

INTERNATIONAL STANDARD

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Information technology — Interchange on 300 mm optical disk cartridges of the write once, read multiple (WORM) type using the SSF method

*Technologies de l'information — Échange sur cartouches de disque
optique de 300 mm de diamètre du type écriture unique-lecture multiple
(WORM) utilisant la méthode SSF*



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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.

International Standard ISO/IEC 13614 was prepared by Joint Technical Committee ISO/IEC JTC 1, *Information technology*, Subcommittee SC 23, *Optical disk cartridges for information interchange*.

Annexes A to G and J form an integral part of this International Standard. Annexes H and K to M are for information only.

Information technology - Interchange on 300 mm optical disk cartridges of the write once, read multiple (WORM) type using the SSF method

Section 1: General

1 Scope

This International Standard specifies the characteristics of 300 mm optical disk cartridges (ODC) of the WORM type providing for embossed information and for data to be written once and read multiple times.

It specifies

- the conditions for conformance testing and the reference drive;
- the mechanical and physical characteristics of the cartridge, so as to provide mechanical interchangeability between data processing systems;
- the format of the information on the disk, both embossed and user-written;
- the characteristics of the embossed information on the disk;
- the optical characteristics of the disk, enabling processing systems to write data onto the disk;
- the minimum quality of user-written data on the disk, enabling data processing systems to read data from the disk.

Together with the standard for Volume and File Structure, this International Standard provides for full data interchange between data processing systems. Interchange involves the ability to write and read data without introducing any error.

2 Conformance

A 300 mm optical disk cartridge is in conformance with this International Standard if it meets all mandatory requirements specified herein.

A drive claiming conformance with this International Standard shall be able, in the operating environment, to write on any optical disk cartridge which is in conformance with this Standard and to read any such optical disk cartridge which has been written with any drive in conformance with this International Standard.

A drive shall not claim conformance if it cannot accept the full range of media conforming to the Standard.

3 Normative references

The following standards contain provisions, which in reference with this text, constitute provisions of this International Standard. At the time of publication, the editions indicated were 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 editions of the standards indicated below. Members of IEC and ISO maintain registers of currently valid International Standards.

IEC 950:1991, *Safety of information technology equipment, including electrical business equipment.*

IEC 721-3-3:1987, *Classification of environmental conditions. Part 3: Classification of groups of environmental parameters and their severities. Section 3: Stationary use at weatherprotected locations.*

4 Definitions

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

- 4.1 case :** The housing for an optical disk, that protects the disk and facilitates disk interchange.
- 4.2 clamping zone :** The annular part of the disk within which the clamping force is applied by the clamping device.
- 4.3 Control Track :** and format necessary for writing and reading the remaining tracks on the optical disk.
- 4.4 Cyclic Redundancy Check (CRC) :** A method for detecting errors in data.
- 4.5 defects management :** A method for handling defective areas on the disk.
- 4.6 Disk Reference Plane :** A plane defined by the perfectly flat annular surface of an ideal spindle on to which the clamping zone of the disk is clamped, and which is normal to the axis of rotation.
- 4.7 entrance surface :** The surface of the disk on to which the optical beam first impinges.
- 4.8 Error Correction Code (ECC) :** An error detecting code designed to correct certain kinds of errors in data.
- 4.9 format :** The arrangement or layout of information on the disk.
- 4.10 Frame :** The smallest addressable part of a track in the Information zone of a disk that can be accessed by the controller of the disk drive independently of other addressable parts of the zone.
- 4.11 holding feature :** The central feature on the disk which interacts with the spindle of the disk drive to provide the radial centring and the clamping force.

- 4.12 interleaving** : The process of allocating the physical sequence of units of data so as to render the data more immune to burst errors.
- 4.13 mark** : A feature of the recording layer which may take the form of a hole, a pit, a bubble or any other type of form that can be sensed by the optical system. The pattern of boundaries between marks and spaces represents the data on the disk.
- 4.14 optical disk** : A disk that will accept and retain information in the form of marks in a recording layer, that can be read with an optical beam.
- 4.15 optical disk cartridge** : A device consisting of a case containing an optical disk.
- 4.16 recording layer** : A layer of the disk on, or in, which data is written during manufacture and/or use.
- 4.17 Reed-Solomon code** : An error detection and/or correction code which is particularly suited to the correction of errors which occur in bursts or are strongly correlated.
- 4.18 sector** : The smallest addressable part of a track in the Information zone of a disk that can be accessed by the host computer independently of other addressable parts of the zone.
- 4.19 space** : A feature of the recording layer which takes no deformation by a hole, a pit, a bubble or any other type of form that can be sensed by the optical system. The pattern of boundaries between marks and spaces represents the data on the disk.
- 4.20 spindle** : The part of the disk drive which contacts the holding feature.
- 4.21 substrate** : A transparent layer of the disk, provided for mechanical support of the recording layer, through which the optical beam accesses the recording layer.
- 4.22 track** : The path which is to be followed by the focus of the optical beam during one revolution of the disk.
- 4.23 track pitch** : The distance between adjacent track centrelines, measured in a radial direction.
- 4.24 WORM disk** : An optical disk in which the data in specified areas can be written only once and read multiple times by an optical beam.
- 4.25 Zone** : An annular area of the disk.

5 Conventions

5.1 Representation of numbers

- A measured value is rounded off to the least significant digit of the corresponding specified value. It implies that a specified value of 1,26 with a positive tolerance of +0,01, and a negative tolerance of -0,02 allows a range of measured values from 1,235 to 1,275 but not including 1,275.
- Letters and digits in parentheses represent numbers in hexadecimal notation.
- The setting of a bit is denoted by ZERO or ONE.
- Numbers in binary notation and bit combinations are represented by strings of ZEROs and ONES.
- Numbers in binary notation and bit combinations are shown with the most significant bit to the left.
- Negative values of numbers in binary notation are given in TWO's complement.
- In each field the data is recorded so that the most significant byte (byte 0) is recorded first. Within each byte the least significant bit is numbered 0 and is recorded last, the most significant bit (numbered 7 in an 8-bit byte) is recorded first. This order of recording applies also to the data input of the Error Detection and Correction circuits and to their output.

5.2 Names

The names of entities, e.g. specific tracks, fields, etc, are given with a capital initial.

6 Acronyms

CRC	Cyclic Redundancy Check
ECC	Error Correcting Code
HCA	Hash Code replacement Algorithm
LPT	Laser Power Test field
ODC	Optical Disk Cartridge
PEP	Phase Encoded Part
PIB	Pre-formatted Information Bit
RLL	Run Length Limited (code)
SFP	Standard Format Part
SSF	Sample Servo Format (tracking method)
VFO	Voltage Frequency Oscillator
WORM	Write Once Read Multiple

7 General description of the optical disk cartridge

The optical disk cartridge which is the subject of this International Standard consists of a case containing an optical disk. An optical beam is used to write data to, or to read data from, the disk.

The case is a protective enclosure for the disk. It has access windows covered by a shutter. The windows are automatically uncovered by the drive when the cartridge is inserted into it.

The disk is described in clause 11.

8 General requirements

8.1 Environments

8.1.1 Testing environment

The test environment is defined as an environment where the air immediately surrounding the optical disk cartridge has the following properties:

temperature	: 23°C ± 2°C
relative humidity	: 45 % to 55 %
atmospheric pressure	: 75 kPa to 105 kPa
air cleanliness	: See annex L.

No condensation on or in the optical disk cartridge shall occur. Before testing the optical disk cartridge shall be conditioned in this environment for 24 h minimum. It is recommended that before testing the entrance surface of the optical disk shall be cleaned according to the instructions of the manufacturer of the disk.

8.1.2 Operating environment

This International Standard guarantees that an optical disk cartridge which meets all requirements of this Standard in the specified test environments provides data interchange over the specified ranges of environmental parameters in the operating environment.

The operating environment is defined as an environment where the air immediately surrounding the optical disk cartridge has the following properties:

temperature	: 10°C to 50°C
relative humidity	: 3 % to 80 %
absolute humidity	: 1g per m ³ to 25 g per m ³
atmospheric pressure	: 75 kPa to 105 kPa
temperature gradient	: 10°C per hour max.
temperature shock	: 20°C max.

relative humidity gradient : 10 % per hour max.

No condensation on or in the ODC shall occur. If an ODC has been exposed to conditions outside those specified in this clause, it shall be acclimatized in an allowed operating environment for at least 2 h before use. (See also annex K.)

Note: The range of operating environments is based on the assumption that the drive is in an office environment (see annex L) and that the temperature inside the drive can be up to 20°C higher than the temperature outside the drive. Under this condition a cartridge shall withstand the specified temperature shock when either loaded into or unloaded from the drive.

It is recommended that before testing the entrance surface of the optical disk shall be cleaned according to the instructions of the manufacturer of the disk.

8.1.3 Storage environment

The optical disk cartridge without any protective enclosure shall not be stored in an environment outside the range allowed for storage. The storage environment is defined as an environment where the air immediately surrounding the optical disk cartridge has the following properties:

temperature	: -10°C to 50°C
relative humidity	: 3 % to 90 %
absolute humidity	: 1g per m ³ to 25 g per m ³
atmospheric pressure	: 65 kPa to 105 kPa
temperature gradient	: 15°C per hour max.
relative humidity gradient	: 10 % per hour max.

No condensation on or in the optical disk cartridge shall occur.

8.1.4 Transportation

This standard does not specify requirements for transportation. Guidance for transportation is given in annex M.

8.2 Safety requirements

The cartridge shall satisfy the safety requirements of IEC 950, when used in the intended manner or in any foreseeable use in an information processing system.

8.3 Flammability

The cartridge and its components shall be made from materials that comply with the flammability class for HB materials, or better, as specified in IEC 950.

9 Reference drive

The Reference Drive is a drive of which several critical components have well defined properties, and which is used to test write and read parameters of the disk for conformance to this Standard. The critical components vary from test to test. This clause gives an outline of all components; components critical for tests in specific clauses only are specified in those clauses.

9.1 Optical system

The basic set-up of the optical system of the Reference Drive used for measuring the write and read parameters is shown in figure 1. Different components and locations of components are permitted, provided that the performance remains the same as that of the set-up in figure 1. The optical system shall be such that the detected light reflected from the entrance surface of the disk is minimized so as not to influence the accuracy of the measurements.

The quadrant photocell delivers four currents I_1, I_2, I_3 and I_4 . The contributions of diagonally arranged cells are added and respectively provide signals S_1 and S_2 . From S_1 and S_2 , two signals are derived : a sum signal S_+ and a difference signal S_- .

9.2 Optical beam

The focussed optical beam used for writing and reading data shall have the following properties:

- a) Wavelength (λ) $780\text{ nm} \begin{matrix} + 15\text{ nm} \\ - 10\text{ nm} \end{matrix}$
- b) Wavelength (λ) divided by the numerical aperture of the objective lens (NA) $\lambda/\text{NA} = 1,423\text{ }\mu\text{m} \pm 0,035\text{ }\mu\text{m}$
- c) Filling D/W of the aperture of the objective lens 1,0 max
- d) Variance of the wavefront of the optical beam near the recording layer $\lambda^2/180\text{ max}$
- e) The optical power and pulse width for writing and reading shall be as specified in 25.2.2, 25.3, 27.2.2 and 28.2.2
- f) Polarization circular.

D is the diameter of the lens aperture and W is the beam diameter of the Gaussian beam where the intensity is $1/e^2$ of the maximum intensity.

9.3 Read channels

A read channel shall be provided to generate signals from the marks in the recording layer. It shall be split into two sub-channels : Channel 1 for reading the embossed marks, Channel 2 for reading the user-written marks. The read amplifier after the photo-detectors in both channels shall have a flat response within ± 1 dB from 100 kHz to 23 MHz.

Sampling of signal S_+ with triggering signals C_d and C_{du} provides the data signals S_d and S_{du} .

9.4 Tracking

The tracking signals are the radial tracking signal S_t and the focusing signal S_f .

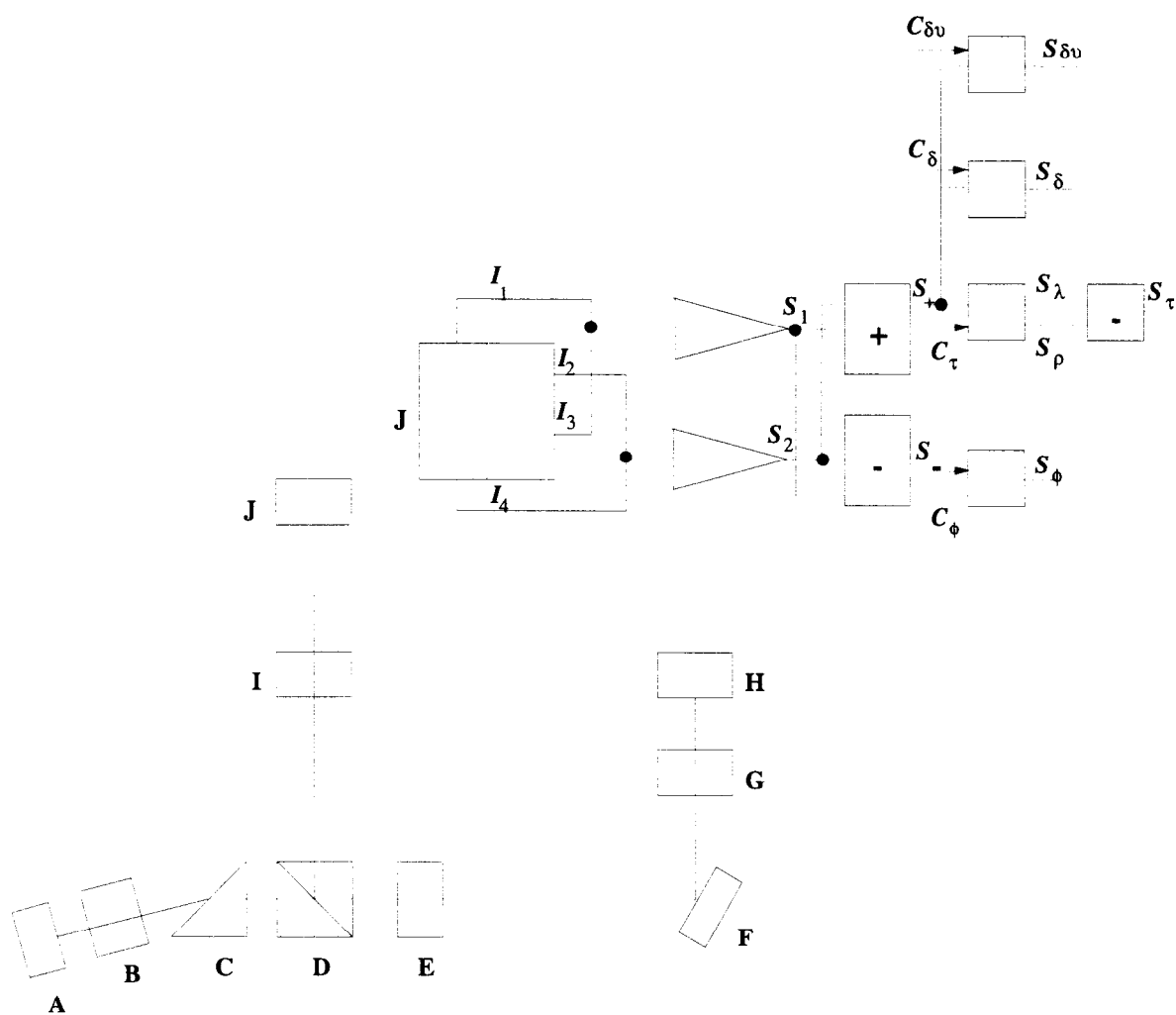
The focusing signal S_f is derived from signal S_- by sampling and holding it when the light spot scans a land part of the track as specified in clauses 15.1.1.2 and 15.1.3. This sampling is triggered by signal C_f .

The radial tracking signal S_t is derived from signal S_+ by sampling and holding it when the light spot scans the left and right laterally displaced features of the offset radial mark specified in clauses 15.1.1.2 and 15.1.3 (signals S_l and S_r). This sampling is triggered by signal C_t .

The requirements for the accuracy with which the focus of the optical beam must follow the tracks is specified in 20.2.4.

9.5 Rotation of the disk

The spindle shall position the disk as specified in 12.5. It shall rotate the disk at $25,0 \text{ Hz} \pm 0,25 \text{ Hz}$. The reference drive shall be able to rotate both directions. The direction of rotation is determined by the sensor hole that indicates side A or side B of the cartridge.



- | | | | |
|----------|--------------------------------|----------|-----------------------------------|
| A | Laser diode | F | Radial mirror |
| B | Collimator lens | G | Objective lens |
| C | Beam shaping prism | H | Optical disk |
| D | Polarizing beamsplitter | I | Cylindrical/spherical lens |
| E | Quarter-wave plate | J | Quadrant photocell |

Figure 1 - Optical system of the Reference Drive

Section 2: Mechanical and physical characteristics

10 Dimensional and physical characteristics of the case

10.1 General description of the case

The case is a rigid protective container (box) of rectangular shape (see figure 2). It includes a shutter which uncovers access windows upon insertion into the drive, and automatically covers them upon removal from the drive. The case shall have means for positioning and identifying the cartridge, and it has a (one) write-inhibit feature.

10.2 Reference planes of the case (see figure 2)

The dimensions of the case are referred to three orthogonal reference planes X, Y and Z. The case shall be constrained such that the four reference surfaces S_1 to S_4 on one side of the case lie in plane Z when measuring those dimensions of the case in clause 10.3 which are referenced to this plane. The intersection of the three planes defines the centre of the radius for the bottom corner of the triangular Location hole (see figure 3). The centres of the radii for the two bottom corners of the rectangular Alignment hole shall lie in X plane (see figure 3). A dimension of a feature referenced to one of the planes is the shortest distance from the feature to the plane.

10.3 Dimensions of the case

The dimensions of the case shall be measured in the test environment.

10.3.1 Overall dimensions (see figure 3)

The total length of the case shall be

$$l_1 = 340,0 \text{ mm} \pm 0,6 \text{ mm} \quad (\text{at testing environment}),$$

$$l_1 = 340,0 \text{ mm} \begin{array}{l} + 1,5 \text{ mm} \\ - 1,1 \text{ mm} \end{array} \quad (\text{at operating environment}).$$

The distance from the bottom of the case to reference plane X shall be

$$l_2 = 35,0 \text{ mm} \pm 0,3 \text{ mm}.$$

The distance from the top of the case to reference plane X shall be

$$l_3 = 305,0 \text{ mm} \pm 0,3 \text{ mm}.$$

The total width of the case shall be

$$l_4 = 320,0 \text{ mm} \pm 0,6 \text{ mm} \quad (\text{at testing environment})$$

$$l_4 = 320,0 \text{ mm} \begin{array}{l} + 1,5 \text{ mm} \\ - 1,1 \text{ mm} \end{array} \quad (\text{at operating environment});$$

The distance from the left hand side of the case to reference plane Y shall be

$$l_5 = 300,0 \text{ mm} \begin{array}{l} + 0,0 \text{ mm} \\ - 0,5 \text{ mm} \end{array}$$

The distance from the right hand side of the case to reference plane Y shall be

$$l_6 = 20 \text{ mm} \pm 0,2 \text{ mm}.$$

The four corners shall be rounded with a radius

$$r_1 = 5 \text{ mm} \pm 1,0 \text{ mm}.$$

The thickness of the case shall be

$$l_7 = 17,0 \text{ mm} \pm 0,4 \text{ mm} \quad (\text{at testing environment})$$

$$l_7 = 17,0 \text{ mm} \pm 0,8 \text{ mm} \quad (\text{at operating environment}).$$

The eight long edges of the case shall be rounded with a radius

$$r_2 = 0,5 \text{ mm max.}$$

10.3.2 Location hole (see figure 3)

The Location hole shall have a rounded triangular shape. The corners shall be rounded with a radius

$$r_3 = 5,0 \text{ mm} \pm 0,1 \text{ mm}.$$

The centre of the of the bottom shall be the point of the intersection of planes X, Y and Z. The angle of this corner shall be

$$\theta_1 = 30^\circ \pm 1^\circ \text{ divided symmetrically by plane Y.}$$

The length of this hole shall be

$$l_8 = 18,0 \text{ mm} \begin{array}{l} + 0,3 \text{ mm} \\ - 0,1 \text{ mm} \end{array}$$

The Location hole shall be held to a depth

$$l_9 = 1,5 \text{ mm min.}$$

Below l_9 the Location hole shall extend to

$$l_{10} = 8 \text{ mm min}$$

with an area equal to, or greater than the Location hole.

The Location hole shall not extend through Side B.

The lead-in edges shall be rounded with a radius

$$r_4 = 0,5 \text{ mm max.}$$

10.3.3 Alignment hole (see figure 3)

The Alignment hole shall have a rounded rectangular shape. The vertical centre line of the hole shall lie

$$l_{11} = 280,0 \text{ mm} \pm 0,2 \text{ mm}$$

from reference plane Y.

Its dimensions shall be

$$l_{12} = 18,0 \text{ mm} \begin{array}{l} + 0,3 \text{ mm} \\ - 0,1 \text{ mm} \end{array}$$

$$l_{13} = 14,0 \text{ mm} \pm 0,5 \text{ mm.}$$

The corners shall be rounded with a radius

$$r_5 = 5,0 \text{ mm} \pm 0,5 \text{ mm.}$$

The centres of the radii for the bottom corners shall lie in plane X. The Alignment hole shall be held to a depth l_9 below which the Alignment hole shall extend to L_{10} with dimensions equal to, or greater than, l_{12} and l_{13} respectively.

The Alignment hole shall not extend through side B.

The lead-in edges shall be rounded with a radius r_4 .

10.3.4 Reference surfaces (see figure 4)

Each side of the case shall contain four reference surfaces S_1 , S_2 , S_3 and S_4 .

Surfaces S_1 and S_2 shall be circular with a diameter

$$d_1 = 24,0 \text{ mm min.}$$

The centre of S_1 shall be located on the plane Y and

$$l_{14} = 4,0 \text{ mm} \pm 0,2 \text{ mm}$$

above plane X.

The centre of S_2 shall be centred at

$$l_{15} = 280,0 \text{ mm} \pm 0,3 \text{ mm}$$

from plane Y and

$$l_{16} = 4,0 \text{ mm} \pm 0,2 \text{ mm}$$

above plane X.

Surfaces S_3 and S_4 shall be circular with a diameter

$$d_2 = 16,0 \text{ mm min}$$

with their centres located at

$$l_{17} = 255,0 \text{ mm} \pm 0,3 \text{ mm}$$

from plane X and

$$l_{18} = 5,0 \text{ mm} \pm 0,2 \text{ mm}$$

$$l_{19} = 270,0 \text{ mm} \pm 0,3 \text{ mm}$$

from plane Y respectively.

All of the reference surfaces S_1 , S_2 , S_3 and S_4 shall be recessed from a case surface with a depth

$$l_{20} = (5,2 - t)/2$$

where t is the enveloped disk thickness.

10.3.5 Detents (see figure 5)

The case shall have four symmetrical detent slots intended for positioning or autoloading the cartridge.

The centres of the two upper slots shall be located at a distance

$$l_{21} = 60 \text{ mm} \pm 0,3 \text{ mm}$$

from the top of the case and the centres of the two lower slots shall be located at a distance l_{21} from the bottom of the case.

Each slot shall have a triangular shape with a width of

$$l_{22} = 8,0 \text{ mm} \pm 0,1 \text{ mm}$$

and an opening angle

$$\alpha = 90^\circ \pm 1^\circ.$$

The root of each slot shall be rounded with a radius

$$r_6 = 3,0 \text{ mm max.}$$

The corners of each slot shall be rounded with a radius

$$r_7 = 1,0 \text{ mm max.}$$

The slots shall not extend through the full thickness of the case. When viewed from the A side, the right slots shall be constrained to side A and the left slots shall be constrained to side B.

10.3.6 Write-inhibit feature (see figure 6)

The case shall have a (one) common write-inhibit feature for both sides A and B. The centre of the write-inhibit feature is located on plane X and

$$l_{23} = 20,0 \text{ mm} \pm 0,1 \text{ mm}$$

from plane Y. Opening of the feature shall be square with the dimension specified by

$$l_{24} = 8,0 \text{ mm} \pm 0,2 \text{ mm}.$$

The closed condition of the opening shall define the write enabled condition ; the opened condition of the opening shall define the write inhibited condition. The surface of the movable piece of the feature shall be at the position

$$l_{25} = 0,5 \text{ mm max.}$$

when in closed position.

The four corners of the opening shall be rounded with a radius

$$r_8 = 0,5 \text{ mm max.}$$

10.3.7 Head and spindle access windows (see figure 7)

Each side of the case shall have a window to enable the spindle and the optical head of the drive to access the disk. The dimensions of each head access and spindle access windows are referenced to a centre line, located at a distance

$$l_{26} = 140,0 \text{ mm} \pm 0,2 \text{ mm}$$

from plane Y.

The width of the window shall be given by

$$l_{27} = 35,0 \text{ mm min.}$$

The bottom of the window shall be at a distance

$$l_{28} = 167,0 \text{ mm max}$$

from plane X.

The centre of the spindle access circular window shall be defined by l_{29}

$$l_{29} = 122,0 \text{ mm} \pm 0,2 \text{ mm}$$

from plane X, and a diameter of the circular window shall be

$$d_3 = 80,0 \text{ mm min.}$$

The top of the head access window shall be located at a distance

$$l_{30} = 289,0 \text{ mm min}$$

from plane X.

The corners of the window shall be rounded with a radius

$$r_9 = 5,0 \text{ mm max.}$$

10.3.8 Shutter, shutter openers and mis-insert protection feature (see figure 8)

The case shall contain a shutter, a side shutter opener feature and a front shutter opener feature.

10.3.8.1 Shutter

The cartridge case shall have a spring-loaded shutter, that shall completely cover the head and spindle access windows when closed. When opened, the shutter shall expose the windows up to at least the minimum size for the circle specified in 10.3.7. The drive shall use either the side shutter opener feature, or the front shutter opener feature to open the shutter.

10.3.8.2 Side shutter opener feature

The side shutter opener feature shall be provided in the right side loading groove viewing from side A. The movement of the shutter shall be controlled with the movement of the movable piece in the loading groove. The surface of the movable piece shall be recessed

$$l_{31} = 0,3 \text{ mm max.}$$

from the bottom of the loading groove. The width of the opening for the movable piece shall be

$$l_{32} = 5,0 \text{ mm} \pm 0,2 \text{ mm.}$$

The dimension of the leading groove at the corner of the case shall be

$$l_{33} = 5,0 \text{ mm} \pm 0,2 \text{ mm}$$

$$l_{34} = 9,0 \text{ mm} \begin{array}{l} + 1,00 \text{ mm} \\ - 0,00 \text{ mm} \end{array}$$

The position of the movable piece in the shutter opening mechanism, when the shutter is completely open, shall not exceed

$$l_{35} = 110,0 \text{ mm min.}$$

The shutter opening stroke of the movable piece shall be completed at the position of

$$l_{36} = 108 \text{ mm max.}$$

from the top of the case. At the bottom of left side groove, a trench shall be provided for the escapement of the shutter opening provision in a drive. The width, depth and length of the trench shall be defined by l_{32} , l_{34} and l_{35} respectively.

10.3.8.3 Front shutter opener feature

The front shutter opener feature is a notch located at the front of the shutter. The notch shall be located at a distance

$$l_{37} = 108,0 \text{ mm} \pm 0,4 \text{ mm}$$

from plane Y, and

$$l_{38} = 5,7 \text{ mm} \pm 0,2 \text{ mm}$$

from plane Z. The dimensions of the notch shall be

$$l_{39} = 19,0 \text{ mm} \begin{array}{l} + 0,4 \text{ mm} \\ - 0,0 \text{ mm} \end{array}$$

in length

$$l_{40} = 5,6 \text{ mm} \begin{array}{l} + 0,3 \text{ mm} \\ - 0,0 \text{ mm} \end{array}$$

in width and

$$l_{41} = 6,0 \text{ mm} \begin{array}{l} + 0,3 \text{ mm} \\ - 0,0 \text{ mm} \end{array}$$

in depth.

10.3.8.4 Mis-insert protection feature

The mis-insert protection feature shall be provided in both loading grooves.

10.3.9 Loading grooves (see figure 9)

Both sides of the case shall contain grooves for loading, and mis-insert protection feature to prevent the cartridge from being inserted improperly.

The case shall have loading grooves in both sides, the cross sectional dimensions are specified by

$$l_{42} = 4,0 \text{ mm} \pm 0,1 \text{ mm}$$

$$l_{43} = 1,0 \text{ mm} \pm 0,1 \text{ mm}$$

$$l_{44} = 4,0 \text{ mm min}$$

$$l_{45} = 9,0 \text{ mm min.}$$

10.3.10 Sensor holes (see figure 10)

The case shall have two sets of three media sensor holes to identify the following conditions:

LOCATION		OPEN	CLOSED
OUTER	SIDE A / SIDE B	A	B
CENTRE	REFLECTANCE	7% - 23%	15% - 50%
INNER	SPARE	---	---

The set of holes at the lower left hand corner of side A of the case pertains to side A of the disk. The holes shall extend through the case, and have a diameter of

$$d_4 = 8,0 \text{ mm} \pm 0,1 \text{ mm}.$$

The positions of their centres shall be specified by

$$l_{46} = 20,0 \text{ mm} \pm 0,2 \text{ mm}$$

from plane X and

$$l_{47} = 5,0 \text{ mm} \pm 0,2 \text{ mm}$$

$$l_{48} = 20,0 \text{ mm} \pm 0,2 \text{ mm}$$

$$l_{49} = 35,0 \text{ mm} \pm 0,2 \text{ mm}$$

$$l_{50} = 275,0 \text{ mm} \pm 0,3 \text{ mm}$$

$$l_{51} = 260,0 \text{ mm} \pm 0,3 \text{ mm}$$

$$l_{52} = 245,0 \text{ mm} \pm 0,3 \text{ mm}$$

from plane Y.

10.3.11 Gripper features (see figure 11)

The case shall have two separate gripper features intended for autoloading. These features are described in 10.3.11.1 and 10.3.11.2.

10.3.11.1 Gripper slots

The case shall have four symmetrical gripper slots. The slots shall have a depth of

$$l_{53} = 14,0 \text{ mm} \pm 0,3 \text{ mm}$$

from the edge of the case and a width of

The lower edge of a slot shall be

$$l_{55} = 12,0 \text{ mm} \pm 0,3 \text{ mm}$$

above the bottom of the case. The lower edge of the slots is recessed by

$$l_{56} = 6,0 \text{ mm} \pm 0,3 \text{ mm}$$

from the side surfaces of the case.

The top outer corner of each slot shall be rounded with a radius

$$r_{10} = 3,0 \text{ mm max.}$$

The inner corners and lower outer corner of each slot shall be rounded with a radius

$$r_{11} = 1,0 \text{ mm max.}$$

10.3.11.2 Gripper holes

The case shall have two symmetrical gripper holes. The centre of each hole shall be located at a distance

$$l_{57} = 75,0 \text{ mm} \pm 0,3 \text{ mm}$$

from each side of the case, and shall be located at a distance

$$l_{58} = 14,0 \text{ mm} \pm 0,3 \text{ mm}$$

from the bottom of the case.

Each hole is defined by a rectangular shape having a width of

$$l_{59} = 12,0 \text{ mm} \pm 0,3 \text{ mm}$$

and a length of

$$l_{60} = 10,0 \text{ mm} \pm 0,3 \text{ mm.}$$

The corners of each hole shall be rounded with a radius

$$l_{12} = 3,0 \text{ mm max.}$$

Each hole shall extend through the thickness of the case.

The opening of each gripper hole from the surface of the case shall extend

$$l_{61} = 7,0 \text{ mm} \pm 0,2 \text{ mm}$$

into the thickness of the case.

The opening shall have a width of

$$l_{62} = 19,0 \text{ mm} \pm 0,3 \text{ mm}$$

and a length of

$$l_{63} = 16,0 \text{ mm} \pm 0,3 \text{ mm}$$

extending from the top edge of a hole.

The top corners of the opening shall be rounded with a radius

$$r_{13} = 3,0 \text{ mm max.}$$

The bottom corners of the opening shall be rounded with a radius

$$r_{14} = 1,0 \text{ mm max.}$$

All edges of the holes and extensions shall be rounded with a radius:

$$r_{15} = 0,5 \text{ mm max.}$$

10.3.12 Label area (see figure 12)

The case shall have the following minimum areas for user labels:

- on side A and side B : 69,0 mm x 206,0 mm,
- on the bottom side : 10,0 mm x 250,0 mm.

These areas shall be recessed by 0,2 mm min. Their positions are specified by the following dimensions and relations between dimensions (see figure 12):

$$l_{64} = 64,0 \text{ mm max}$$

$$l_{65} - l_{64} = 206,0 \text{ mm max}$$

$$l_{66} = 187,0 \text{ mm max}$$

$$l_{67} - l_{66} = 69,0 \text{ mm max}$$

$$l_4 - 2 \times l_{68} = 250,0 \text{ mm max}$$

$$l_7 - 2 \times l_{69} = 9,0 \text{ mm max.}$$

All corners of the Label areas shall be rounded with a radius

$$r_{16} = 3,0 \text{ mm max.}$$

10.4 Mechanical characteristics

10.4.1 Material

The case shall be constructed from any suitable materials such that it meets the requirements of this International Standard. The dimensions of the case in an operating environment can be estimated from the dimensions in 10.3.

10.4.2 Mass

The mass of the case without the optical disk shall not exceed 850 g.

10.4.3 Distortion

The cartridge shall meet the requirement of the distortion test defined in annex A. The requirement guarantees that a cartridge can be inserted into the slot of a drive.

10.4.4 Compliance

The cartridge shall meet the requirement of the compliance (flexibility) test defined in annex B. The requirement guarantees that a cartridge can be constrained in the proper plane of operation within the drive.

10.4.5 Shutter opening force

The spring force on the shutter shall be such that the force required to open the shutter does not exceed 5 N. It shall be sufficiently strong to close a free-sliding shutter, irrespective of the orientation of the case.

11 Dimensional, mechanical and physical characteristics of the disk

11.1 General description of the disk

The disk includes two facing circular substrates with some additional mechanical features joining the substrates. A recording layer shall be coated on one (single sided) or both (double sided) inner surfaces (see figure 13). The information zone of the substrate is transparent to allow an optical beam to focus on the recording layer through the substrate. Pre-formatted information is included in the recording layer to allow the optical beam to follow a spiral track through the information zone. In the case of a double sided media, one side shall have a reverse spiral direction from the other. For single sided media, either spiral direction is allowed. The centre zone of the substrates provides the interface with the spindle of the drive. This interface provides the radial centring, axial positioning and clamping area of the disk.

11.2 Reference axis and plane of the disk

The dimensions of the disk are referred to a reference axis A and a reference plane P. P is defined by the perfectly flat annular surface of an ideal spindle onto which the clamping zone of the disk is clamped, and which is normal to the axis of rotation of this spindle. Axis A passes through the centre of the centre hole of the holding feature, and is normal to plane P.

11.3 Dimensions of the disk

The outer diameter of the disk shall be

$$300,0 \text{ mm} \begin{array}{l} + 0,5 \text{ mm} \\ - 0,0 \text{ mm} \end{array}$$

The disk is divided into five annular zones, which are, from the centre to the outer edge, Centre Zone, Clamping Zone, Transition Zone, Information Zone and Rim Zone.

The nominal value of the thickness of the disk except in the Centre Zone shall be in the range of

$$2,4 \text{ mm to } 5,2 \text{ mm}.$$

The tolerances for each nominal value of the thickness shall be within $\pm 0,2 \text{ mm}$.

The centres of all radii in 11.3 lie on axis A.

The positions of the top and bottom surfaces of the disk include changes due to the axial deflection of the disk and variations in the overall thickness of the disk, caused by e.g. the protective layer and/or adhesive labels.

The dimensions of the disk shall be measured in the testing environment.

11.3.1 Centre Zone (see figure 13)

The centre hole shall have a diameter

$$d_5 = 35,0 \text{ mm} \begin{array}{l} + 0,1 \text{ mm} \\ - 0,0 \text{ mm} \end{array}$$

The Centre Zone shall extend from the centre of the disk to

$$r_{17} = 30,0 \text{ mm} \pm 0,2 \text{ mm}.$$

11.3.2 Clamping Zone (see figure 13)

The Clamping Zone shall extend from r_{17} to

$$r_{18} = 38,0 \text{ mm} \pm 0,2 \text{ mm}.$$

11.3.3 Transition Zone

The Transition Zone shall extend from r_{18} to

$$r_{19} = 64,0 \text{ mm} \pm 0,1 \text{ mm}.$$

11.3.4 Information Zone

The Information Zone shall extend from r_{19} to

$$r_{20} = 142,0 \text{ mm} \pm 0,1 \text{ mm}.$$

11.3.5 Rim Zone

The Rim Zone shall extend from r_{20} to media edge.

11.4 Mechanical characteristics

All requirements in this clause must be met in the operating environment.

11.4.1 Material

The disk shall be made from any suitable materials such that it meets the requirements of this International Standard. The only material properties specified by this Standard are the properties of the substrate in the Information zone. The dimensions of the disk in an operating environment can be estimated from the dimensions in 11.3.

11.4.2 Mass

The mass of the disk shall be 600 g max.

11.4.3 Moment of inertia

The moment of inertia of the disk relative to axis A shall be $6,0 \text{ g.m}^2$ max.

11.4.4 Imbalance

The imbalance of the disk relative to axis A shall not exceed 0,08 g.m.

11.4.5 Axial deflection

The axial deflection of the disk in the Information Zone is measured as the axial deviation of the recording layer, as seen by the optical head of the Reference Drive (see clause 9). Thus it comprises the tolerances on the thickness of the substrate, on its index of refraction and the deviation of the entrance surface from plane P. The nominal position of the recording layer with respect to reference plane P is determined by the nominal thickness of the substrate.

The deflection of any point of the recording layer in the information zone from its nominal position, in a direction normal to plane P, shall not exceed 0,5 mm for rotational frequencies of the disk up to 25,0 Hz.

11.4.6 Axial acceleration

The maximum allowed axial error $e_{\max}$ (see annex C) shall not exceed $\pm 1,0 \mu\text{m}$, measured using the Reference Servo for axial tracking of the recording layer. The rotational frequency of the disk shall be $25,0 \text{ Hz} \pm 0,25 \text{ Hz}$. The stationary part of the motor is assumed to be motionless (no external disturbances). The measurement shall be made using a servo with the transfer function

$$\mathcal{H}_\sigma = \frac{1}{c} \left(\frac{\omega_o}{i\omega} \right)^2 \frac{1 + i c \omega / \omega_o}{1 + i \omega / c \omega_o}$$

where $i = \sqrt{-1}$, $\omega = 2\pi f$, $\omega_o = 2\pi f_o$ and $c = 3$

or any other servo with $|1+H|$ within 20 % of $|1+H_s|$ in the bandwidth of 25 Hz to 1,5 kHz. Thus, the disk shall not require an acceleration of more than 35 m/s^2 at the frequencies lower than 1,5 kHz from the servo motor of the Reference Servo.

11.4.7 Radial runout

The radial runout of the tracks in the recording layer in the Information zone is measured as seen by the optical head of the Reference Drive (see clause 9). Thus it includes the distance between the axis of rotation of the spindle and reference axis A, the tolerances on the dimensions between axis A and the location of the track, and effects of non-uniformities in the index of refraction.

The runout, defined as the difference between the maximum and minimum distance of the centre of any track from the axis of rotation, measured along a fixed radial line over one revolution of the disk, shall not exceed $90 \mu\text{m}$ at a rotational frequency of the disk of $25,0 \text{ Hz} \pm 0,25 \text{ Hz}$.

11.4.8 Radial acceleration

The maximum allowed radial error $e_{\max}$ (see Annex C) shall not exceed $\pm 0,10 \mu\text{m}$, measured using the Reference Servo for radial tracking of tracks. The rotational frequency of the disk shall be $25,0 \text{ Hz} \pm 0,25 \text{ Hz}$. The stationary part of the motor is assumed to be motionless (no external disturbances). The measurement shall be made using a servo with the transfer function

$$H_{\sigma} = \frac{1}{c} \left(\frac{\omega_o}{i\omega} \right)^2 \frac{1 + i c \omega / \omega_o}{1 + i \omega / c \omega_o}$$

where $i = \sqrt{-1}$, $\omega = 2\pi f$, $\omega_o = 2\pi f_o$ and $c = 3$

or any other servo with $|1+H|$ within 20 % of $|1+H_s|$ in the bandwidth of 25 Hz to 1,5 kHz. Thus, the disk shall not require an acceleration of more than 10 m/s^2 at the frequencies lower than 1,5 kHz from the servo motor of the Reference Servo.

11.4.9 Tilt

Tilt is the angle which the normal to the entrance surface, averaged over an area of 1 mm diameter, makes with the normal to plane P. It shall not exceed 5 mrad in the Information Zone.

11.5 Optical characteristics

11.5.1 Index of refraction

The index of refraction of the substrate in the Information Zone shall be within the range from 1,46 to 1,60.

11.5.2 Thickness of the substrate

The thickness of the substrate, from the entrance surface to the recording layer, in the Information Zone shall be

$$0,5903 \times \frac{n^3}{n^2 - 1} \times \frac{n^2 + 0,6250}{n^2 + 0,5929} \text{ mm} \pm 0,050 \text{ mm}$$

where n is the index of refraction.

11.5.3 Birefringence

The birefringence of double-pass shall not exceed 100 nm.

11.5.4 Reflectance

The double-pass optical transmission of the substrate and the reflectance of the recording layer are measured together as the reflectance r of the disk. The measurement excludes the reflection of the entrance surface.

The value of r at the standard wavelength specified in 9.2 shall lie within the range from 0,07 to 0,50 for all types of disks.

The nominal value of r shall be specified in byte 3 of the PEP control data (see annex F).

The actual value r_m shall be measured with the focussed beam and wavelength of the Reference Drive (see clause 9). It shall be measured in any unrecorded, ungrooved area.

At any point within the Information Zone the value r_m shall be within $\pm 12\%$ of the value of r .

12 Interface between cartridge and drive

12.1 Clamping method

When the cartridge is inserted into the drive, the shutter of the case is opened and the drive spindle engages the disk. The disk is held against the spindle by an axial clamping force. The radial positioning of the disk is provided by the centring of the axle of the spindle in the centre hole. The turntable of the spindle shall support the disk in its clamping zone, determining the axial position of the disk.

12.2 Hub (see figure 13)

The disk shall have a hub as a clamping feature having the centre hole of diameter d_5 . The diameter of the hub shall be

$$d_6 = 55,0 \text{ mm} \pm 0,2 \text{ mm}$$

and shall protrude

$$l_{70} = 2,5 \text{ mm} \pm 0,1 \text{ mm}$$

from the disk surface. The outer edge of the hub shall be rounded with a radius

$$r_{21} = 0,2 \text{ mm max.}$$

The material of the hub shall be a magnetizable material and the hub shall have twelve holes of diameter

$$d_7 = 4,0 \text{ mm} \pm 0,1 \text{ mm.}$$

The holes shall be arranged along the circle of radius

$$d_8 = 43,0 \text{ mm} \pm 0,1 \text{ mm.}$$

The depth of the holes shall be

$$l_{71} = 2,0 \text{ mm min.}$$

The leading edge of the centre hole shall have the chamfer with an angle of

$$\theta_3 = 15^\circ \pm 0,2^\circ$$

to the direction of the axis A, and the depth of the leading edge of the centre hole shall be

$$l_{72} = 1,5 \text{ mm} \pm 0,1 \text{ mm.}$$

12.3 Clamping force

The clamping force shall not exceed 22 N and the clamping device shall meet the requirements in annex J.

12.4 Capture cylinder (see figure 14)

The capture cylinder is defined as the volume in which the spindle can expect the centre of the hole in the hub to be, just prior to capture, and with the cartridge constrained as in 10.4.4. The centre of the hole is defined as the point on axis A at a distance l_{72} from the plane defined by the hub surface (see 11.3.1 and figure 13).

The size of the cylinder defines the permissible play of the disk inside its cavity in the case. The cylinder is referred to perfectly sized alignment and location pins in the drive; it includes the tolerances of those dimensions of the case and the disk which are between the two pins mentioned and the centre of the hub.

The bottom of the cylinder is parallel to the plane Z, and shall be located a distance

$$l_{73} = 0,5 \text{ mm min}$$

above plane Z. The top of the cylinder shall be

$$l_{74} = 5,9 \text{ mm max}$$

above plane Z. The radius of the cylinder shall be

$$d_9 = 4,8 \text{ mm max.}$$