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

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

Reference number
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Foreword

ISO (the International Organization for Standardization) is a worldwide federation of national standards bodies (ISO member bodies). The work of preparing International Standards is normally carried out through ISO technical committees. Each member body interested in a subject for which a technical committee has been established has the right to be represented on that committee. International organizations, governmental and non-governmental, in liaison with ISO, also take part in the work.

Draft International Standards adopted by the technical committees are circulated to the member bodies for approval before their acceptance as International Standards by the ISO Council. They are approved in accordance with ISO procedures requiring at least 75 % approval by the member bodies voting.

International Standard ISO 9293 was prepared by the European Computer Manufacturers Association (as Standard ECMA-107) and was adopted, under a special "fast-track" procedure, by Technical Committee ISO/TC 97, *Information processing systems*, in parallel with its approval by the ISO member bodies.

Users should note that all International Standards undergo revision from time to time and that any reference made herein to any other International Standard implies its latest edition, unless otherwise stated.

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

Section one : General

0 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 purpose 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 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 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 flexible 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.

— The interchange file will be especially for direct updating by interactive application.

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

These characteristics are advantageous for :

— interchange of sets of text files or of small files, or of multiple-part document files;

— 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.

1 Scope and field of application

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

This International Standard is applicable to various types of flexible 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 a flexible disk cartridge, and also specifies a set of recorded descriptors which identifies :

— the files which may be interchanged;

— the locations of the files;

— the attributes of the files;

— the location of unused space for recording on the FDC;

— the 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 flexible disk cartridges as the medium of interchange. For this purpose it specifies the functions within systems which are intended to originate or to receive flexible disk cartridges which conform to this International Standard.

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

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

2 Conformance

2.1 Conformance of a flexible disk cartridge

A flexible disk cartridge shall be in conformance with this International Standard when all information recorded on it conforms to the requirements of section 2 of this International Standard.

A prerequisite to such conformance is the conformance of the flexible disk cartridge to the appropriate International Standard for data interchange of flexible disk cartridges.

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 3 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.

3 References

ISO 646, *Information processing — ISO 7-bit coded character set for information interchange.*

ISO 7487, *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 1: Dimensional, physical and magnetic characteristics.*

— *Part 3: Track format B.*

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

ISO 8378, *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.*

— *Part 3: Track format B.*

ISO 8630, *Information processing — Data interchange on* 130 mm (5.25 in) *high density flexible cartridges using modified frequency modulation recording at* 13 262 ftprad, 3,8 tpmm (96 tpi), *on both sides*

— *Part 1: Dimensional, physical and magnetic characteristics.*[1)]

— *Part 3: Track format B for 80 tracks.*[1)]

ISO 8860, *Information processing — Data interchange on* 90 mm (3.5 in) *flexible disk cartridges using modified frequency modulation recording at* 7 958 ftprad, 5,3 tpmm (135 tpi), *on both sides*

— *Part 1: Dimensional, physical and magnetic characteristics.*

— *Part 2: Track format.*

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 a flexible disk cartridge.

4.4 defective sector: A sector which cannot be read or written without error.

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

4.6 file: A named collection of information.

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

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

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

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

1) At present at the stage of draft.

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

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

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

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

In addition the following definitions apply specifically to section four.

4.15 fixed-length record: A record contained in a file in which all records must have the same length.

4.16 record: Related data treated as a unit of information.

4.17 segment: A part of a record.

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

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

5 Notations

The following notations are used in this 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, $rem(x,y) = x - y \times ip(x/y)$

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 two: Requirements for the medium

6 Volume structure

6.1 Arrangement of data on a flexible disk cartridge

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

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

6.1.2 Physical Addresses

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

6.1.3 Logical Sector Number

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

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

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

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

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

6.1.4 System Area and Data Area

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

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

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

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

6.1.5 Parameters of the Volume Structure

This 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.

Table 2

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

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

6.2 Arrangement of the Data Area

6.2.1 Clusters

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

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

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

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

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

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

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

6.2.2.3 Defective Clusters

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

6.3 Arrangement of the System Area

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

6.3.1 FDC Descriptor and space for system use

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

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

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

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

6.3.2 File Allocation Table (FAT)

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

Each entry in the FAT shall indicate the status of the corresponding cluster. The FAT entries shall be used to identify the set of clusters that are allocated to each file. 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 and shall be as specified in annex A.

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

6.3.3 Root Directory

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

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

6.3.4 Size of the System Area

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

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

where

RSC is the number of sectors preceding the first FAT, i.e. the Reserved Sectors Count;

SF is the number of sectors in the FAT;

RDE is the number of Root Directory Entries;

SS is the number of bytes in the Data Field of a sector;

NOS is the number of sides available for recording;

SPT is the number of sectors per track.

6.4 Files

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

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

6.4.1 File Space

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

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

6.4.2 Relation to clusters

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

— The Cluster Number of the first cluster of the File Space shall be recorded in the Starting Cluster Number field of the Directory entry of the file.

— For each cluster of the File Space, except the last one, the corresponding FAT entry shall contain the Cluster Number of the next cluster of the File Space.

— For the last cluster of the File Space, the corresponding FAT entry shall contain an entry indicating that it is the last cluster of the file.

6.4.3 File length

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

the File Space then any remaining bytes in the File Space shall be ignored in interchange.

6.5 Sub-directories

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

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

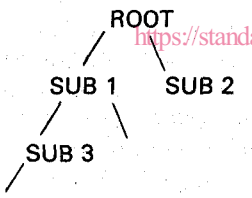
$$ip\left(\frac{1}{32}K \times SC \times SS\right)$$

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 Contents of a file

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

NOTE — 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 International 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 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 ISO 646 (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