ftprad, 3,8 tpmm (96 tpi), on both sides*
– *Part 1: Dimensional, physical and magnetic characteristics.*

ISO 8378-3:1986, *Information processing - Data interchange on 130 mm (5,25 in) flexible disk cartridges using modified frequency modulation recording at 7 958 ftprad, 3,8 tpmm (96 tpi), on both sides*
– *Part 3: Track format B.*

ISO 8630-1:1987, *Information processing - Data interchange on 130 mm (5,25 in) flexible disk cartridges using modified frequency modulation recording at 13 262 ftprad, on 80 tracks on each side*
– *Part 1: Dimensional, physical and magnetic characteristics.*

ISO 8630-3:1987, *Information processing - Data interchange on 130 mm (5,25 in) flexible disk cartridges using modified frequency modulation recording at 13 262 ftprad, on 80 tracks on each side*
– *Part 3: Track format B for 80 tracks.*

ISO 8860-1:1987, *Information processing - Data interchange on 90 mm (3,5 in) flexible disk cartridges using modified frequency modulation recording at 7 958 ftprad, on 80 tracks on each side*
– *Part 1: Dimensional, physical and magnetic characteristics.*

ISO 8860-2:1987, *Information processing - Data interchange on 90 mm (3,5 in) flexible disk cartridges using modified frequency modulation recording at 7 958 ftprad, on 80 tracks on each side*
– *Part 2: Track format.*

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 9529-1:1989, *Information processing systems - Data interchange on 90 mm (3,5 in) flexible disk cartridges using modified frequency modulation recording at 15 916 ftprad, on 80 tracks on each side*
– *Part 1: Dimensional, physical and magnetic characteristics.*

ISO/IEC 9529-2:1989, *Information processing systems - Data interchange on 90 mm (3,5 in) flexible disk cartridges using modified frequency modulation recording at 15 916 ftprad, on 80 tracks on each side*
– *Part 2: Track format.*

ISO/IEC 10089:1991, *Information technology - 130 mm rewritable optical disk cartridge for information interchange.*

ISO/IEC 10090:1992, *Information technology - 90 mm optical disk cartridges, rewritable and read only, for data interchange.*

ISO/IEC 10994:1992, *Information technology - 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.*

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ISO/IEC 11560:1992, *Information technology - Information interchange on 130 mm optical disk cartridges using the magneto-optical effect, for write once, read multiple functionality.*

ISO/IEC 13422:- [1], *Information technology - Data Interchange on 90 mm flexible disk cartridges 10 Mbytes capacity using sector servo tracking - ISO type 304.*

ISO/IEC 13481:1993, *Information technology - Data interchange on 130 mm optical disk cartridges - Capacity: 1 gigabyte per cartridge.*

ISO/IEC 13549:1993, *Information technology - Data interchange on 130 mm optical disk cartridges - Capacity: 1,3 gigabytes per cartridge.*

ISO/IEC 13842:- [1], *Information technology - 130 mm optical disk cartridges - Capacity: 2 Gbytes per cartridge - For information interchange.*

ISO/IEC 13963:1994, *Information technology - Data interchange on 90 mm optical disk cartridges - Capacity: 230 megabytes per cartridge.*

4 Definitions

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

4.1 byte : A string of binary digits operated upon as a unit. In this International 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 initiaally 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.

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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 International 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 $(x,y) = x - y \times \text{ip}(x/y)$

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.

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Section 2 - Requirements for the medium

6 Volume structure

6.1 Arrangement of data on an FDC

6.1.1 FDC parameters

For the purpose of this International 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

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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 International 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 *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:

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

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;

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– 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:

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

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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:

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

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:

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