

Implementation of
ISO/IEC 13549:1993

**Information
technology —
Data interchange
on 130 mm optical disk
cartridges —
Capacity: 1,3 gigabytes
per cartridge**

UDC 681.327.68

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- British Computer Society
- ICI Imagedata
- Institute of Quality Assurance
- Institution of Electrical Engineers
- International Computers Limited
- Kodak Limited

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National foreword

This British Standard reproduces verbatim ISO/IEC 13549:1993 and implements it as the UK national standard.

This British Standard is published under the direction of the Information Systems Technology Standards Policy Committee whose Technical Committee IST/4 has the responsibility to:

- aid enquirers to understand the text;
- present to the responsible international committee any enquiries on interpretation, or proposals for change, and keep UK interests informed;
- monitor related international and European developments and promulgate them in the UK.

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Summary of pages

This document comprises a front cover, an inside front cover, pages i and ii, the ISO/IEC title page, pages ii to viii, pages 1 to 89 and a back cover.

This standard has been updated (see copyright date) and may have had amendments incorporated. This will be indicated in the amendment table on the inside front cover.

**Information technology — Data
interchange on 130 mm optical disk
cartridges — Capacity: 1,3 gigabytes per
cartridge**

*Technologies de l'information — Échange de données sur cartouches de
disque optique de diamètre 130 mm — Capacité: 1,3 gigabyte par
cartouche*



Reference number
ISO/IEC 13549:1993(E)

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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 of an International Standard requires approval by at least 75 % of the national bodies casting a vote.

International Standard ISO/IEC 13549 was prepared by the European Computer Manufacturers Association (as Standard ECMA-184) 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.

Annex A to Annex F form an integral part of this International Standard, Annex G to Annex P are for information only.

Patents

During the preparation of the ECMA standard, information was gathered on patents upon which application of the standard might depend. Relevant patents were identified as belonging to IBM and the Sony Corporation. However, neither ECMA nor ISO/IEC can give authoritative or comprehensive information about evidence, validity or scope of patent and like rights. The patent holders have stated that licences will be granted under reasonable and non-discriminatory terms. Communications on this subject should be addressed to

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Section 1. General

Introduction

This International Standard specifies the characteristics of 130 mm Optical Disk Cartridges (ODC) with a capacity of 1,3 Gbytes per cartridge. This International Standard is the first of a series of International Standards for ODCs of different capacities, based on the optical disk cartridge specified in ISO/IEC 10089. Whilst the latter specifies a fully re-writable disk, this International Standard specifies four related, but different implementations of such cartridges, viz.

- | | |
|-------------------|--|
| Type R/W | Provides for data to be written, read, and erased many times over the whole of both recording surfaces of the disk using the thermo-magnetic and magneto-optical effects. |
| Type P-ROM | Provides for a part of both disk surfaces to be pre-recorded and reproduced by stamping or other means. This part of the disk is read without recourse to the magneto-optical effect. All parts which are not pre-recorded, provide for data to meet the requirements of Type R/W. |
| Type O-ROM | Provides for the whole of both disk surfaces to be pre-recorded and reproduced by stamping or other means. This type of disk is read without recourse to the magneto-optical effect. |
| Type WO | Provides write once, read multiple functionality on the whole of both disk surfaces using the thermo-magnetic and magneto-optical effects. |

1 Scope

This International Standard specifies

- the conditions for conformance testing;
- the environments in which the cartridges are to be operated and stored;
- the mechanical, physical and dimensional characteristics of the case and of the cartridges, so as to provide mechanical interchangeability between the data processing systems;
- the format of the information on the disk, both embossed and user-written, including the physical disposition of the tracks and sectors, the error correction codes, and the modulation method used;
- the characteristics of the embossed information on the disk;
- the magneto-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.

This International Standard provides for interchange between optical disk drives. Together with a standard for volume and file structure, it provides for full data interchange between data processing systems.

2 Conformance

2.1 Optical disk cartridge (ODC)

An optical disk cartridge claiming conformance with this International Standard shall specify its Type. It shall be in conformance if it meets all mandatory requirements specified herein for that Type.

2.2 Generating system

A claim of conformance with this International Standard shall specify which Type(s) is (are) supported. A system generating an ODC for interchange shall be entitled to claim conformance with this International Standard if it meets the mandatory requirements of this Standard for the Type(s) specified.

2.3 Receiving system

A claim of conformance with this International Standard shall specify which Type(s) is (are) supported. A system receiving an ODC for interchange shall be entitled to claim conformance with this International Standard if it is able to handle any ODC which conforms to this International Standard for the Type(s) specified.

3 Normative reference

The following standard contains 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 editions of the standard listed below.

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

4 Definitions

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

4.1

band

a part of the Data Zone comprising a fixed number of consecutive physical tracks with data embossed or recorded at a constant frequency

4.2

case

the housing for an optical disk, that protects the disk and facilitates disk interchange

4.3

channel bit

the smallest element of data on a disk. It is recorded as either a space or a mark. Two channel bits are used to represent one user bit

4.4

clamping zone

the annular part of the disk within which the clamping force is applied by the clamping device

4.5

control track

a track containing the information on media parameters and format necessary for writing, reading and erasing the remaining tracks on the optical disk

4.6

cyclic redundancy check (CRC)

a method for detecting errors in data

4.7

defect management

a method for handling the defective areas on the disk

4.8

disk reference plane

a plane 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

4.9

entrance surface

the surface of the disk on to which the optical beam first impinges

4.10

error correction code (ECC)

an error-detecting code designed to correct certain kinds of errors in data

4.11

format

the arrangement or layout of the data on the disk

4.12**fully embossed disk**

an optical disk cartridge in which all data fields in the Data Zone are embossed

4.13**fully rewritable disk**

an optical disk cartridge in which the data in specified areas can be rewritten by an optical beam

4.14**hub**

the central feature on the disk which interacts with the spindle of the disk drive to provide radial centring and the clamping force

4.15**interleaving**

the process of allocating the physical sequence of units of data so as to render the data more immune to burst errors

4.16**kerr rotation**

the rotation of the plane of polarization of an optical beam upon reflection from the recording layer as caused by the magneto-optical Kerr effect

4.17**land and groove**

a trench-like feature of the disk, applied before the recording of any information, and used to define the track location. The groove is located nearer to the entrance surface than the land with which it is paired to form a track

4.18**logical track**

either 31 consecutive sectors for disks with 512-byte sectors or 17 consecutive sectors for disks with 1 024-byte sectors. The first sector of each logical track is assigned Sector Number 0

4.19**logical ZCAV**

a disk format requiring Zoned Constant Angular Velocity operation and with tracks in the Data Zone all being logical tracks

4.20**mark**

a feature of the recording layer which may take the form of a magnetic domain, a pit, or any other type or form that can be sensed by the optical system. The pattern of marks represents the data on the disk

4.21**ODC with write once, read multiple functionality**

an optical disk cartridge which can be initialized only once and the data in specified areas can be written only once after initialization

4.22**optical disk**

a disk that will accept and retain information in the form of marks in a recording layer or have these marks pre-recorded, that can be read with an optical beam

4.23**optical disk cartridge (ODC)**

a device consisting of a case containing an optical disk

4.24**partially embossed disk**

an optical disk cartridge which contains both rewritable and embossed data fields in the Data Zone

4.25

physical track

the path which is followed by the focus of the optical beam during one revolution of the disk

4.26

physical track group

a fixed number of consecutive physical tracks in the Data Zone

4.27

pitch

the distance between adjacent physical track centrelines, measured in a radial direction

4.28

polarization

the direction of polarization of an optical beam is the direction of the electric vector of the beam

NOTE 1 The plane of polarization is the plane containing the electric vector and the direction of propagation of the beam. The polarization is right-handed when to an observer looking in the direction of propagation of the beam, the end-point of the electric vector would appear to describe an ellipse in the clockwise sense.

4.29

pre-recorded mark

a mark so formed as to be unalterable by magneto-optical means

4.30

read power

the optical power, incident at the entrance surface of the disk, used when reading

NOTE 2 It is specified as a maximum power that may be used without damage to the written data. Lower power may be used provided that the signal-to-noise ratio and other requirements of this International Standard are met.

4.31

recording layer

a layer of the disk on, or in, which data is written during manufacture and/or use

4.32

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

4.33

spindle

the part of the disk drive which contacts the disk and/or hub

4.34

substrate

a transparent layer of the disk, provided for mechanical support of the recording layer, through which the optical beam accesses the recording layer

4.35

write-inhibit hole

a hole in the case which, when detected by the drive to be open, inhibits both write and erase operations

5 Conventions and notations

5.1 Representation of numbers

— A measured value is rounded off to the least significant digit of the corresponding specified value. Thus, 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.

— 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.

- In each field the information is recorded so that the most significant byte (byte 0) is recorded first. Within each byte the least significant bit is numbered bit 0, the most significant bit (i.e. bit 7 in an 8-bit byte) is recorded first. This order of recording applies also to the data input of the error-correcting codes, to the cyclic redundancy code, and to their output.
- Bit combinations are shown with the most significant bit to the left.
- Negative values are expressed in TWO's complement notation.
- Unless otherwise stated, all track numbers refer to logical tracks.

5.2 Names

The name of entities, e.g. specific tracks, fields, etc., is shown with a capital initial.

6 List of acronyms

ALPC	Auto Laser Power Control
AM	Address Mark
CRC	Cyclic Redundancy Code
DDS	Disk Definition Structure
DMA	Defect Management Area
ECC	Error Correction Code
ID	Identifier
ODC	Optical Disk Cartridge
ODF	Offset Detection Flag
O-ROM	Optical Read Only Memory
PA	Postamble
PDL	Primary Defect List
PEP	Phase-Encoded Part of the Control Tracks
P-ROM	Partial Read Only Memory
RLL(2,7)	Run Length Limited (code)
R-S LDC	Reed-Solomon Long Distance Code
R/W	Rewritable
SCSI	Small Computer System Interface
SDL	Secondary Defect List
SFP	Standard Formatted Part of the Control Tracks
SM	Sector Mark
VFO	Variable Frequency Oscillator
WO	Write Once
ZCAV	Zoned Constant Angular Velocity

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, or to erase 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 intended for use in a drive with optical access from one side only. To gain access to the second side of a disk, the cartridge has to be reversed before insertion into the drive.

A disk consists of two sides of the same Type, assembled together with the recording layers on the inside. Part of the disk or the entire disk may contain read-only data in the form of pits embossed by the manufacturer. This data can be read using the diffraction of the optical beam by the embossed pits.

The entire disk may be of Type WO.

8 General requirements

8.1 Environments

8.1.1 *Testing environment*

The test environment is the environment where the air immediately surrounding the optical disk cartridge shall have the following properties:

temperature	:23 °C ± 2 °C
relative humidity (RH)	:45 % to 55 %
atmospheric pressure	:60 kPa to 106 kPa
air cleanliness	:Class 100 000 (see Annex A)

No condensation on or in the optical disk shall occur. Before testing, the optical disk cartridge shall be conditioned in this environment for 48 h minimum. It is recommended that, before testing, the entrance surface of the optical disk be cleaned according to the instructions of the manufacturer of the disk.

Unless otherwise stated all test and measurements shall be made in this testing environment.

8.1.2 *Operating environment*

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

The operating environment is the environment where the air immediately surrounding the optical disk cartridge shall have the following properties:

temperature	:5 °C to 55 °C
relative humidity	:3 % to 85 %
absolute humidity	:1 g/m ³ to 30 g/m ³
atmospheric pressure	:60 kPa to 106 kPa
temperature gradient	:10 °C /h max.
relative humidity gradient	:10 % /h max.
air cleanliness	:Office environment (see Annex G)
magnetic field strength at the recording layer for any condition under which a beam is in focus	:32 000 A/m max.
magnetic field strength at the recording layer during any other condition	:48 000 A/m 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 H.)

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, defined as the environment where the air immediately surrounds the optical disk cartridge, shall have the following properties:

temperature	– 10 °C to 55 °C
relative humidity	3 % to 90 %
absolute humidity	1 g/m ³ to 30 g/m ³
atmospheric pressure	60 kPa to 106 kPa
temperature gradient	15 °C /h max.
relative humidity gradient	10 % /h max.

air cleanliness	:Office environment (see Annex G)
magnetic field	:48 000 A/m max.

No condensation on or in the ODC shall be allowed to occur.

8.1.4 Transportation

This International Standard does not specify requirements for transportation; guidance is given in Annex J.

8.2 Temperature shock

The optical disk cartridge shall withstand a temperature shock of up to 20 °C when inserted into, or removed from, the drive.

8.3 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.

8.4 Flammability

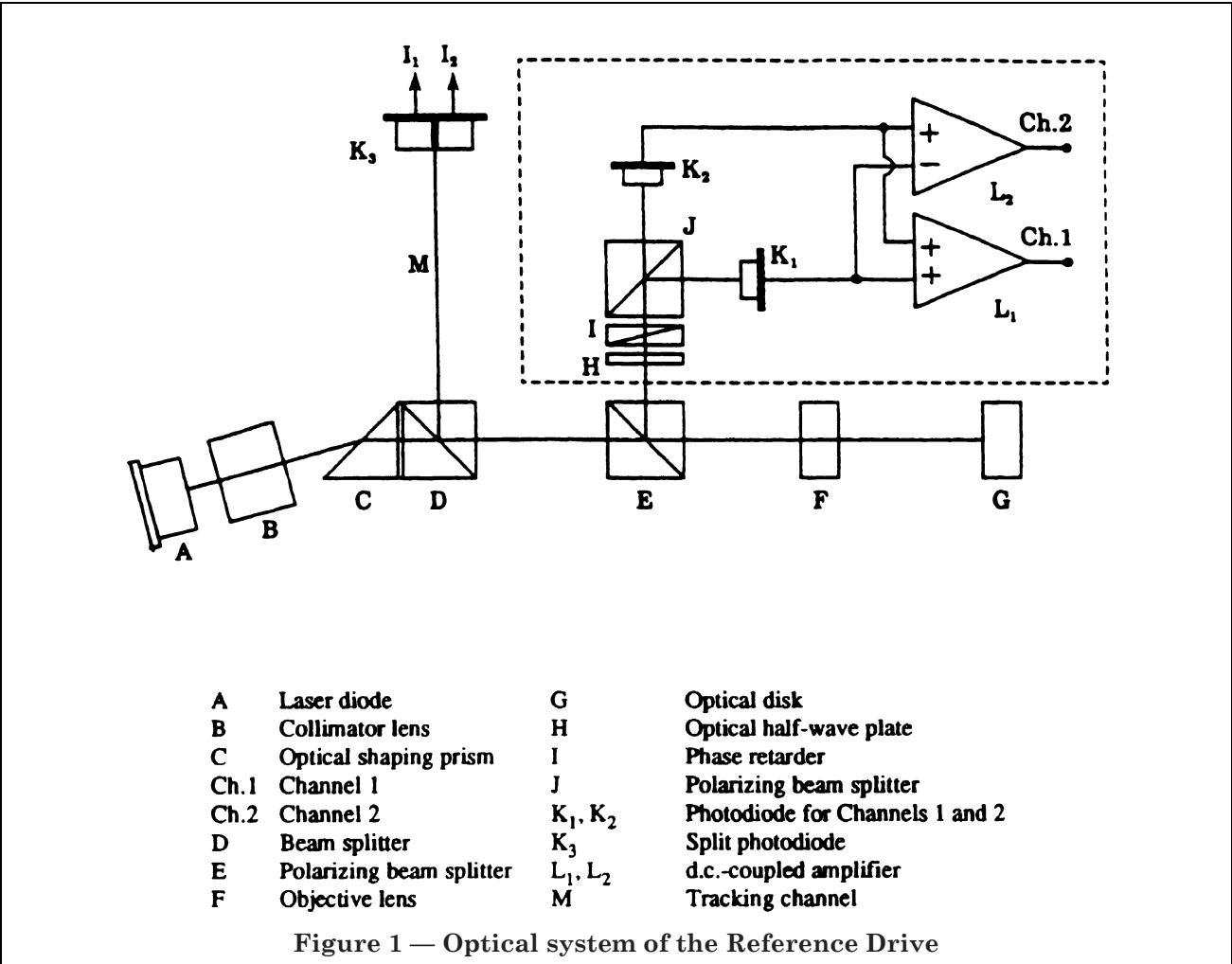
The cartridge and its components shall be made from materials that comply with the flammability class for HB materials, or, as specified in IEC 950.

9 Reference Drive

The Reference Drive is a drive several critical components of which have well defined properties and which is used to test write, read and erase parameters of the disk for conformance to this International 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 these clauses.

9.1 Optical system

The basic set-up of the optical system of the Reference Drive for measuring the write, read, and erase parameters is shown in Figure 1. Different components and locations of components are permitted, providing 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 measurement.



In the absence of polarization changes in the disk, the polarizing beamsplitter J shall be aligned to make the signal of detector K equal to that of detector K₂. The direction of polarization in this case is called the neutral direction. The phase retarder I shall be adjusted such that the optical system does not show more than 2,5° phase retardation between the neutral polarization and the polarization perpendicular to it. This position of the retarder is called the neutral position.

The phase retarder can be used for the measurement of the narrow-band signal-to-noise ratio (see 15.3.5). The beam splitter J shall have a p-s intensity reflectance ratio of at least 100.

The intensity reflectance R_p of the beam splitter E from F to H for the neutral polarization direction shall be nominally 0,30. The reflectance R_s for the polarization perpendicular to the neutral direction shall be nominally 0,95. The actual value of R_s shall not be smaller than 0,90.

The imbalance of the magneto-optical signal is specified for a beam splitter with nominal reflectances. If the measurement is made on a drive with reflectances R_p' and R_s' for beam splitter E, then the measured imbalance shall be multiplied by

$$\sqrt{\frac{R_s R_p}{R_p' R_s'}}$$

to make it correspond to the nominal beam splitter E.

The output of Channel 1 is the sum of the currents through photodiodes K_1 and K_2 , and is used for reading embossed marks. The output of Channel 2 is the difference between the photodiode currents, and is used for reading user-written marks with the magneto-optical effect.

9.2 Optical beam

The focused optical beam used for writing, reading and erasing data shall have the following properties:

- | | | |
|----|--|---|
| a) | Wavelength (λ): | $780 \text{ nm} \begin{smallmatrix} + 15 \\ - 10 \end{smallmatrix} \text{ nm}$ |
| b) | Wavelength (λ) divided by the numerical aperture (NA) of the objective lens: | $\lambda/\text{NA} = 1,423 \text{ } \mu\text{m} \pm 0,023 \text{ } \mu\text{m}$ |
| c) | Filling D/W of the aperture of the objective lens | 1,0 max. |
| d) | Variance of the wave front of the optical beam at the recording layer: | $\lambda^2/180 \text{ max.}$ |
| e) | Extinction ratio: | 0,01 max. |
| f) | The optical power and pulse for writing, reading, erasing, and the magnetic field shall be as specified in 15.1.3 , 15.1.4 , and 15.1.5 . | |

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.

The extinction ratio is the ratio of the minimum power observed behind a linear polarizer in the optical beam, which is rotated over at least 180° .

9.3 Read channels

Two read channels shall be provided to generate signals from the marks in the recording layer.

Channel 1 shall be used for reading the embossed marks, using the diffraction of the optical beam by the marks. Channel 2 shall be used for reading the user-written marks, using the rotation of the polarization of the optical beam due to the magneto-optical effect of the marks. The read amplifiers after the photo-detectors in Channel 1 and Channel 2 shall have a flat response within $\pm 1 \text{ dB}$ from 100 kHz to 34 MHz.

9.4 Tracking

The tracking channel of the drive provides the tracking error signals to control the servos for the axial and radial tracking of the optical beam. The method of generating the axial tracking error is not specified for the Reference Drive. The radial tracking error is generated by a split photo-diode detector in the tracking channel. The division of the diode runs parallel to the image of the tracks on the diode.

The requirements for the accuracy with which the focus of the optical beam must follow the tracks are specified in **15.1.2.3**.

9.5 Rotation of the disk

The spindle shall position the disk as specified in **13.6**. It shall rotate the disk at $30,0 \text{ Hz} \pm 0,3 \text{ Hz}$. The direction of rotation shall be counter-clockwise when viewed from the objective lens.

Section 2. Mechanical and physical characteristics

10 Dimensions and mechanical characteristics of the case

10.1 General

The case shall be a rigid, protective enclosure of rectangular shape and include 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 write-inhibit holes.

The dimensions of the inside of the case are not specified in this International Standard, but are determined by the movement of the disk inside the case allowed by **13.5** and **13.6**.

10.2 Case drawings

The case is represented schematically by the following drawings; for information purposes, third angle projection is used.

- Figure 2 shows the hub dimensions.
- Figure 3 shows a composite drawing of Side A of the case in isometric form, with the major features identified from Side A.
- Figure 4 shows the envelope of the case with respect to a location hole at the intersection of the X and Y axes and reference plane P.
- Figure 5a) shows the surfaces S_1 , S_2 , S_3 and S_4 which establish the reference plane P.
- Figure 5b) shows the details of surface S_3 .
- Figure 6 shows the details of the insertion slot and detent.
- Figure 7 shows the gripper slots, used for automatic handling.
- Figure 8 shows the write-inhibit holes.
- Figure 9 shows the media ID sensor holes.
- Figure 10 shows the shutter sensor notch.
- Figure 11 shows the head and motor window.
- Figure 12 shows the shutter opening features.
- Figure 13 shows the capture cylinder.
- Figure 14 shows the user label areas.

10.3 Sides, reference axes and reference planes

10.3.1 Relationship of Sides A and B

The features essential for physical interchangeability are represented in Figure 3. When Side A of the cartridge faces upwards, Side A of the disk faces downwards. Sides A and B of the case are identical as far as the features given here are concerned. The description is given for one side only. References to Sides A and B can be changed to B or A respectively.

Only the shutter and the slot for the shutter opener, described in **10.15** and **10.16** are not identical for both sides of the case.

10.3.2 Reference axes and case reference planes

There is a reference plane P for each side of the case. Each reference plane P contains two orthogonal axes, X and Y, to which the dimensions of the case are referred. The intersection of the X and Y axes defines the centre of the location hole. The X axis extends through the centre of the alignment hole.

10.4 Materials

The case shall be constructed from any suitable materials such that it meets the requirements of this International Standard.

10.5 Mass

The mass of the case without the optical disk shall not exceed 150 g.

10.6 Overall dimensions (see Figure 4)

The total length of the case shall be

$$L_1 = 153,0 \text{ mm} \pm 0,4 \text{ mm}$$

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

$$L_2 = 127,0 \text{ mm} \pm 0,3 \text{ mm}$$

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

$$L_3 = 26,0 \text{ mm} \pm 0,3 \text{ mm}$$

The total width of the case shall be

$$L_4 = 135,0 \text{ mm} \begin{matrix} + 0,0 \\ - 0,6 \end{matrix} \text{ mm}$$

The distance from the left-hand side of the cartridge to the reference axis Y shall be

$$L_5 = 128,5 \text{ mm} \begin{matrix} + 0,0 \\ - 0,5 \end{matrix} \text{ mm}$$

The distance from the right-hand side of the cartridge to the reference axis Y shall be

$$L_6 = 6,5 \text{ mm} \pm 0,2 \text{ mm}$$

The width shall be reduced on the top by the radius

$$R_1 = L_4$$

originating from a point defined by L_5 and

$$L_7 = 101,0 \text{ mm} \pm 0,3 \text{ mm}$$

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

$$R_2 = 1,5 \text{ mm} \pm 0,5 \text{ mm}$$

and the two corners at the bottom with a radius

$$R_3 = 3,0 \text{ mm} \pm 1,0 \text{ mm}$$

The thickness of the case shall be

$$L_8 = 11,00 \text{ mm} \pm 0,30 \text{ mm}$$

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

$$R_4 = 1,0 \text{ mm max.}$$

10.7 Location hole (see Figure 4)

The centre of the location hole shall coincide with the intersection of the reference axes X and Y. It shall have a square form with a side length of

$$L_9 = 4,10 \text{ mm} \begin{matrix} + 0,00 \\ - 0,06 \end{matrix} \text{ mm}$$

held to a depth of

$$L_{10} = 1,5 \text{ mm (i.e. typical wall thickness)}$$

after which a cavity extends through to the alignment hole on the opposite side of the case.

The lead-in edges shall be rounded with a radius

$$R_5 = 0,5 \text{ mm max.}$$

10.8 Alignment hole (see Figure 4)

The centre of the alignment hole shall lie on reference axis X at a distance of

$$L_{11} = 122,0 \text{ mm} \pm 0,2 \text{ mm}$$

from the reference axis Y.

The dimensions of the hole shall be

$$L_{12} = 4,10 \text{ mm} \begin{matrix} + 0,00 \\ - 0,06 \end{matrix} \text{ mm}$$

and

$$L_{13} = 5,0 \text{ mm} \begin{matrix} + 0,2 \\ - 0,0 \end{matrix} \text{ mm}$$

held to a depth of L_{10} , after which a cavity extends through to the location hole on the opposite side of the case.

The lead-in edges shall be rounded with radius R_5 .

10.9 Surfaces on reference plane P [see Figure 5a) and Figure 5b)]

The reference plane P for a side of the case shall contain four surfaces (S_1 , S_2 , S_3 and S_4) on that side of the case, specified as follows:

— Two circular surfaces S_1 and S_2 .

Surface S_1 shall be a circular area centred around the square location hole and have a diameter of

$$D_1 = 9,0 \text{ mm min.}$$

Surface S_2 shall be a circular area centred around the rectangular alignment hole and have a diameter of

$$D_2 = 9,0 \text{ mm min.}$$

— Two elongated surfaces S_3 and S_4 , that follow the contour of the cartridge and shutter edges.

Surfaces S_3 and S_4 are shaped symmetrically.

Surface S_3 shall be defined by two circular sections with radii

$$R_6 = 1,5 \text{ mm} \pm 0,1 \text{ mm}$$

with an origin given by

$$L_{14} = 4,0 \text{ mm} \pm 0,1 \text{ mm}$$

$$L_{15} = 86,0 \text{ mm} \pm 0,3 \text{ mm}$$

and

$$R_7 = 1,5 \text{ mm} \pm 0,1 \text{ mm}$$

with an origin given by

$$L_{16} = 1,9 \text{ mm} \pm 0,1 \text{ mm}$$

$$L_{17} = 124,5 \text{ mm} \pm 0,3 \text{ mm}$$

The arc with radius R_7 shall continue on the right hand side with radius

$$R_8 = 134,0 \text{ mm} \begin{matrix} +0,2 \\ -0,7 \end{matrix} \text{ mm}$$

which is a dimension resulting from $L_5 + L_{14} + R_6$ with an origin given by L_5 and L_7 . A straight, vertical line shall smoothly join the arc of R_6 to the arc of R_8 .

The left-hand side of S_3 shall be bounded by radius

$$R_9 = 4,5 \text{ mm} \pm 0,3 \text{ mm}$$

which is a dimension resulting from $L_{18} + L_{14} - R_6$ with an origin given by

$$L_{18} = 2,0 \text{ mm} + 0,1 \text{ mm}$$

$$L_{19} = 115,5 \text{ mm} + 0,3 \text{ mm.}$$

The left-hand side of the boundary shall be closed by two straight lines. The first one shall smoothly join the arc of R_6 to the arc of R_9 . The second one shall run from the left and tangent of R_7 to its intersection with R_9 . Along the left hand side of surface S_3 there shall be a zone to protect S_3 from being damaged by the shutter. In order to keep this zone at a minimum practical width

$$R_{10} = 4,1 \text{ mm max.}$$

This radius originates from the same point as R_9 .

10.10 Insertion slots and detent features (see Figure 6)

The case shall have two symmetrical insertion slots with embedded detent features. The slots shall have a length of

$$L_{20} = 26,0 \text{ mm} \pm 0,3 \text{ mm}$$

a width of

$$L_{21} = 6,0 \text{ mm} \begin{matrix} +0,3 \\ -0,0 \end{matrix} \text{ mm}$$

and a depth of

$$L_{22} = 3,0 \text{ mm} \pm 0,1 \text{ mm}$$

located

$$L_{23} = 2,5 \text{ mm} \pm 0,2 \text{ mm}$$

from reference plane P.

The slots shall have a lead-in chamfer defined by

$$L_{24} = 0,5 \text{ mm max.}$$

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

The detent notch shall be a semi-circle of radius

$$R_{11} = 3,0 \text{ mm} \pm 0,2 \text{ mm}$$

with the origin defined by

$$L_{26} = 13,0 \text{ mm} \pm 0,3 \text{ mm}$$

$$L_{27} = 2,0 \text{ mm} \pm 0,1 \text{ mm}$$

$$L_{73} = 114,0 \text{ mm} \pm 0,3 \text{ mm}$$

The dimensions L_{22} , L_{26} and L_{73} are interrelated, their values shall be such that they are all three within specification.

10.11 Gripper slots (see Figure 7)

The case shall have two symmetrical gripper slots with a depth of

$$L_{28} = 5,0 \text{ mm} \pm 0,3 \text{ mm}$$

from the edge of the case and a width of

$$L_{29} = 6,0 \text{ mm} \pm 0,3 \text{ mm}$$

The upper edge of a slot shall be

$$L_{30} = 12,0 \text{ mm} \pm 0,3 \text{ mm}$$

above the bottom of the case.

10.12 Write-inhibit holes (see Figure 8)

Sides A and B shall each have a write-inhibit hole. The case shall include a device for opening and closing each hole. The hole at the left-hand side of Side A of the case, is the write-inhibit hole for Side A of the disk. The protected side of the disk shall be made clear by inscriptions on the case or by the fact that the device for Side A of the disk can only be operated from Side A of the case.

When writing and erasing on Side A of the disk are not allowed, the write-inhibit hole shall be open all through the case. It shall have a diameter

$$D_3 = 4,0 \text{ mm min.}$$

Its centre shall be specified by

$$L_{31} = 8,0 \text{ mm} \pm 0,2 \text{ mm}$$

$$L_{32} = 111,0 \text{ mm} \pm 0,3 \text{ mm}$$

on Side A of the case.

When writing and erasing are allowed on Side A of the disk, the write-inhibit hole shall be closed on Side A of the case, at a depth of typically L_{10} , i.e. the wall thickness of the case. In this state, the opposite side of the same hole, at Side B of the case, shall be closed and not recessed from the reference plane P of Side B of the case by more than

$$L_{33} = 0,5 \text{ mm}$$

The opposite side of the write-inhibit hole for protecting Side B of the disk shall have a diameter D_3 . Its centre shall be specified by L_{31} and

$$L_{34} = 11,0 \text{ mm} \pm 0,2 \text{ mm}$$

on Side A of the case.

10.13 Media sensor holes (see Figure 9)

There shall be two sets of four media sensor holes. 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

$$D_4 = 4,0 \text{ mm } \begin{matrix} + 0,3 \\ - 0,0 \end{matrix} \text{ mm}$$

the positions of their centres shall be specified by L_{32} , L_{34} and

$$L_{35} = 19,5 \text{ mm } \pm 0,2 \text{ mm}$$

$$L_{36} = 17,0 \text{ mm } \pm 0,2 \text{ mm}$$

$$L_{37} = 23,0 \text{ mm } \pm 0,2 \text{ mm}$$

$$L_{38} = 29,0 \text{ mm } \pm 0,2 \text{ mm}$$

$$L_{39} = 93,0 \text{ mm } \pm 0,3 \text{ mm}$$

$$L_{40} = 99,0 \text{ mm } \pm 0,3 \text{ mm}$$

$$L_{41} = 105,0 \text{ mm } \pm 0,3 \text{ mm}$$

A hole is deemed to be open when there is no obstruction in this hole over a diameter D_4 all through the case.

A hole for Side A of the disk is deemed to be closed, when the hole is closed on both Side A and Side B of the case. The closure shall be recessed from reference plane P by

$$L_{42} = 0,1 \text{ mm max.}$$

The holes are numbered consecutively from 1 to 4. Hole No. 1 is the hole closest to the left-hand edge of the case. The optical disk cartridge according to this International Standard uses only hole No. 1. The other three holes shall be in the closed state.

The function of hole No. 1 is to indicate whether or not the disk is of high reflectivity type. When the hole is open, the disk is of high reflectivity and fully embossed. When hole No. 1 is closed, the disk is not of high reflectivity, thus the cartridge is either of Type R/W or Type P-ROM or Type WO.

10.14 Head and motor window (see Figure 11)

The case shall have a window on each side to enable the optical head and the motor to access the disk. The dimensions are referenced to a centreline, located at a distance of

$$L_{46} = 61,0 \text{ mm } \pm 0,2 \text{ mm}$$

to the left of reference axis Y.

The width of the head access shall be

$$L_{47} = 20,00 \text{ mm min.}$$

$$L_{48} = 20,00 \text{ mm min.}$$

and its height shall extend from

$$L_{49} = 118,2 \text{ mm min. to}$$

$$L_{50} = 57,0 \text{ mm max.}$$

The four inside corners shall be rounded with a radius of

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

The motor access window shall have a diameter of

$$D_5 = 35,0 \text{ mm min.}$$

and its centre shall be defined by L_{46} and

$$L_{51} = 43,0 \text{ mm } \pm 0,2 \text{ mm}$$

10.15 Shutter (see Figure 12)

The case shall have a spring-loaded, unidirectional shutter with an optional latch, designed to completely cover the head and motor windows when closed. A shutter movement of 41,5 mm minimum shall be sufficient to ensure that the head and motor window is opened to the minimum size specified in 10.14. The shutter shall be free to slide in a recessed area of the case so as to ensure that the overall thickness shall not exceed L_8 . The spring shall be sufficiently strong to close a free-sliding shutter, irrespective of the orientation of the cartridge.

The shutter opening force shall be 3 N max.

The right-hand side of the top of the shutter shall have a lead-in ramp with an angle.

$$A_2 = 25^\circ \text{ max.}$$

The distance from the reference planes P to the nearest side of the ramp shall be

$$L_{52} = 3,0 \text{ mm max.}$$

10.16 Slot for shutter opener (see Figure 12)

The shutter shall have only one slot in which the shutter opener of the drive can engage to open the shutter. The slot shall be dimensioned as follows:

When the shutter is closed, the vertical edge used to push the shutter open shall be located at a distance of

$$L_{53} = 34,5 \text{ mm} \pm 0,5 \text{ mm}$$

from reference axis Y on Side B of the case.

The length of the slot shall be

$$L_{54} = 4,5 \text{ mm} \pm 0,1 \text{ mm}$$

and the angle of the lead-out ramp shall be

$$A_3 = 52,5^\circ \pm 7,5^\circ$$

The depth of the slot shall be

$$L_{55} = 3,5 \text{ mm} \pm 0,1 \text{ mm}$$

The width of the slot from the reference plane P of Side B of the case shall be

$$L_{56} = 6,0 \text{ mm} \begin{matrix} + 0,5 \\ - 0,0 \end{matrix} \text{ mm}$$

If a shutter latch is employed, the distance between the latch and reference plane P of Side B of the case shall be

$$L_{57} = 3,0 \text{ mm max.}$$

10.17 Shutter sensor notch (see Figure 10)

The shutter sensor notch is used to ensure that the shutter is fully open after insertion of the optical disk cartridge into the drive. Therefore, the notch shall be exposed only when the shutter is fully open.

The dimensions shall be

$$L_{43} = 3,5 \text{ mm} \pm 0,2 \text{ mm}$$

$$L_{44} = 71,0 \text{ mm} \pm 0,3 \text{ mm and}$$

$$L_{45} = 9,0 \text{ mm} \begin{matrix} + 0,0 \\ - 2,0 \end{matrix} \text{ mm}$$

The notch shall have a lead-out ramp with an angle

$$A_1 = 45^\circ \pm 2^\circ$$

10.18 User label areas (see Figure 14)

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

- on Side A and Side B: 35,0 mm × 65,0 mm
- on the bottom side: 6,0 mm × 98,0 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 14).

L_{61}	= 4,5 mm min.
$L_{62} - L_{61}$	= 65,0 mm min.
$L_{64} - L_{63}$	= 35,0 mm min.
L_{65}	= 4,5 mm min.
$L_{66} - L_{65}$	= 65,0 mm min.
$L_{67} + L_{68}$	= 35,0 mm min.
$L_8 - L_{71} - L_{72}$	= 6,0 mm min.
$L_4 - L_{69} - L_{70}$	= 98,0 mm min.

11 Dimensional and physical characteristics of the disk

11.1 Dimensions of the disk

11.1.1 Outer diameter

The outer diameter of the disk shall be 130,0 mm nominal. The tolerance is determined by the movement of the disk inside the case allowed by **13.5** and **13.6**.

11.1.2 Thickness

The total thickness of the disk outside the hub area shall be 2,8 mm maximum. The total thickness of the disk is defined as the distance between the reference planes of each side of the disk.

11.1.3 Clamping zone (see Figure 2)

The outer diameter of the zone shall be

$$D_6 = 35,0 \text{ mm min.}$$

The inner diameter of the zone shall be

$$D_7 = 27,0 \text{ mm max.}$$

11.1.4 Clearance zone

Within the zone defined by the outer diameter D_6 of the Clamping Zone and the inner diameter of the Reflective Zone (see **16.2.2**) there shall be no projection from either disk reference plane in the direction of the optical system of more than 0,2 mm.

11.2 Mass

The mass of the disk shall not exceed 120 g.

11.3 Moment of inertia

The moment of inertia of the disk shall not exceed 0,22 g·m².

11.4 Imbalance

The imbalance of the disk shall not exceed 0,01 g·m.

11.5 Axial deflection

The deviation of any point of the recording layer from its nominal position, in a direction normal to the disk reference plane, shall not exceed $\pm 0,30$ mm for rotational frequencies of the disk up to 30 Hz. The deviation shall be measured by the optical system defined in **15.1.1** and **15.1.2**.

The nominal position of the recording layer with respect to the disk reference plane is determined by the nominal thickness of the substrate and its index of refraction.

11.6 Axial acceleration

The maximum allowed axial error $e_{\max}$ (see Annex K) shall not exceed $\pm 0,93 \mu\text{m}$, measured using the Reference Servo for axial tracking of the recording layer. The rotational frequency of the disk shall be $30,0 \text{ Hz} \pm 0,3 \text{ Hz}$. 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

$$H_s(i\omega) = \frac{1}{3} \left(\frac{\omega_0}{i\omega} \right)^2 \frac{1 + \frac{3i\omega}{\omega_0}}{1 + \frac{i\omega}{3\omega_0}}$$

where:

$$\omega = 2\pi f$$

$$\omega_0/2\pi = 904 \text{ Hz}$$

$$i = \sqrt{-1}$$

or any other servo with $|1 + H|$ within 20 % of $|1 + H_s|$ in the bandwidth of 30 Hz to 100 kHz. Thus, the disk shall not require an acceleration of more than 10 m/s^2 at low frequencies from the servo motor of the Reference Servo.

11.7 Dynamic radial runout

The difference between the maximum and the minimum distance of any track from the axis of rotation, measured along a fixed radial line over one revolution of the disk, shall not exceed $50 \mu\text{m}$ as measured by the optical system under conditions of a hub mounted on a perfect sized test fixture shaft, for rotational frequencies of the disk up to 30 Hz.

11.8 Radial acceleration

The maximum allowed radial error $e_{\max}$ (see Annex K) shall not exceed $\pm 0,14 \mu\text{m}$, measured using the Reference Servo for radial tracking of the tracks. The rotational frequency of the disk shall be $30,0 \text{ Hz} \pm 0,3 \text{ Hz}$. 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

$$H_s(i\omega) = \frac{1}{3} \left(\frac{\omega_0}{i\omega} \right)^2 \frac{1 + \frac{3i\omega}{\omega_0}}{1 + \frac{i\omega}{3\omega_0}}$$

where:

$$\omega = 2\pi f$$

$$\omega_0/2\pi = 1\,276 \text{ Hz}$$

$$i = \sqrt{-1}$$

or any other servo with $|1 + H|$ within 20 % of $|1 + H_s|$ in the bandwidth of 30 Hz to 100 kHz. Thus, the disk shall not require an acceleration of more than 3 m/s^2 at low frequencies from the servo motor of the Reference Servo.

11.9 Tilt

The tilt angle, defined as the angle which the normal to the entrance surface, averaged over a circular area of 1 mm diameter, makes with the normal to the disk reference plane, shall not exceed $4,5 \text{ mrad}$ in the operating environment.

12 Drop test

The optical disk cartridge shall withstand dropping on each surface and on each corner from a height of 760 mm onto a concrete floor covered with a vinyl layer 2 mm thick. The cartridge shall withstand all such impacts without any functional failure.

13 Interface between disk and drive

13.1 Clamping technique

Radial positioning of the optical disk shall be provided by the centring of the axle of the spindle in the centre hole of the hub.

The turntable of the drive spindle shall support the disk in the clamping zone, determining the axial position of the disk in the case.

A clamping force shall be provided by the attraction between magnets in the spindle and a magnetizable ring in the hub.

13.2 Dimensions of the hub (see Figure 2)

13.2.1 Outer diameter of the hub

This diameter shall be

$$D_8 = 25,0 \text{ mm } \begin{matrix} + 0,0 \\ - 0,2 \end{matrix} \text{ mm}$$

13.2.2 Height of the hub

The height shall be

$$h_1 = 2,2 \text{ mm } \begin{matrix} + 0,0 \\ - 0,2 \end{matrix} \text{ mm}$$

13.2.3 Diameter of the centre hole

The diameter of the centre hole shall be

$$D_9 = 4,004 \text{ mm } \begin{matrix} + 0,012 \\ - 0,000 \end{matrix} \text{ mm}$$

13.2.4 Height of the top of the centre hole at diameter D_9

The height of the top of the centre hole at diameter D_9 measured above the disk reference plane, shall be

$$h_2 = 1,9 \text{ mm min.}$$

13.2.5 Centring length at diameter D_9

This length shall be

$$h_3 = 0,5 \text{ mm min.}$$

The hole shall have a diameter larger than or equal to D_9 between the centring length and the disk reference plane. The hole shall extend through the substrate.

13.2.6 Radius at diameter D_9

There shall be a radius at the rim of the hub with height

$$h_4 = 0,2 \text{ mm } \pm 0,1 \text{ mm}$$

At the two surfaces which it intersects, the radius shall be blended to prevent offsets or sharp ridges.

13.2.7 Chamfer at diameter D_8

The height of the chamfer at the rim of the hub shall be

$$h_5 = 0,2 \text{ mm } \begin{matrix} + 0,2 \\ - 0,0 \end{matrix} \text{ mm}$$

The angle of the chamfer shall be 45° , or a corresponding full radius shall be used.

13.2.8 Outer diameter of the magnetizable ring

This diameter shall be

$$D_{10} = 19,0 \text{ mm min.}$$

13.2.9 Inner diameter of the magnetizable ring

This diameter shall be

$$D_{11} = 8,0 \text{ mm max.}$$

13.2.10 Thickness of the magnetizable material

This thickness shall be

$$h_6 = 0,5 \text{ mm min.}$$

13.2.11 Position of the top of the magnetizable ring relative to the disk reference plane

This position shall be

$$h_7 = 2,2 \text{ mm } \begin{matrix} + 0,0 \\ - 0,1 \end{matrix} \text{ mm}$$

13.3 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, provided by the magnetizable material in the hub (see Annex F) and the magnets in the spindle. The radial positioning of the disk is provided by the centring of the axis of the spindle in the centre hole of the hub. A cup-shaped turntable of the spindle shall support the disk in its Clamping Zone, determining the axial position of the disk in the case.

13.4 Clamping force

The clamping force exerted by the spindle shall be less than 14 N (see Annex F).

The adsorbent force measured by the test device specified in Annex F shall be in the range of 8,0 N to 12,0 N.

13.5 Capture cylinder for the hub (see Figure 13)

The capture cylinder is defined as the volume in which the spindle can expect the centre of the hole of the hub to be at the maximum height of the hub, just prior to capture. The size of the cylinder limits the allowable play of the disk inside its cavity in the case. This cylinder is referred to perfectly located and perfectly sized alignment and location pins in the drive, and includes tolerances of dimensions of the case and the disk between the two pins mentioned and the centre of the hub. The bottom of the cylinder is parallel to the reference plane P, and shall be located at a distance of

$$L_{58} = 0,5 \text{ mm min.}$$

above the reference plane P of Side B of the case when Side A of the disk is to be used. The top of the cylinder shall be located at a distance of

$$L_{59} = 4,3 \text{ mm max.}$$

above the same reference plane. The diameter of the cylinder shall be

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

Its centre shall be defined by the nominal values of L_{46} and L_{51} .

13.6 Disk position in the operating condition (see Figure 13)

When the disk is in the operating condition within the drive, the position of the active recording layer shall be

$$L_{60} = 5,35 \text{ mm } \pm 0,15 \text{ mm}$$

above reference plane P of the side of the case that faces the optical system. Moreover, the torque to be exerted on the disk in order to maintain a rotational frequency of 30 Hz shall not exceed 0,01 N.m, when the axis of rotation is within a circle with a diameter of

$$D_{13} = 0,2 \text{ mm max.}$$

and a centre given by the nominal values of L_{46} and L_{51} .