INTERNATIONAL STANDARD

ISO/IEC 14760

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1997-12-15

Information technology — Data interchange on 90 mm overwritable and read only optical disk cartridges using phase change — Capacity: 1,3 Gbytes per cartridge

Technologies de l'information — Échange de données sur cartouches de disque optique de recouvrement et de lecture seule, de 90 mm *de diamètre, utilisant un changement de phase — Capacité: 1,3 Gbytes par cartouche*

Reference number
ISO/IEC 14760:1997(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 as an International Standard requires approval by at least 75 % of the national bodies casting a vote.

International Standard ISO/IEC 14760 was prepared by Joint Technical Committee ISO/IEC JTC 1, *Information technology*, Subcommittee SC 23, *Optical disk cartridges for information interchange*.

Annexes A to J form an integral part of this International Standard. Annexes K to S are for information only.

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Introduction

The International Standards for optical disk cartridges issued up to now by ISO/IEC JTC 1 are based on a technology known as *magneto-optical (MO),* this International Standard is the first based on a different technology known as *phase change (PC).*

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Information technology - Data interchange on 90 mm overwritable and read only optical disk cartridges using phase change - Capacity: 1,3 Gbytes per cartridge

Section 1 - General

1 Scope

This International Standard specifies the characteristics of 90 mm Optical Disk Cartridges (ODCs) using the phase change technology, with a capacity of 1,3 Gbytes per cartridge. It specifies three related Types of such cartridges.

Type R/W Provides for data to be written or overwritten and read many times over the recording surface of the disk using the phase change overwritable effect.

Type P-ROM Provides for a part of the recording surfaces of the disk to be embossed by stamping or other means. This part of the disk is read without recourse to the phase change overwritable effect. All parts which are not embossed provide for data to meet the requirements of Type R/W.

Type O-ROM Provides for the whole of the recording surfaces of the disk to be embossed and reproduced by stamping or other means. This type of disk is read without recourse to the phase change overwritable effect.

For each Type, this International Standard provides for 512-byte and 2 048-byte sectors. All sectors of a given cartridge have the same size.

Type R/W, Type P-ROM and Type O-ROM are also referred to as "fully overwritable", "partially embossed" and "fully embossed", respectively.

This International Standard specifies

- the conditions for conformance testing and the Reference Drive;
- the environments in which the cartridges are to be operated, stored and transported;
- 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; 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 phase change overwritable characteristics of the disk, enabling processing systems to overwrite 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)

A claim of conformance with this International Standard shall specify the Type implemented. An ODC shall be in conformance with this International Standard 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 in conformance with this International Standard if it meets the mandatory requirements of this International Standard for the Type(s) specified.

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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 in conformance to this International Standard if it is able to process any recording made on the cartridge in accordance with the Type(s) specified.

2.4 Compatibility statement

A claim of conformance by a generating or receiving system with this International Standard shall include a statement listing other International Standards supported, if any. This statement shall specify the number of the standard(s), the ODC type(s) supported (where appropriate) and whether support includes reading only or both reading and overwriting.

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 subjected to revision, and parties to agreements based on this International Standard are encouraged to investigate the possibility of applying the most recent edition of the standard indicated below. Members of IEC and ISO maintain registers of currently valid International Standards.

IEC 950:1991, *Safety of information technology 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.

4.2 case: The housing for an optical disk, that protects the disk and facilitates disk interchange.

4.3 Channel bit: The elements by which the binary values ZERO and ONE are represented on the disk by either a space or a mark.

NOTE - In this International Standard each input bit is represented by two Channel bits. Their sequence depends on that of the input bits.

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 overwriting and reading 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 data.

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 embossed mark: A mark so formed as to be unalterable by phase change optical means.

4.10 entrance surface: The surface of the disk onto which the optical beam first impinges.

4.11 Error Correction Code (ECC): An error-detecting code designed to correct certain kinds of errors in data.

4.12 field: A subdivision of a sector.

4.13 format: The arrangement or layout of information on the disk.

4.14 fully embossed disk: An optical disk in which all data fields in the Data Zone are embossed.

4.15 fully overwritable disk: An optical disk in which the data in specified areas can be written using one-beam overwrite (see 4.22).

4.16 groove: See 4.19.

4.17 hub: The central feature on the disk which interacts with the spindle of the disk drive to provide radial centring and the clamping force.

4.18 interleaving: The process of allocating the physical sequence of units of data so as to render the data more immune to burst errors.

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4.19 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 with which the land is to be paired to form a track is located nearer to the entrance surface than the land and the data is recorded in the grooves.

4.20 logical track: Either 16 contiguous sectors for 512-byte sector disks or 4 contiguous sectors for disks with 2048-byte sector disks in less than one complete revolution of the disk. Sector number 0 is assigned to the first sector of each logical track.

4.21 mark: A feature of the recording layer which may take the form an amorphous spot, a pit, or any other type of form that can be sensed by the optical system. The pattern of marks represents the data on the disk.

NOTE - Subdivisions of a sector which are named 'mark' are not marks in the sense of this definition.

4.22 one-beam overwrite: A method by which the information is written by overwriting without prior erasing using a laser beam.

4.23 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.

4.24 optical disk cartridge (ODC): A device consisting of a case containing an optical disk.

4.25 partially embossed disk: An optical disk which contains both overwritable and embossed data fields in the Data Zone.

4.26 phase change (PC): A physical effect in which the laser beam irradiated area of a recording film is heated so as to reversibly change from an amorphous state to a crystalline state, and vice versa.

4.27 physical track: The path followed by the focus of the optical beam during one revolution of the disk.

4.28 physical track group: A fixed number of consecutive physical tracks in the Data Zone.

4.29 pitch: The distance between adjacent physical track centrelines, measured in a radial direction.

4.30 polarization: The direction of polarization of an optical beam is the direction of the electric vector of the beam.

NOTE - The plane of polarization is the plane containing the electric vector and the direction of propagation of the beam. The polarization is circularly 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 circle in the clockwise sense.

4.31 read power: The optical power, incident at the entrance surface of the disk, used when reading.

4.32 recording layer: A layer of the disk on, or in, which data is written during manufacture and/or use.

4.33 Reed-Solomon code: An error detection and/or correction code which is particularly suited for the correction of errors which occur in bursts or are strongly correlated.

4.34 sector: The smallest addressable part of a track in the Information Zone of a disk that can be accessed independently of other addressable parts of the zone.

4.35 spindle The part of the disk drive which contacts the disk and/or hub.

4.36 substrate: A transparent layer of the disk, provided for mechanical support of the recording layer, through which the optical beam accesses the recording layer.

4.37 ZCAV: A disk format requiring Zoned Constant Angular Velocity operation, all tracks in the Data Zone being logical tracks.

4.38 zone: An annular area of the disk.

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. It implies that a specified value of 1,26 with a positive tolerance + 0,01, and a negative tolerance - 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.

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- Numbers in binary notation and bit combinations are represented by strings of 0 and 1.
- 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 number 0 and is recorded last, the most significant bit (numbered 7 in a 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.
- Unless otherwise stated, a group of decimal digits of the form **xx...x/yy...y** indicates that the value **xx...x** is a byte, sector, or track number of a disk with 512-byte sectors and **yy...y** of a disk with 2 048-byte sectors.

5.2 Names

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

6 List of acronyms

AM	Address Mark
CRC	Cyclic Redundancy Check
DDS	Disk Definition Structure
DMA	Defect Management Area
ECC	Error Correction Code
EDAC	Error Detection and Correction Code
FA1	Functional Area 1
FA2	Functional Area 2
ID	Identifier
LBA	Logical Block Address
LSB	Least Significant Byte
MSB	Most Significant Byte
ODC	Optical Disk Cartridge
O-ROM	Optical Read Only Memory
PA	Postamble
PC	Phase change
PDL	Primary Defect List
PLL	Phase-Lock Loop Circuit
P-ROM	Partial Read Only Memory
RLL(2,7)	Run Length Limited (code)
R-S	Reed-Solomon (code)
R/W	Read/Write
SDL	Secondary Defect List
VFO	Variable Frequency Oscillator
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.

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.

A disk consists of two sides assembled together with the recording layers inside.

The optical disk is recordable on both sides. Data is written onto the disk as marks in the form of an amorphous spot in the recording layer and can be overwritten by new data with a focused optical beam, using the phase change effect between amorphous and crystalline states. The data is read with a focused optical beam, using phase change effect as the reflective difference between amorphous and crystalline states. The beam accesses the recording layer through the transparent substrate of the disk.

Part of the disk or the entire disk may contain read-only data in the form of pits embossed by the manufacturer. This data is read using the diffraction of the optical beam by the embossed pits.

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8 General requirements

8.1 Environments

8.1.1 Test environment

The test environment is the 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	: 60 kPa to 106 kPa
air cleanliness	: Class 100 000 (see annex G)

No condensation on or in the optical disk cartridge 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 tests and measurements shall be made in this test environment.

8.1.2 Operating environment

The International Standard requires that an optical disk cartridge which meets all requirements of this International Standard in the specified test environment provides 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 has 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 Q)

No condensation on or in the optical disk cartridge shall occur. If an optical disk cartridge 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 L).

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 60 °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 Q)

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

8.1.4 Transportation

This International Standard does not specify requirements for transportation; guidance is given in annex P.

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.

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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 better, 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 overwrite and read 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 used for measuring the overwrite 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 optical beam emitted from a laser diode A shall be collimated by a collimator lens B, and the ellipticity of the collimated beam shall be corrected by the optical shaping prism C.

After passing through the polarizing beam splitter D and the quarter-wave plate E, the p-polarized beam becomes a right-handed circularly polarized light. After being converted to circularly light, the light which is focused on the data recording surface of the optical disk G by the objective lens F .

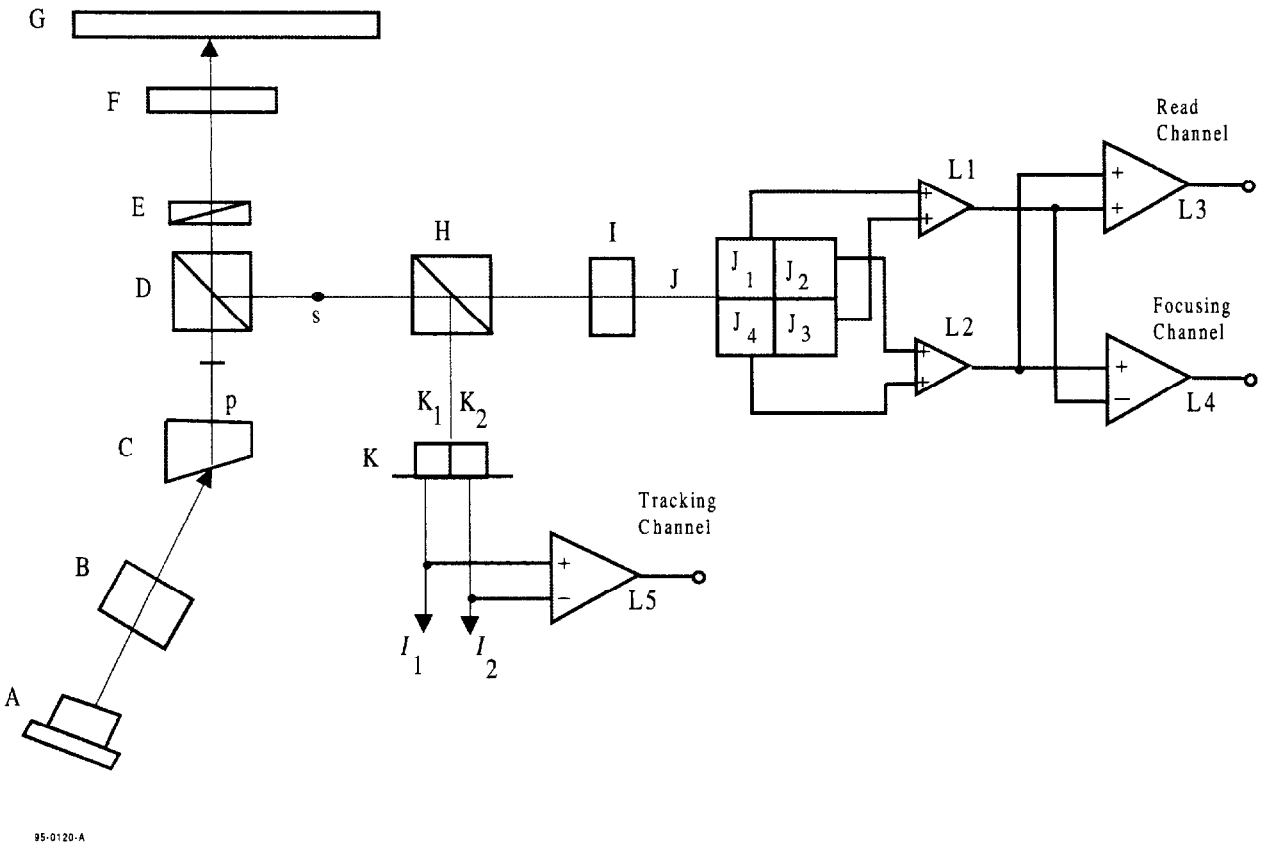
The circularly polarized light reflected back from the optical disk G, which is polarized to the left-handed, is converted to a s-polarized light through the quarter-wave plate E, and all of the s-polarized light shall be reflected to the direction of the beam splitter H by the polarizing beam splitter D. One-half of the light intensity is then reflected by the beam splitter H, while the other half is transmitted.

The polarizing beam splitter D shall have a p-s intensity reflectance ratio of at least 100.

The output of Tracking Channel is the difference between currents I_1 and I_2 of a split photo diode K (K_1 and K_2) and is used for the radial tracking of the optical beam.

J is a quadrant photo diode. The output of Read Channel is the sum of the currents through photo diodes J_1, J_2, J_3, and J_4, and is used for reading embossed marks and user-written marks with the reflective change. The output of the Focusing Channel is the difference between the sum of currents through photo diodes J_2 and J_4 and the sum of current thorough photo diodes J_1 and J_3, and shall be used for the focusing.

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A	Laser diode	G	Optical disk
B	Collimator lens	H	Beam splitter
C	Optional shaping prism	I	Cylindrical/spherical lens
D	Polarizing beam splitter	J	Quadrant-split photo diode for Read Channel and Focusing Channel
E	Quarter-wave plate	K	Split photo diode for Tracking Channel
F	Objective lens	L1,2,3,4,5	d.c.-coupled amplifiers

Figure 1 - Optical system of the Reference Drive

9.2 Optical beam

The focused optical beam used for overwriting and reading data shall have the properties:

a) Wavelength (λ)	685 nm ± 10 nm
b) The numerical aperture of the objective lens (NA)	0,60
c) Wavelength (λ) divided by NA	λ/ NA = 1,14 µm ± 0,02 µm
d) Filling D/W of the aperture of the objective lens	0,8 max.
e) Variance of the wavefront of the optical beam near the surface of the recording layer	0 to λ^2/ 400
f) Polarization	circular
g) Extinction ratio	0,01 max.
h) Read power	see 20.2.2
i) Overwrite power and pulse width	see 24.3.2

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.

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9.3 Read Channel

The Read Channel shall be provided to generate signals from the marks in the recording layer. It shall be used for reading the embossed marks, using the diffraction of the optical beam by the marks, and for reading the user-written marks, using the intensity change of the reflected light due to the phase change effect of the marks.

The read amplifier after the photo-detectors in Read Channel shall have a flat response within 1 dB from d.c. to 25 MHz.

9.4 Focusing and tracking

The Tracking Channel of the Reference Drive provides the tracking error signal to control the servos for the radial tracking of the optical beam. The Focusing Channel of the Reference Drive provides the focusing error signal to control the servo for the axial tracking of the optical beam. The requirements for the accuracy with which the optical beam shall follow the tracks are specified in 20.2.4.

9.5 Rotation of the disk

The spindle shall position the disk as specified in 12.4. It shall rotate the disk at 50,00 Hz ± 0,05 Hz. The direction of rotation shall be counter-clockwise when viewed from the objective lens.

Section 2 - Mechanical and physical characteristics

10 Dimensional and physical characteristics of the case

10.1 General description of the case (see figure 2)

The case is a rigid protective container of rectangular shape. It has head and spindle windows on Sides A and B to allow the spindle of the drive to clamp the disk by its hub and the optical head(s) of the drive to access Sides A and B. A shutter uncovers the windows upon insertion into the drive, and automatically covers them upon removal from the drive. The case has features that enable a drive to reject a mis-inserted cartridge, to inhibit writing, sensor holes, detents and gripper slots for an autochanger.

10.2 Reference planes of the case

The dimensions of the case shall be referred to three orthogonal reference planes X, Y and Z (see annex H). The case shall be constrained such that eight reference surfaces S1 to S8 on Side A of the case lie in plane Z. The intersection of the three planes defines the centre of the location hole. The centre of the alignment hole shall lie on the intersection of planes X and Z. On Side B, some dimensions are referred to reference plane X and two planes Y' and Z', where

- Y' is a plane parallel to reference plane Y at a nominal distance of 80,0 mm,
- Z' is a plane parallel to reference plane Z at a nominal distance of 5,0 mm.

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. The dimensions of the case in an operating environment can be estimated from the dimensions specified in this clause.

10.3.1 Overall dimensions (see figure 3)

The overall dimensions specified below are identical for Side A and Side B.

The total length of the case shall be

$$L_1 = 94{,}0 \text{ mm} \pm 0{,}3 \text{ mm}$$

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

$$L_2 = 76{,}0 \text{ mm} \pm 0{,}2 \text{ mm}$$

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

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L_3 = 18,0 mm ± 0,2 mm

The total width of the case shall be

L_4 = 90,0 mm $^{+\ 0,0\ mm}_{-\ 0,4\ mm}$

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

L_5 = 85,0 mm $^{+\ 0,1\ mm}_{-\ 0,3\ mm}$

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

L_6 = 5,0 mm ± 0,1 mm

The each corner shall be rounded with a radius

R_1 = 2,0 mm ± 0,2 mm

In the zones extending

L_7 = 8,6 mm min.

from the left-hand and right-hand edges of the case, the thickness of the case shall be

L_8 = 5,0 mm $^{+\ 0,2\ mm}_{-\ 0,0\ mm}$

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

R_2 = 0,3 mm $^{+\ 0,2\ mm}_{-\ 0,0\ mm}$

10.3.2 Location hole (see figure 3)

On Side A, the centre of the location hole shall coincide with the intersection of reference planes X, Y and Z. The diameter D_1 of the hole shall be

D_1 = 3,60 mm $^{+\ 0,00\ mm}_{-\ 0,06\ mm}$

held to a depth

L_9 = 1,5 mm min,

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_3 = 0,5 mm max.

On Side B, the centre of the location hole shall coincide with the intersection of reference plane X and planes Y' and Z'. The dimensions of the location hole are the same as on Side A.

10.3.3 Alignment hole (see figure 3)

On Side A, the centre of the alignment hole shall lie on the intersection of planes X and Z at a distance

L_{10} = 80,0 mm ± 0,2 mm

from the reference plane Y.

The alignment hole shall have a substantially rectangular shape. Its dimensions shall be

L_{11} = 3,60 mm $^{+\ 0,00\ mm}_{-\ 0,06\ mm}$

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$$L_{12} = 4{,}4 \text{ mm} \begin{matrix} +\ 0{,}2 \text{ mm} \\ -\ 0{,}0 \text{ mm} \end{matrix}$$

held to a depth L_9, 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 a radius R_3.

On Side B, the centre of the alignment hole shall lie on the intersection of reference plane X and plane Z' at a distance L_{10} from plane Y'. The dimensions of this hole are the same on Side A.

10.3.4 Reference surfaces (see figure 4)

The dimensions of the reference surfaces specified below are the same on Side A and Side B.

There shall be eight reference surfaces S1, S2, S3, S4, S5, S6, S7 and S8 on Side A of the case.

Surfaces S1 and S2 shall be circular with a diameter

$$D_2 = 7{,}0 \text{ mm min.}$$

S1 shall be centred on the location hole, and S2 shall be centred on the alignment hole.

Surfaces S3 and S4 shall be circular with a diameter

$$D_3 = 6{,}0 \text{ mm min.}$$

with their centres located at

$$L_{13} = 54{,}0 \text{ mm} \pm 0{,}2 \text{ mm}$$

$$L_{14} = 1{,}0 \text{ mm} \pm 0{,}2 \text{ mm}$$

and

$$L_{15} = 81{,}0 \text{ mm} \pm 0{,}2 \text{ mm.}$$

Surfaces S5, S6, S7 and S8 shall be semicircular with a radius

$$R_4 = 2{,}5 \text{ mm min.}$$

with their centres located at

$$L_{16} = 7{,}0 \text{ mm} \pm 0{,}2 \text{ mm}$$

$$L_{17} = 65{,}5 \text{ mm} \pm 0{,}2 \text{ mm}$$

on the edge of the case.

No portion of the case or of the shutter mechanism (see 10.3.10) shall protrude more than

$$L_{18} = 0{,}15 \text{ mm max.}$$

beyond the reference plane Z for Side A, or plane Z' for Side B.

10.3.5 Detents (see figure 5)

The case shall have two symmetrical detents. The detent shall have a depth

$$L_{19} = 2{,}0 \text{ mm} \begin{matrix} +0{,}3 \text{ mm} \\ -\ 0{,}1 \text{ mm} \end{matrix}$$

measured from the edge of the case. The width of the detent shall be

$$L_{20} = 3{,}0 \text{ mm} \begin{matrix} +0{,}3 \text{ mm} \\ -\ 0{,}1 \text{ mm} \end{matrix}$$

The upper edge of the detent shall be at a distance

$$L_{21} = 40{,}0 \text{ mm} \pm 0{,}2 \text{ mm}$$

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from reference plane X. The part of the bottom of the detent that is parallel to reference plane Y shall extend below the upper edge of the detent by

L_{22} = 1,5 mm min.

The lower edge of the detent shall be parallel to the upper edge over a distance

L_{23} = 1,0 mm min.

The corners of the detents shall be rounded with a radius R_5

R_5 = 0,3 mm ± 0,1 mm

10.3.6 Functional Areas (see figure 6)

The case shall have two rectangular through openings, called Functional Areas FA1 and FA2, respectively, as shown in figure 6 for Side A.

Their dimensions shall be

L_{24} = 4,4 mm min.

L_{25} = 3,6 mm min.

The centre of FA1 is defined by a line parallel to reference plane Y at a distance L_{10} from this reference plane Y, and a line parallel to reference plane X at a distance

L_{26} = 12,8 mm ± 0,2 mm

from this reference plane X. The centre of FA2 is defined by the intersection of reference plane Y and said parallel to reference plane X at the distance L_{26}.

The cartridge shall have devices capable of

- either closing FA1 or FA2,

- or closing both FA1 and FA2.

The two Functional Areas shall indicate whether or not writing on the disk is permitted, as specified in table 1 (see also figure 6).

Table 1 - Use of the Functional Areas

Functional Areas	Writing
FA1: Closed	Permitted on Side A
FA1: Open	Inhibited on Side A
FA2: Closed	Permitted on Side B
FA2: Open	Inhibited on Side B

The surface of the device shall be located below reference plane Z for Side A or plane Z' for Side B at a distance

L_{27} = 0,3 mm max.

On Side B, FA1 designates the opening on the right-hand side and FA2 designates the opening on the left-hand side.

10.3.7 Media sensor holes (see figure 7)

The case shall have four media sensor holes A_1, A_2, A_3 and A_4 in side A with a diameter D_4.

D_4 = 3,0 mm min.

The centre of each hole shall be at a distance L_{28} , L_{29} , L_{30} and L_{31}, respectively, from reference plane Y, and at a distance L_{32} from reference plane X.

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L_{28} = 5,5 mm ± 0,2 mm

L_{29} = 11,0 mm ± 0,2 mm

L_{30} = 69,0 mm ± 0,2 mm

L_{31} = 74,5 mm ± 0,2 mm

L_{32} = 12,8 mm ± 0,2 mm.

Side B shall have four corresponding media sensor holes B_1 , B_2 , B_3 and B_4 with the diameter D_4. Dimensions L_{28} to L_{31} are related to a plane Y'.

The media sensor holes shall indicate attributes of the cartridge, as specified in the table 2.

Table 2 - Use of the Media sensor holes

Media sensor hole	Attribute	Type of Cartridge
A_1: Closed	Low reflectance	R/W or P-ROM (see table 1)
A_1: Open	High reflectance	O-ROM The utilized disk side is not valid, if Functional Areas FA1 is closed.
A_2: Closed	---	Reserved
A_3: Closed	---	Reserved
A_4: Closed	---	Reserved

If the media sensor holes are obturated by a plug, the surface of the plug shall not be recessed from reference plane Z for Side A or plane Z' for Side B by more than

L_{33} = 0,2 mm

If a media sensor hole is open, the room below it shall be free over at least

L_{34} = 3,0 mm

10.3.8 Spindle and head windows (see figure 8)

Sides A and B of the case shall have an identical window enabling the spindle and the optical head of the drive to access the disk.

The dimensions of the window are referenced to a centreline, located at a distance

L_{35} = 40,0 mm ± 0,2 mm

from reference plane Y. The widths of the window shall be given by

$$L_{36} = 11{,}0 \text{ mm} \begin{matrix} +0{,}2 \text{ mm} \\ -0{,}0 \text{ mm} \end{matrix}$$

and

$$L_{37} = 11{,}0 \text{ mm} \begin{matrix} +0{,}2 \text{ mm} \\ -0{,}0 \text{ mm} \end{matrix}$$

The top of the window shall be curved by radius

R_6 = 43,7 mm min.

originating from the intersection of L_{35} and

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L_{38} = 27,0 mm ± 0,2 mm

The area bounded by R_6 and the top of the case shall be recessed from reference plane Z by

$$L_{39} = 1{,}6 \text{ mm} \begin{matrix} +\ 0{,}2 \text{ mm} \\ -\ 0{,}0 \text{ mm} \end{matrix}$$

over the width of the window.

The bottom of the window shall be the arc of the semi-circle which smoothly joins the sides of the window. The centre of the semi-circle shall be defined by the intersection of L_{35} and L_{38}.

10.3.9 Insertion slots (see figure 9)

On Side A, the left and right edges of the case shall present each an insertion slot into which the shutter opener can move. The bottom of the right-hand side (as seen from Side A) insertion slot shall be at a distance

L_{40} = 43,8 mm ± 0,3 mm

from reference plane X. The bottom of the left-hand side insertion slot shall be at a distance

L_{41} = 41,0 mm ± 0,3 mm

from reference plane X. The depth of these slots, measured from the edge of the case shall be

L_{42} = 2,5 mm ± 0,2 mm

The side of the insertion slots parallel to reference plane Z shall be at a distance

L_{43} = 1,25 mm ± 0,10 mm

from this reference plane Z. The width of the insertion slots shall be

L_{44} = 2,5 mm ± 0,1 mm.

The lead-in edge at the right-hand side insertion slot shall have a ramp defined by L_{42} and

L_{45} = 72,0 mm ± 0,3 mm

A_1 = 10° ± 1°.

On Side B, these dimensions are referred to reference plane X and to plane Z'.

10.3.10 Shutter (see figure 10)

The case shall have a spring-loaded shutter designed to completely cover the spindle and head windows when closed. When open, the shutter shall expose the windows.

The shutter shall be free to slide in a recessed area of the case. The overall thickness of the case and shutter shall not exceed L_8 by more than L_{18} (see 10.3.4).

The shutter opener tab shall be provided in the right-hand side insertion slot (seen from Side A) which the shutter opener of the drive can push to open the shutter.

The dimensions of the shutter opener tab in the insertion slot shall be

L_{46} = 0,5 mm max.

L_{47} = 2,0 mm min.

L_{48} = 1,6 mm ± 0,1 mm

$$L_{49} = 1{,}8 \text{ mm} \begin{matrix} +\ 0{,}2 \text{ mm} \\ -\ 0{,}0 \text{ mm} \end{matrix}$$

When the shutter is closed, the position of the tab above reference plane X shall be

$$L_{50} = 68{,}0 \text{ mm} \begin{matrix} +\ 0{,}5 \text{mm} \\ -\ 0{,}0 \text{ mm} \end{matrix}$$

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A movement of the tab to

L_{51} = 45,5 mm min.

shall be sufficient to open the windows.

It shall be possible to move the tab further up to

L_{52} =43,8 mm max.

without exceeding the shutter opening force as specified 10.4.5, while leaving the minimum size window open.

10.3.11 Gripper slots (see figure 11)

The case shall have two symmetrical gripper slots on the bottom of the case. The hole of the slots shall have a width

L_{53} = 5,0 mm $^{+\,0,2\ \text{mm}}_{-\,0,0\ \text{mm}}$

Their height shall be

L_{54} = 2,6 mm ± 0,1 mm

Their depth, i.e. the wall thickness of the case on this edge, shall be

L_{55} = 1,0 mm ± 0,2 mm

The centres of these holes shall be located at a distance

L_{56} = 18,5 mm ± 0,2 mm

L_{57} = 61,5 mm ± 0,2 mm

respectively, from reference plane Y and at a distance

L_{58} = 2,5 mm ± 0,1 mm

from reference plane Z.

The dimensions of the free space inside the case, behind these holes shall be L_{54} and

L_{59} = 7,5 mm min.

L_{60} = 3,5 mm min.

10.3.12 Label area (see figure 12)

The case shall have label areas on Side A and Side B, with dimensions shown below. Dimensions L_{61} and L_{62} are related to a plane Y'.

L_{61} = 4,5 mm ± 0,3 mm

L_{62} = 25,5 mm ± 0,3 mm

L_{63} = 12,5 mm ± 0,3 mm

L_{64} = 65,5 mm ± 0,3 mm

L_{65} = 55,0 mm ± 0,3 mm

L_{66} = 75,5 mm ± 0,3 mm.

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

R_7 = 2,0 mm max.

The areas on each side shall be recessed by

L_{67} = 0,2 mm min.

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10.4 Mechanical characteristics

All requirements of this clause shall be met in the operating environment.

10.4.1 Material

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

10.4.2 Mass

The mass of the case without the optical disk shall not exceed 50 g.

10.4.3 Edge distortion

The cartridge shall meet the requirement of the edge distortion test defined in annex A.

10.4.4 Compliance

The cartridge shall meet the requirement of the compliance (flexibility) test defined in annex B. The requirement ensures 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 1,5 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 consists of two circular substrates attached by an adhesive layer with a hub on each side of the disk (see figure 13). A recording layer shall be coated on the inner surface of the substrate. The Information Zone of the substrate is transparent to allow an optical beam to focus on the recording layer through the substrate.

The Information and Clamping Zones are on different planes.

When the disk is mounted on the spindle, the hub in the clamping side interacts with the spindle, and provides the radial centring of the disk and the clamping force.

Surfaces A and B of the disk are identical, thus the following description refers to one side only, unless otherwise specified.

11.2 Reference axis and plane of the disk

The reference plane P is the plane including the clamping zone of surface A of the disk.

Some dimensions of the hub are referred to a reference plane P, that 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 the rotation of this spindle.

The reference axis A passes through the centre of the centre hole of the hub, and is normal to plane P (see figure 13).

11.3 Dimensions of the disk (see figure 13)

The dimensions of the disk shall be measured in the test environment. The dimensions of the disk in an operating environment can be estimated from the dimensions specified in this clause. The outer diameter D_5 of the disk, shall be

$$D_5 = 86{,}0 \text{ mm} \begin{matrix} +\,0{,}0 \text{ mm} \\ -\,0{,}5 \text{ mm} \end{matrix}$$

The diameter D_6 of the centre hole of the disk without the hub shall be

$$D_6 = 6{,}0 \text{ mm min.}$$

The height L_{68} from plane P and the total thickness L_{69} of the disk between diameters D_5 and

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

shall be

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$$L_{68} = 0{,}45 \text{ mm} \begin{matrix} +\ 0{,}05 \text{ mm} \\ -\ 0{,}00 \text{ mm} \end{matrix}$$

and

L_{69} = 1,25 mm ± 0,06 mm, excluding axial deflection.

The zone from the diameter D_6 to D_7 outside the clamping zone shall not protrude from plane P.

11.3.1 Hub dimensions (see figure 13)

The diameter of the centre hole of the hub shall be

$$D_8 = 4{,}004 \text{ mm} \begin{matrix} +\ 0{,}012 \text{ mm} \\ -\ 0{,}000 \text{ mm} \end{matrix}$$

The outer diameter of the hub shall be

$$D_9 = 15{,}0 \text{ mm} \begin{matrix} +\ 0{,}3 \text{ mm} \\ -\ 0{,}5 \text{ mm.} \end{matrix}$$

The height of the hub shall be

$$h_1 = 0{,}25 \text{ mm} \begin{matrix} +\ 0{,}00 \text{ mm} \\ -\ 0{,}10 \text{ mm} \end{matrix}$$

The position of the top of the magnetizable surface shall be

$$h_2 = 0{,}25 \text{ mm} \begin{matrix} +\ 0{,}00 \text{ mm} \\ -\ 0{,}10 \text{ mm} \end{matrix}$$

The height of the centring hole above reference plane P shall be

h_3 = 0,05 mm max.

The centring length at a diameter D_8 shall be

h_4 = 0,15 mm min.

The lead-in edge of the centre hole shall have chamfer C_1 of 45° by 0,2 mm ± 0,1 mm or shall be rounded off by a radius

R_8 = 0,2 mm ± 0,1 mm.

The outer edge of the centre hole shall have a chamfer C_2 of 45° by 0,4 mm ± 0,1 mm or shall be rounded off by a radius

R_9 = 0,4 mm ± 0,1 mm.

The hub shall have any suitable magnetizable material for clamping the disk. Its dimensions shall be

D_{10} = 13,0 mm min.

D_{11} = 6,0 mm max.

and its adsorbent force measured by the test device specified in annex F shall be in the range of 3,0 N to 4,5 N.

11.3.2 Clamping zone (see figure 13)

The outer diameter of the clamping zone shall be

D_{12} = 21,0 mm min.

The inner diameter of the clamping zone shall be

D_{13} = 16,0 mm max.

11.4 Mechanical characteristics

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

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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 International Standard are the magnetic properties of the magnetizable zone in the hub (see 11.3.1) and the optical properties of the substrate in the Information Zone (see 11.5).

11.4.2 Mass

The mass of the disk shall not exceed 12,0 g.

11.4.3 Moment of inertia

The moment of inertia of the disk relative to axis A shall not exceed 0,011 g•m^2.

11.4.4 Imbalance

The imbalance of the disk relative to axis A shall not exceed 0,006 g•m.

11.4.5 Axial deflection

The axial deflection of the disk is measured as the axial deviation of the recording layer. 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 ± 0,2 mm for rotational frequencies of the disk up to 50 Hz.

11.4.6 Axial acceleration

The maximum allowed tracking error e_{max} (see annex K) shall not exceed ± 0,6 µm, measured using the Reference Servo for axial tracking of the recording layer. The rotational frequency of the disk shall be 50,00 Hz ± 0,05 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

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

where

$\omega = 2\pi f$

$\omega_0/2\pi = 1\,880$ Hz

$i = \sqrt{-1}$

or any other servo with $|1+H|$ within 20% of $|1+H_S|$ in the bandwidth of 50 Hz to 170 kHz. Thus, the disk shall not require an axial acceleration of more than 27,8 m/s^2 at low frequencies 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. 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-uniformity 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 50 µm at a rotational frequency of the disk of 50,00 Hz ± 0,05 Hz.

11.4.8 Radial acceleration

The maximum allowed tracking error $e_{max.}$ (see annex K) shall not exceed ± 0,05 µm, measured using the Reference Servo for radial tracking of the tracks. The rotational frequency of the disk shall be 50,00 Hz ± 0,05 Hz. The stationary part of the motor

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is assumed to be motionless (no external disturbances). The measurement shall be made using a servo with the transfer function

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

where

$\omega = 2\pi f$

$\omega_0/2\pi = 2\,980$ Hz

$i = \sqrt{-1}$

or any other servo with $|1+H|$ within 20% of $|1+H_S|$ in the bandwidth of 50 Hz to 170 kHz. Thus, the disk shall not require a radial acceleration of more than 5,8 m/s^2 at low frequencies from the servo motor of the Reference Servo.

11.4.9 Tilt

The tilt is the angle which the normal to the entrance surface, averaged over an area of 1 mm in 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 1,40 to 1,60.

11.5.2 Thickness of the substrate

The nominal thickness of the substrate, from the entrance surface to the recording layer, in the Information Zone shall be 0,60 mm ± 0,02 mm when the index of refraction of the substrate is equal to 1,58.

If the index of refraction is not equal to 1,58 , the thickness of the substrate, from the entrance surface to the recording layer, in the Information Zone shall be

$$t(n) = 0{,}254\,6\left(\frac{n^3}{n^2-1}\right)\left(\frac{n^2-0{,}264\,9}{n^2-0{,}000\,8}\right)$$

with a tolerance of ± 0,02 mm, where n is the index of refraction.

11.5.3 Birefringence

The birefringence of the substrate shall not exceed 70 nm in the Information Zone under the test environment, when measured by the round trip optical path described in annex S.

11.5.4 Reflectance

The reflectance of the recording layer is the value of the Mirror Zone specified in 17.2.1, measured through the substrate and does not include the reflectance of the entrance surface. The nominal value R of the reflectance shall be specified by the manufacturer in byte 3 and byte 19 of the Control Zones (see annex D).

The value of R shall lie within the range from 0,14 to 0,28 for partially embossed and fully overwritable disks. The value of R shall lie within the range from 0,50 to 0,90 for high reflectance fully embossed disks (see annex J).

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, 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

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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.

12.2 Clamping force

The clamping force exerted by the spindle on the hub shall not exceed 5 N.

12.3 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 h_1 below plane P (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 located and 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 plane Z, and shall be located a distance

$$L_{70} = 0{,}7 \text{ mm min.}$$

above plane Z. The top of the cylinder is located a distance

$$L_{71} = 2{,}3 \text{ mm max.}$$

above plane Z. The radius of the cylinder shall be

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

and its centre shall be given by the nominal values of L_{29} and L_{32} in the drive.

12.4 Disk position in operating condition (see figure 14)

When the disk is in the operating condition within the drive, the position of plane P of the disk shall be

$$L_{72} = 1{,}45 \text{ mm} \pm 0{,}10 \text{ mm}$$

above plane Z of the case, and the axis of rotation shall be within a circle with a radius

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

and a centre given by the nominal values of L_{35} and L_{38}.

The torque to be exerted on the disk in the operating condition in order to maintain a rotational frequency of 50 Hz shall not exceed 0,01 N•m.

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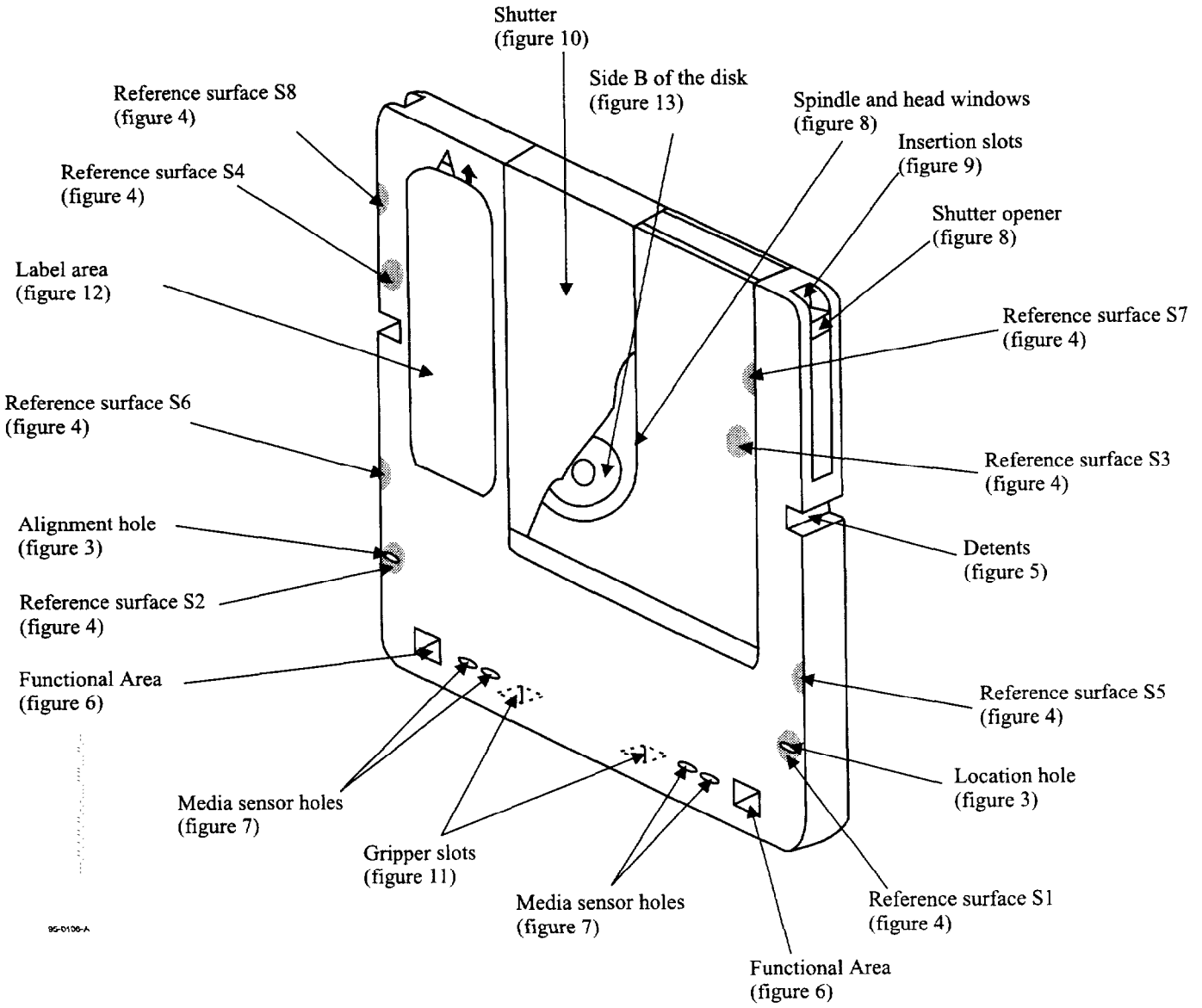


Figure 2 - General view of Side A of the case

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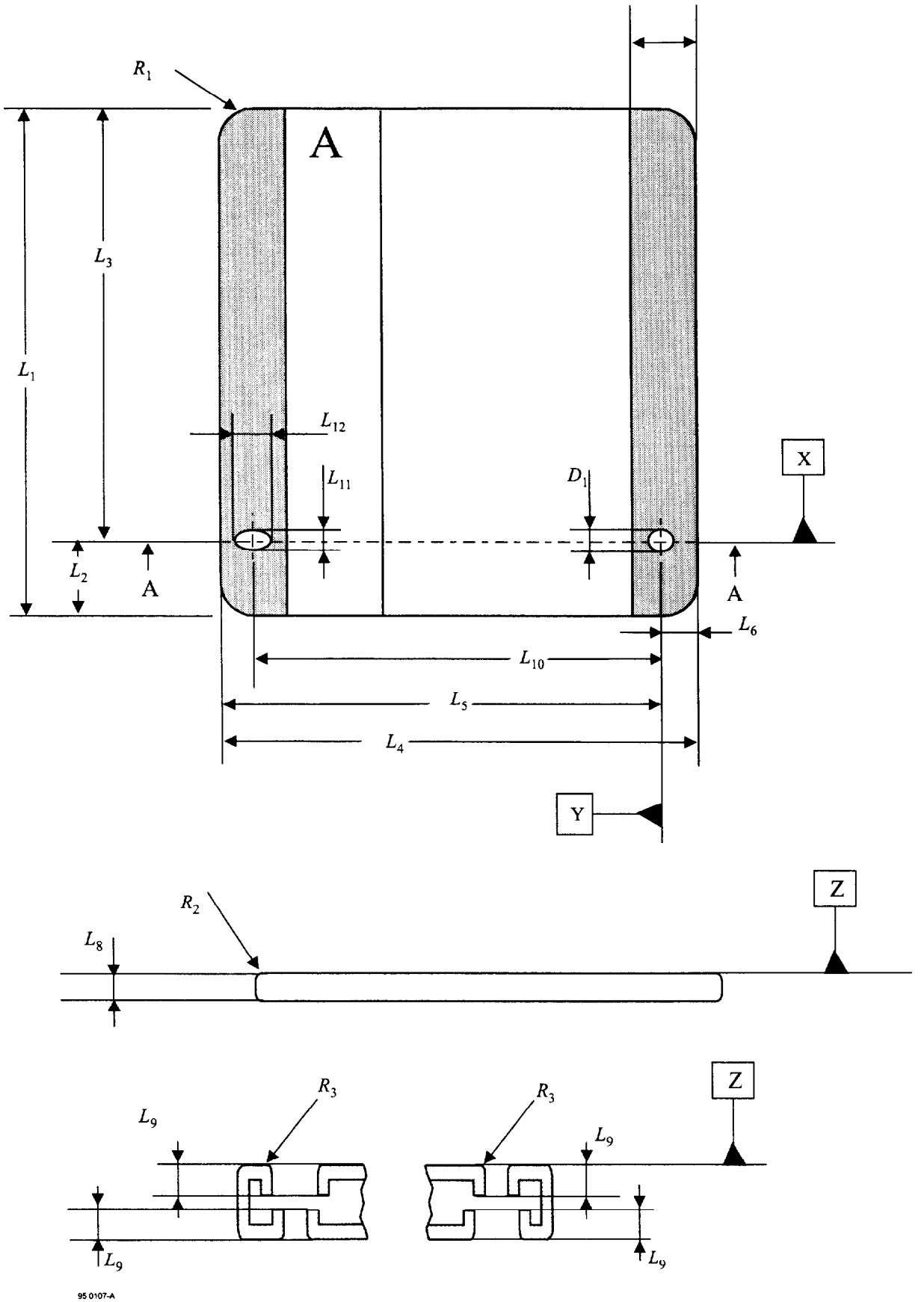


Figure 3 - Overall dimensions, viewed on Side A of the case

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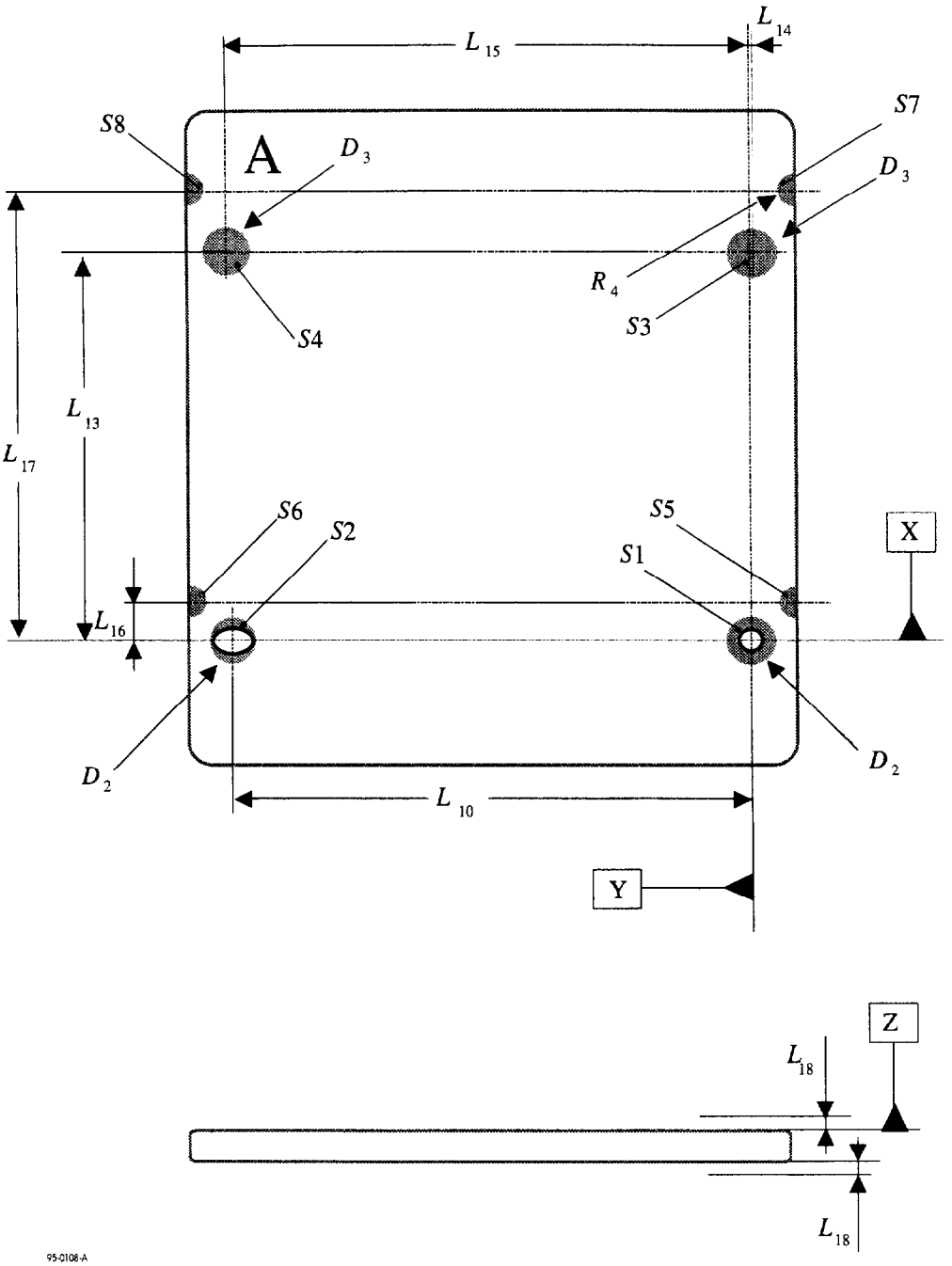


Figure 4 - Reference surfaces on Side A of the case

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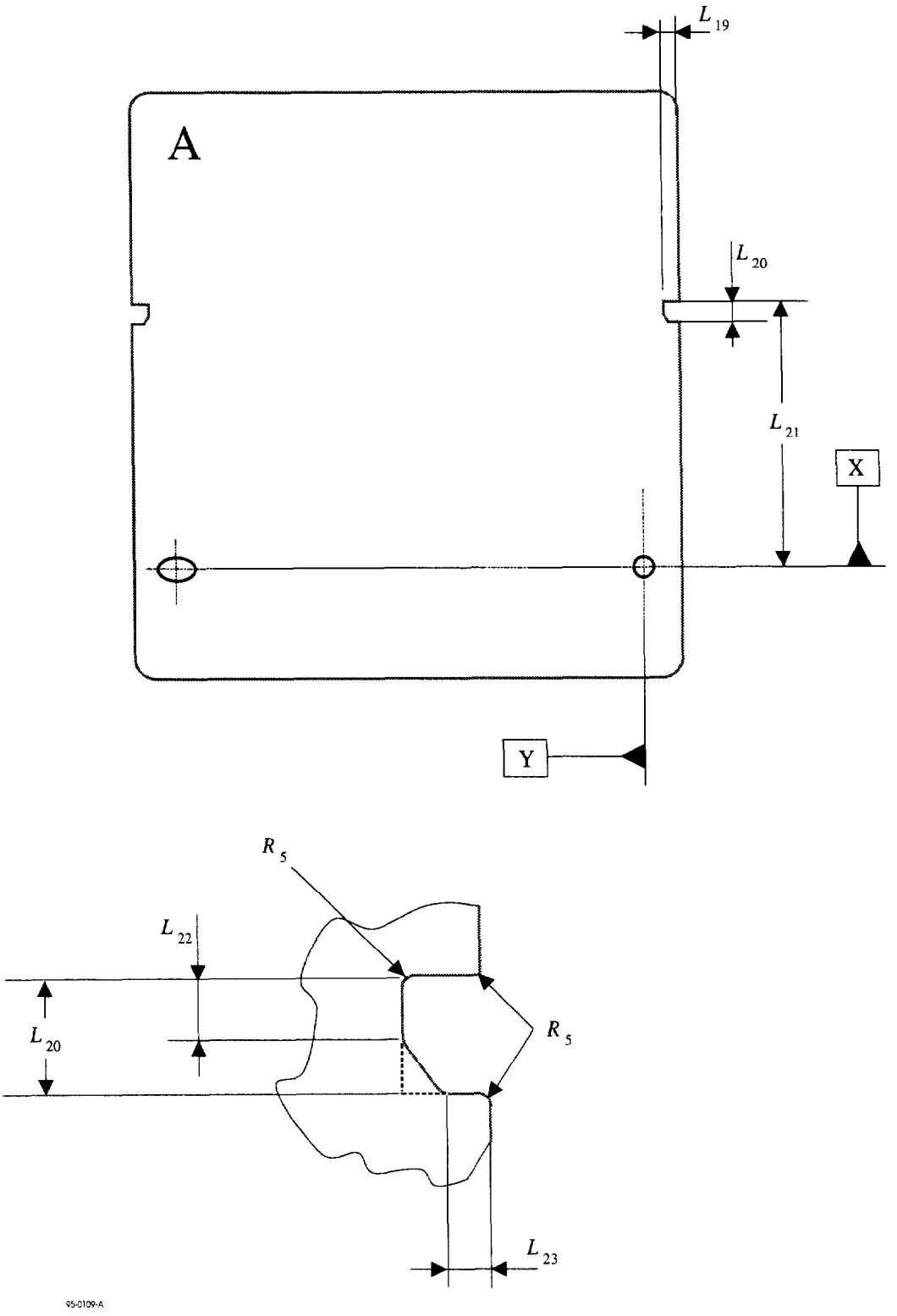


Figure 5 - Detents, seen on Side A of the case

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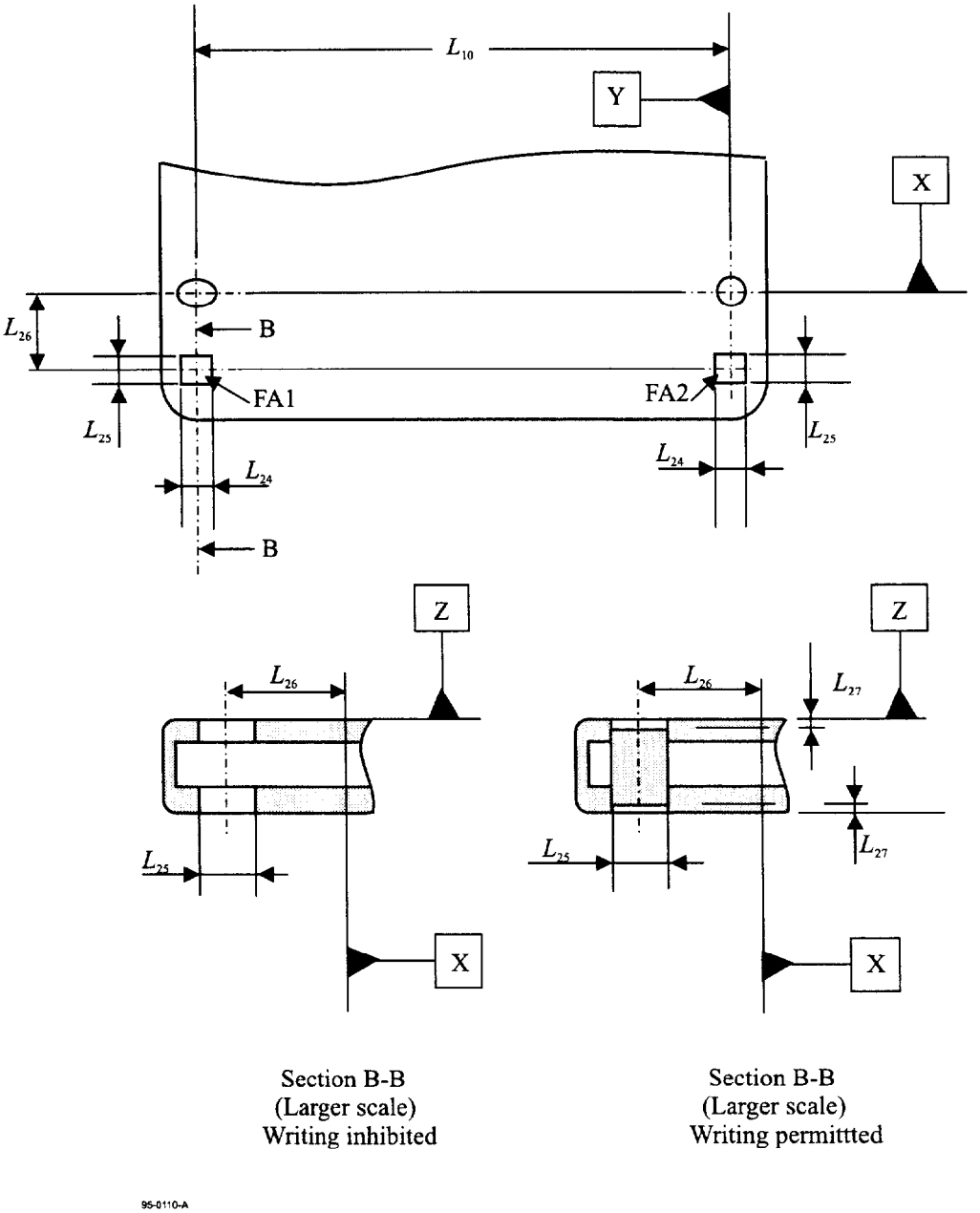


Figure 6 - Functional Areas FA1 and FA2, seen on Side A of the case

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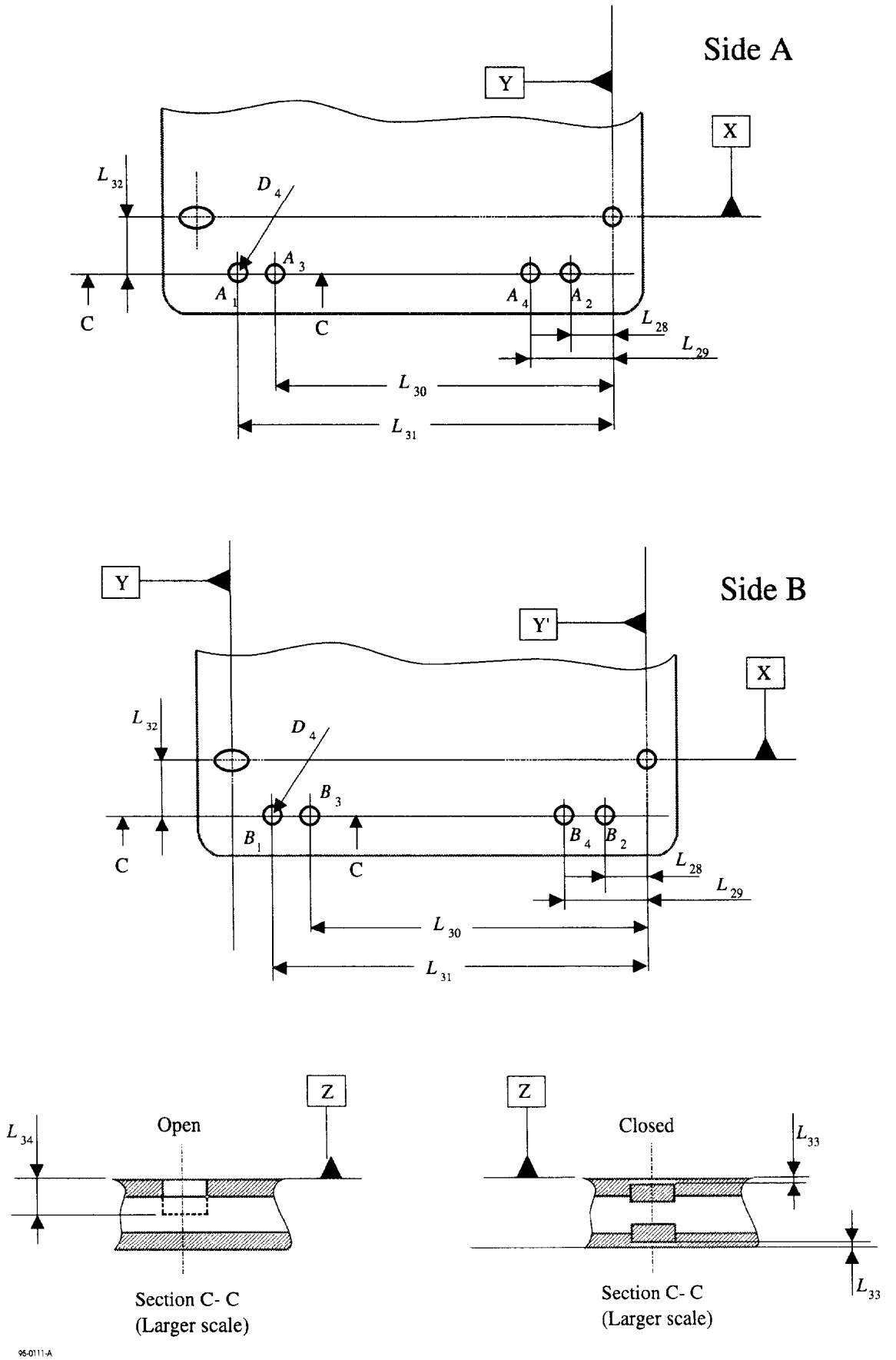


Figure 7 - Media sensor holes

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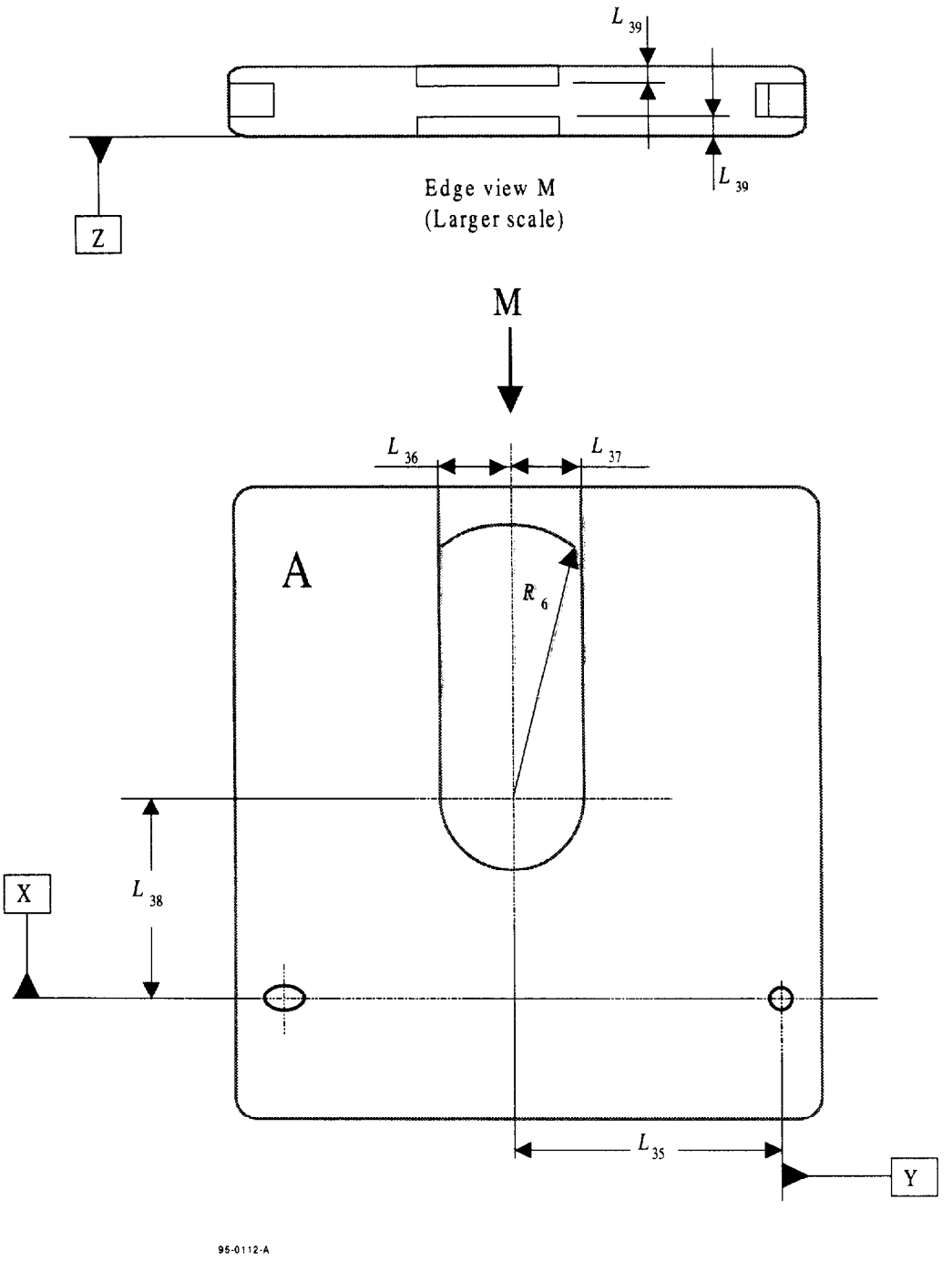


Figure 8 - Spindle and head windows on Side A of the case without shutter

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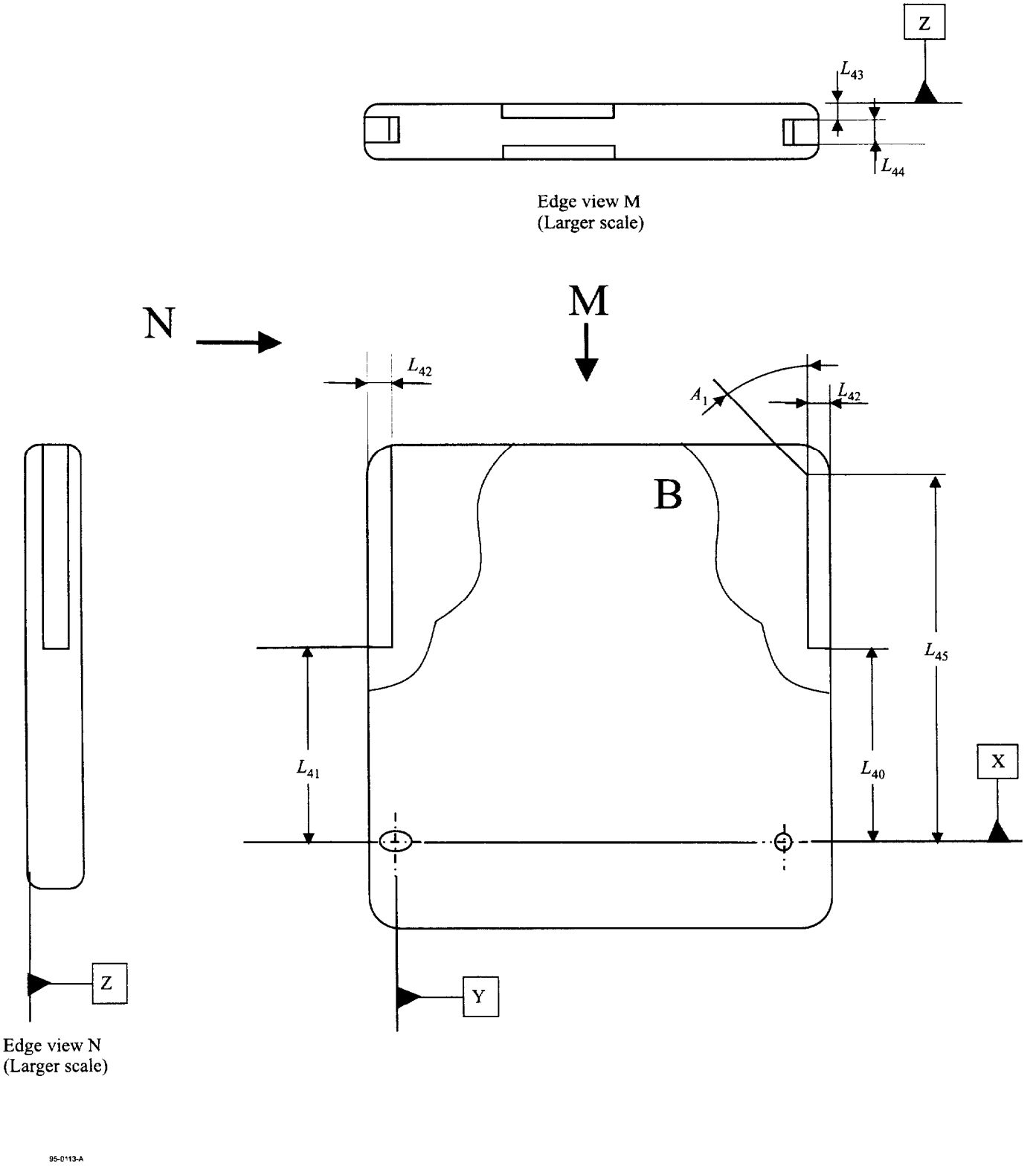


Figure 9 - Insertion slots, seen on Side B of the case

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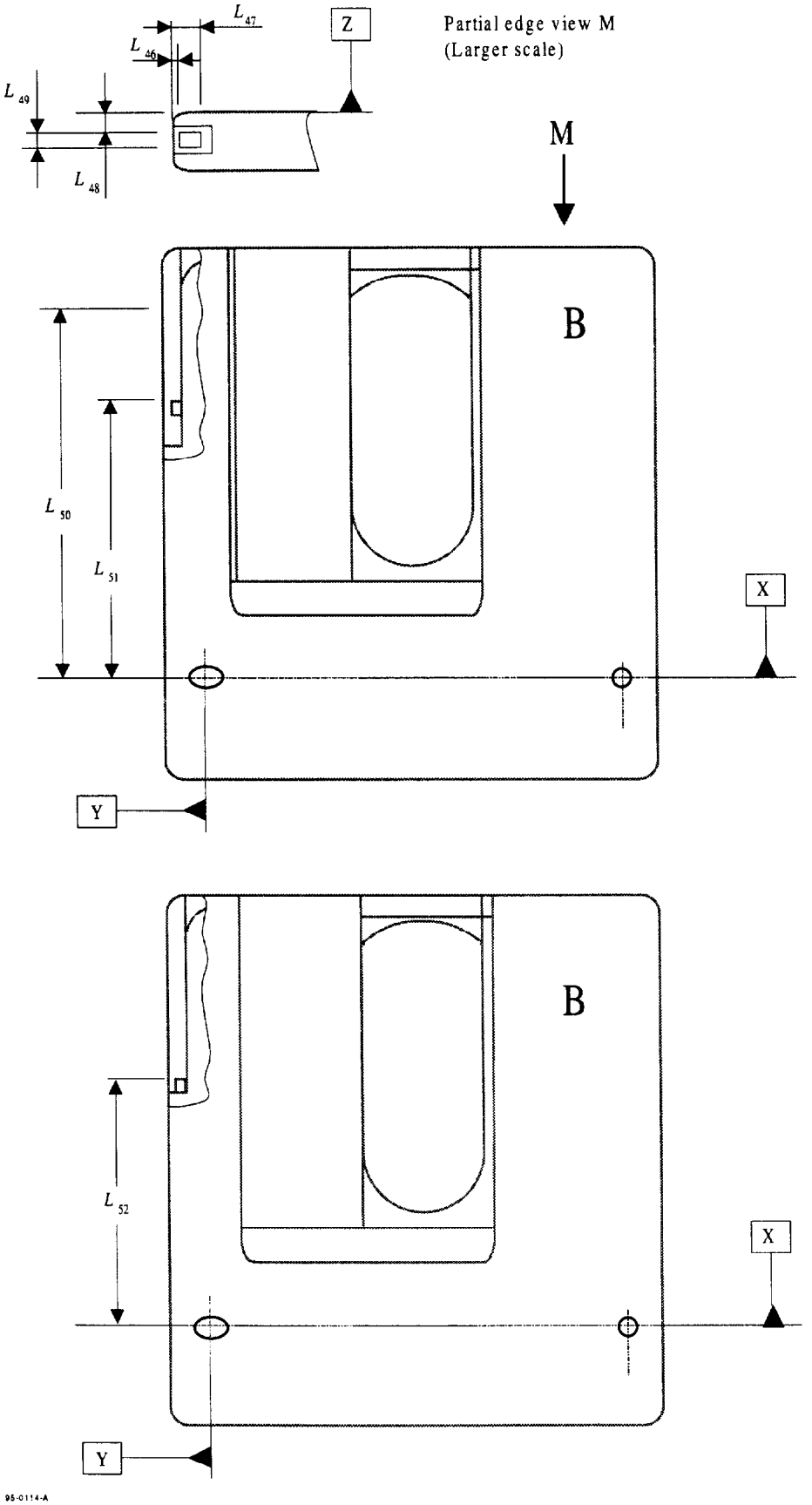


Figure 10 - Shutter in just open position (top) and completely open position (bottom), seen on Side B of the case

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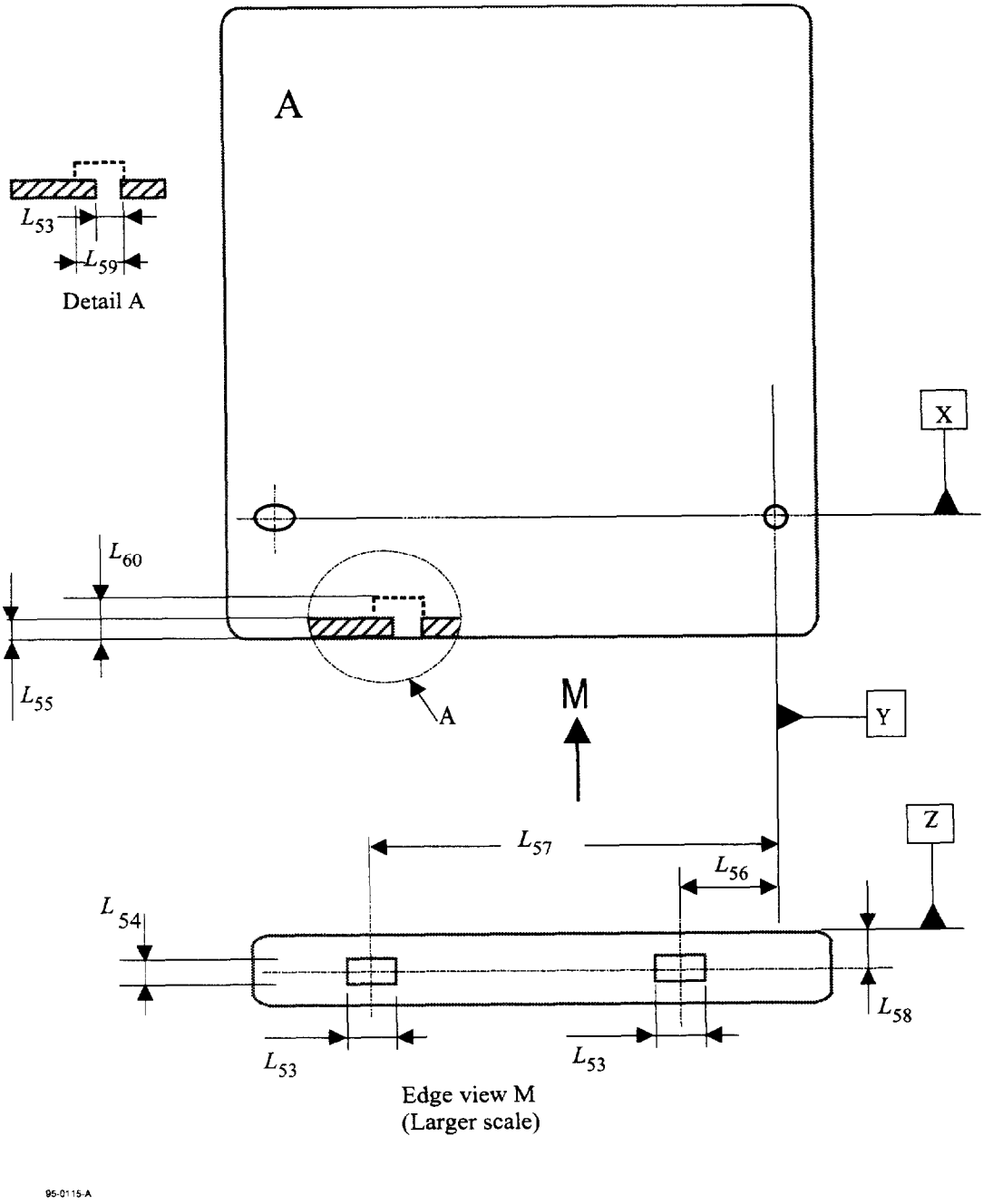


Figure 11 - Gripper slots seen on Side A of the case without shutter

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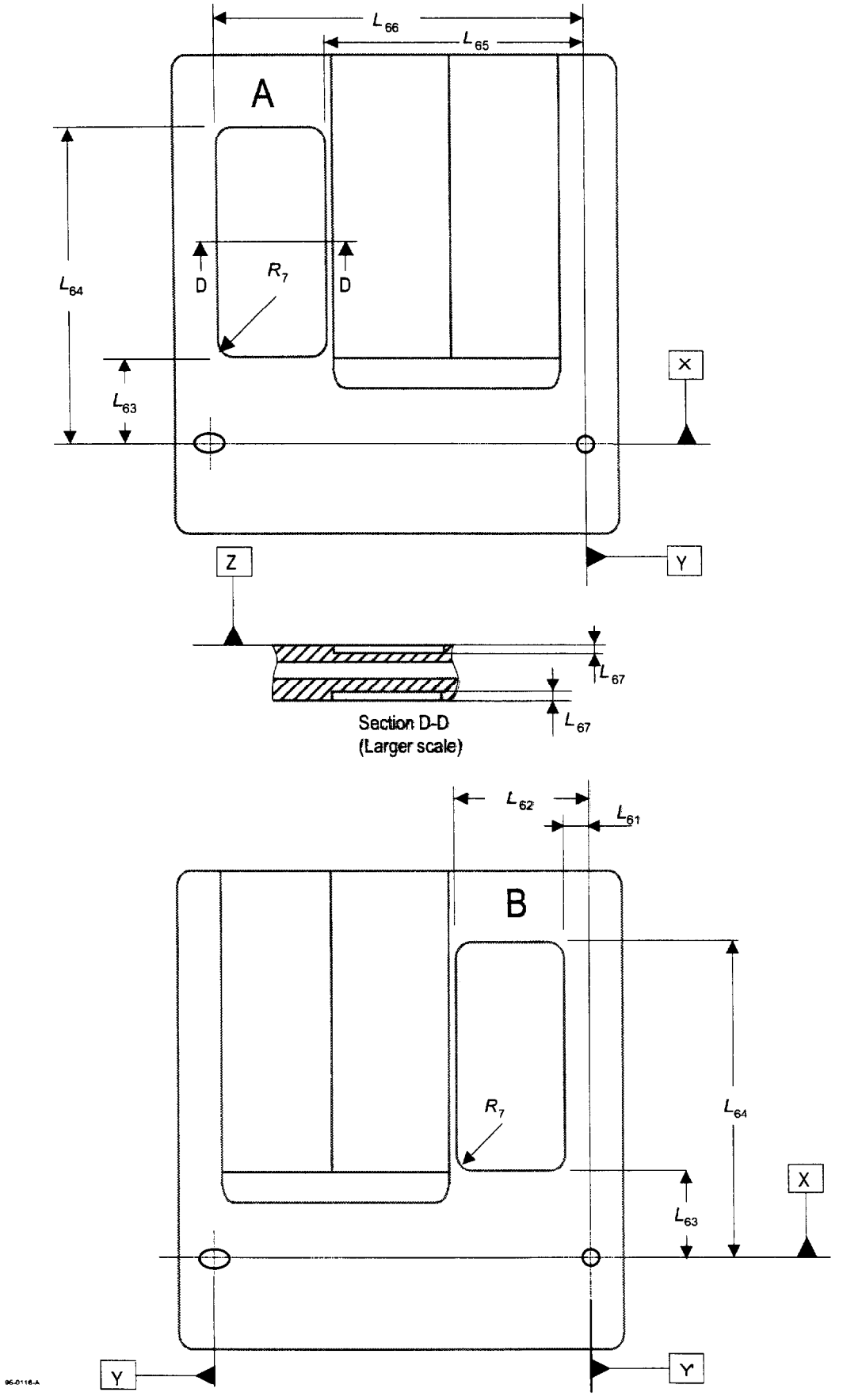


Figure 12 - Label area

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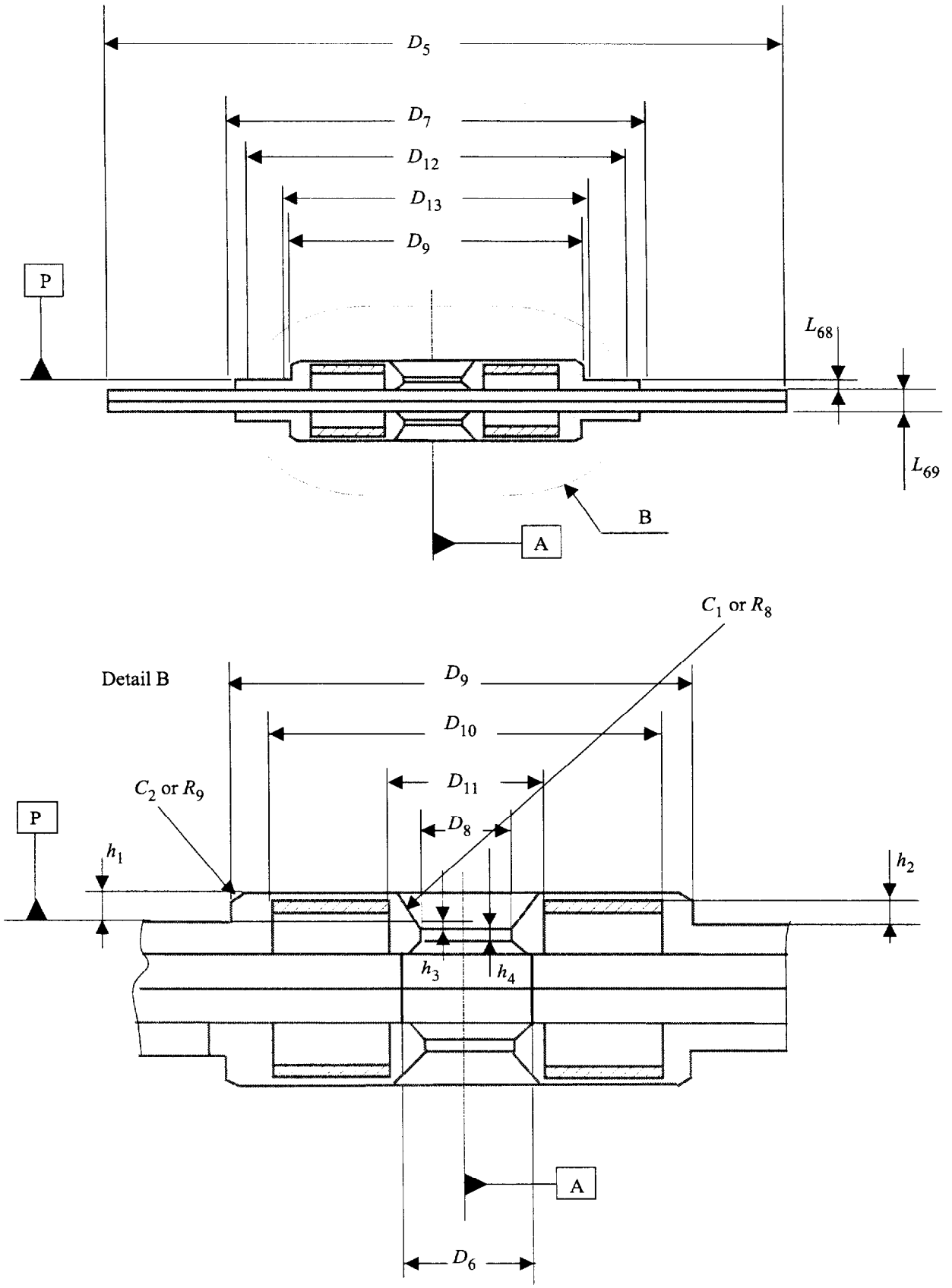


Figure 13 - Hub dimensions and clamping zone

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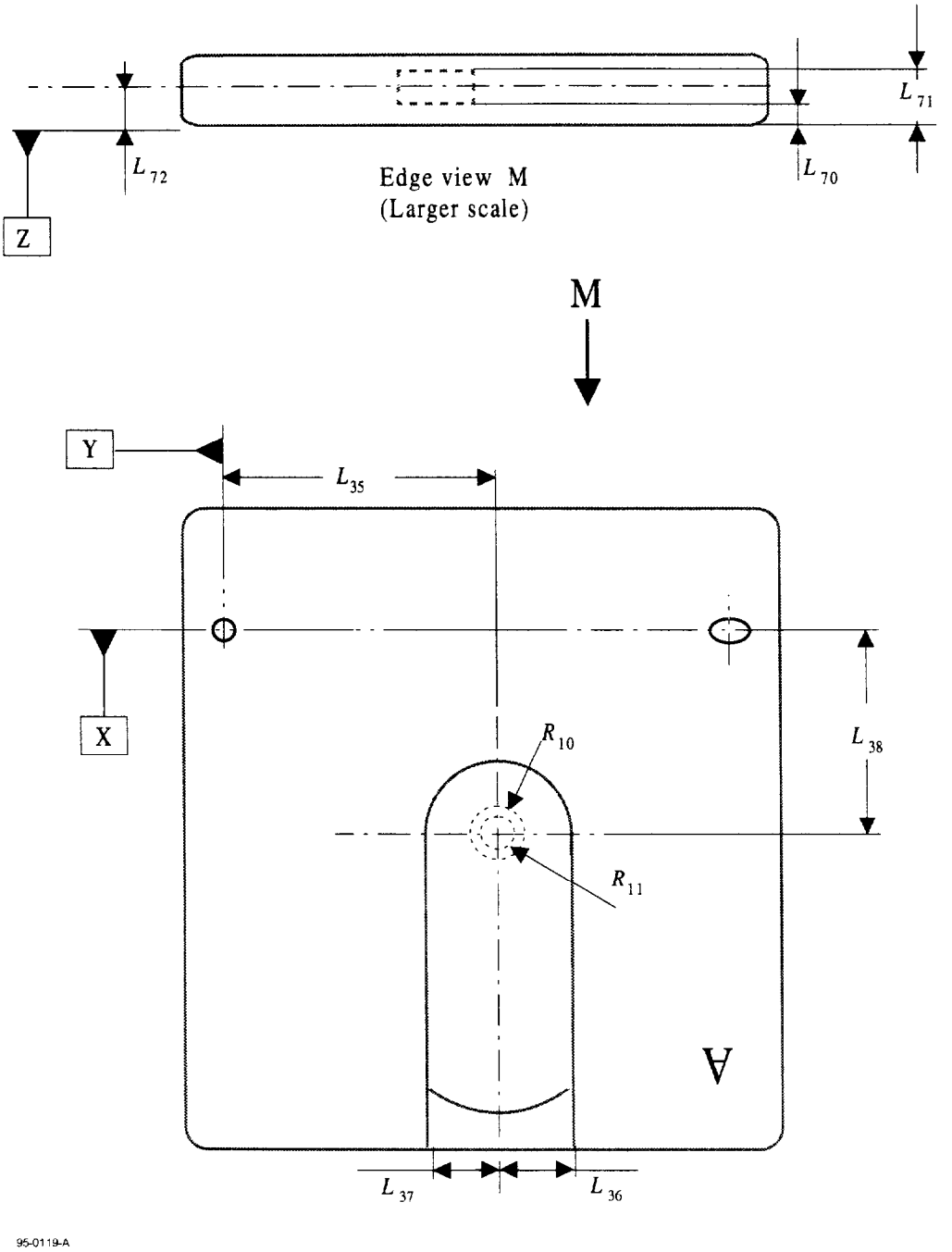


Figure 14 - Capture cylinder and disk position in operating condition

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Section 3 - Format of information

13 Geometry of physical tracks

13.1 Physical track shape

The Information Zone shall contain tracks intended for the Continuous Servo groove tracking method.

A physical track consists of a land-groove-land combination, where each land is shared with a neighbouring physical track. A groove is a trench-like feature, the bottom of which is located nearer to the entrance surface than the land. The centre of the physical track, i.e. where the recording is made, is the centre of the groove. The grooves shall be continuous, except for Header field. The shape of the groove is determined by the requirements of clause 21.

Each physical track shall form a 360° turn of a continuous spiral.

13.2 Direction of track spiral

The disk shall rotate counter-clockwise as viewed from the optical head. The track shall then spiral inward from the outer diameter to the inner diameter.

13.3 Physical track pitch

The physical track pitch is the distance between adjacent physical track centrelines, measured in a radial direction. It shall be 0,90 µm ± 0,05 µm.

The width of a band of 20 112 physical tracks shall be 18,10 mm ± 0,10 mm.

14 Track format

14.1 Track number

Each logical track shall be identified by a track number.

Track 0 shall be the first track of the Data Zone. It shall be located at a radius of 41,10 mm ± 0,10 mm.

The track numbers of tracks located at radii smaller than that of track 0 shall be increased by 1 for each track.

The track numbers of tracks located at radii larger than that of track 0 shall be negative, and decrease by 1 for each track. Their value is given in the ID field in TWO's complement, thus track -1 is indicated by (3FFFF) in case of 512-byte sectors or (FFFFF) in case of 2 048-byte sectors.

14.2 Track layout

On each logical track there shall be 16 sectors in case of 512-byte sectors or 4 sectors in case of 2 048-byte sectors.

The length of each sector shall be 11 568 / 38 096 Channel bits. The fields of a sector either contain 8-bit bytes, each represented by 16 Channel bits, or are defined as Channel bit patterns.

The sectors shall be equally spaced over a track in such a way that the distance between the first Channel bit of a sector and the first Channel bit of the next sector shall be 11 568 Channel bits ± 3 Channel bits in case of 512-byte sectors or 38 096 Channel bits ± 5 Channel bits in case of 2 048-byte sectors.

14.3 Clock frequencies and periods

The nominal clock frequency and period for each data band at the rotational speed of 50 Hz is shown in table 3a and table 3b below. These values are for reference only. The actual frequency and period shall be adjusted so that there is the correct number of Channel bits in one physical track by the formula below.

(68 - (Data Band Number)) × 11 568 for 512-byte sectors

(20 - (Data Band Number)) × 38 096 for 2 048-byte sectors

where 68 / 20 is the number of sectors per physical track in Band 0 of the Data Zone (see 17.2.5) and 11 568 / 38 096 is the number of Channel bits per sector.

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Table 3a - Nominal clock frequencies and periods for 512-byte sectors

Zone or band	Clock Frequency in MHz	Period T in ns
Buffer Zone	39,331 2	25,4
Test Zone	39,331 2	25,4
Control Zone	39,331 2	25,4
Buffer Zone	39,331 2	25,4
Band 0	39,331 2	25,4
Band 1	38,752 8	25,8
Band 2	38,174 4	26,2
Band 3	37,596 0	26,6
Band 4	37,017 6	27,0
Band 5	36,439 2	27,4
Band 6	35,860 8	27,9
Band 7	35,282 4	28,3
Band 8	34,704 0	28,8
Band 9	34,125 6	29,3
Band 10	33,547 2	29,8
Band 11	32,968 8	30,3
Band 12	32,390 4	30,9
Band 13	31,812 0	31,4
Band 14	31,233 6	32,0
Band 15	30,655 2	32,6
Band 16	30,076 8	33,2
Band 17	29,498 4	33,9
Band 18	28,920 0	34,6
Band 19	28,341 6	35,3
Band 20	27,763 2	36,0
Band 21	27,184 8	36,8
Band 22	26,606 4	37,6
Band 23	26,028 0	38,4
Band 24	25,4496	39,3
Band 25	24,871 2	40,2
Band 26	24,292 8	41,2
Band 27	23,714 4	42,2
Band 28	23,136 0	43,2
Band 29	22,557 6	44,3
Buffer Zone	22,557 6	44,3
Control Zone	22,557 6	44,3
Test Zone	22,557 6	44,3
Acquire Zone	22,557 6	44,3

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Table 3b - Nominal clock frequencies and periods for 2 048-byte sectors

Zone or band	Clock Frequency in MHz	Period T in ns
Buffer Zone	38,096 0	26,2
Test Zone	38,096 0	26,2
Control Zone	38,096 0	26,2
Buffer Zone	38,096 0	26,2
Band 0	38,096 0	26,2
Band 1	36,191 2	27,6
Band 2	34,286 4	29,2
Band 3	32,381 6	30,9
Band 4	30,476 8	32,8
Band 5	28,572 0	35,0
Band 6	26,667 2	37,5
Band 7	24,762 4	40,4
Band 8	22,857 6	43,7
Buffer Zone	20,952 8	47,7
Control Zone	20,952 8	47,7
Test Zone	20,952 8	47,7
Acquire Zone	20,952 8	47,7

14.4 Radial alignment

The Headers of the sectors shall be radially aligned in such a way that the angular distance between the first Channel bit of sectors in adjacent tracks within each data band, Lead-in Zone or Lead-out Zone shall be less than 4 Channel bits.

14.5 Sector number

The sectors on a track shall be numbered consecutively from 0 to 15 in case of 512-byte sectors and from 0 to 3 in case of 2 048-byte sectors.

15 Sector format

15.1 Sector layout

A sector shall comprise a Header and a Recording field in which 512 user data bytes or 2 048 user data bytes can be recorded. The Header of each sector shall be embossed. The Recording field can be empty, user-written or embossed. The length of the sector shall correspond to 723 bytes or 2 381 bytes nominally. Tolerances allowed by 14.2 are taken up by the Buffer, i.e. the last field of the sector. The length of the Header field corresponds to 47 bytes and the length of the Recording field corresponds to 676 bytes or 2 334 bytes.

The layout of a sector is shown in figure 15a and figure 15b. The numbers indicate the length of field in bytes.

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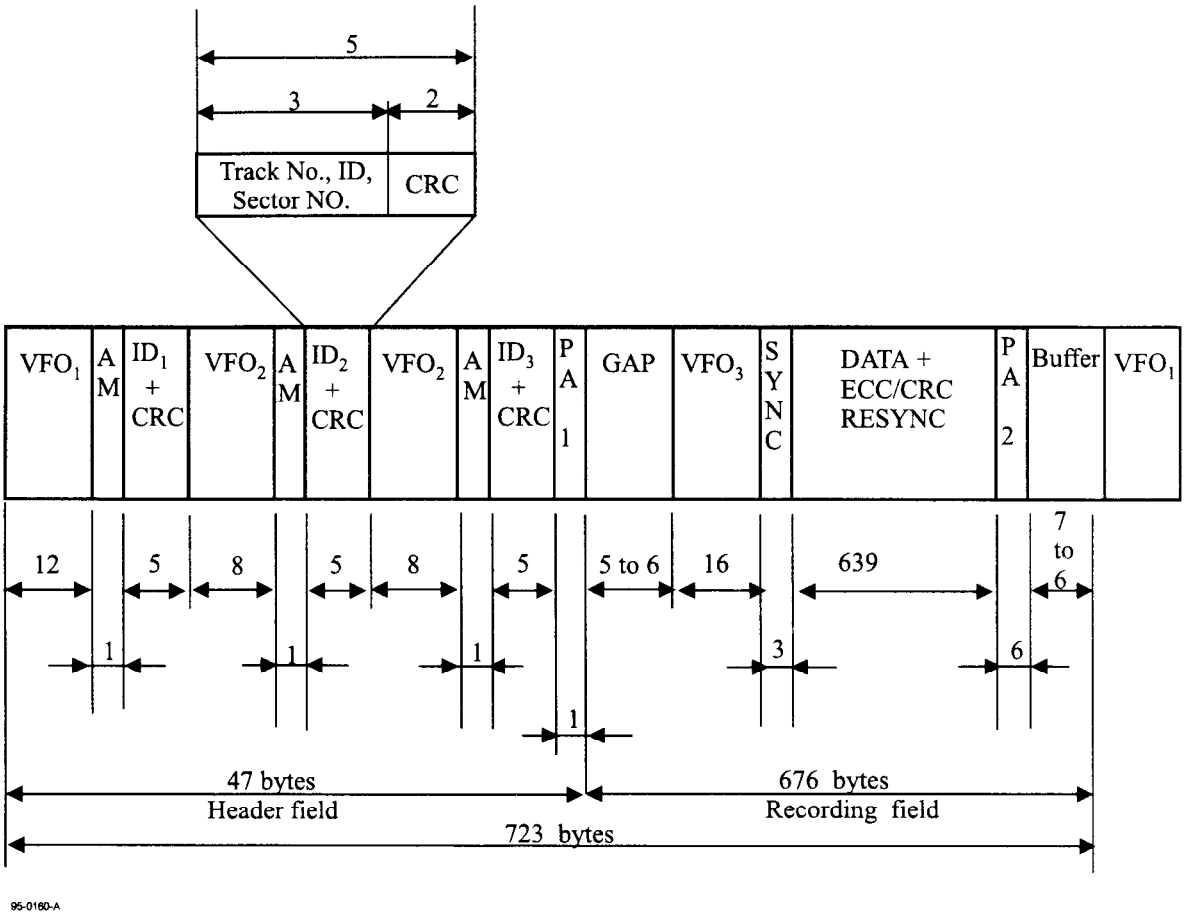


Figure 15a - Sector layout (512-byte sectors)

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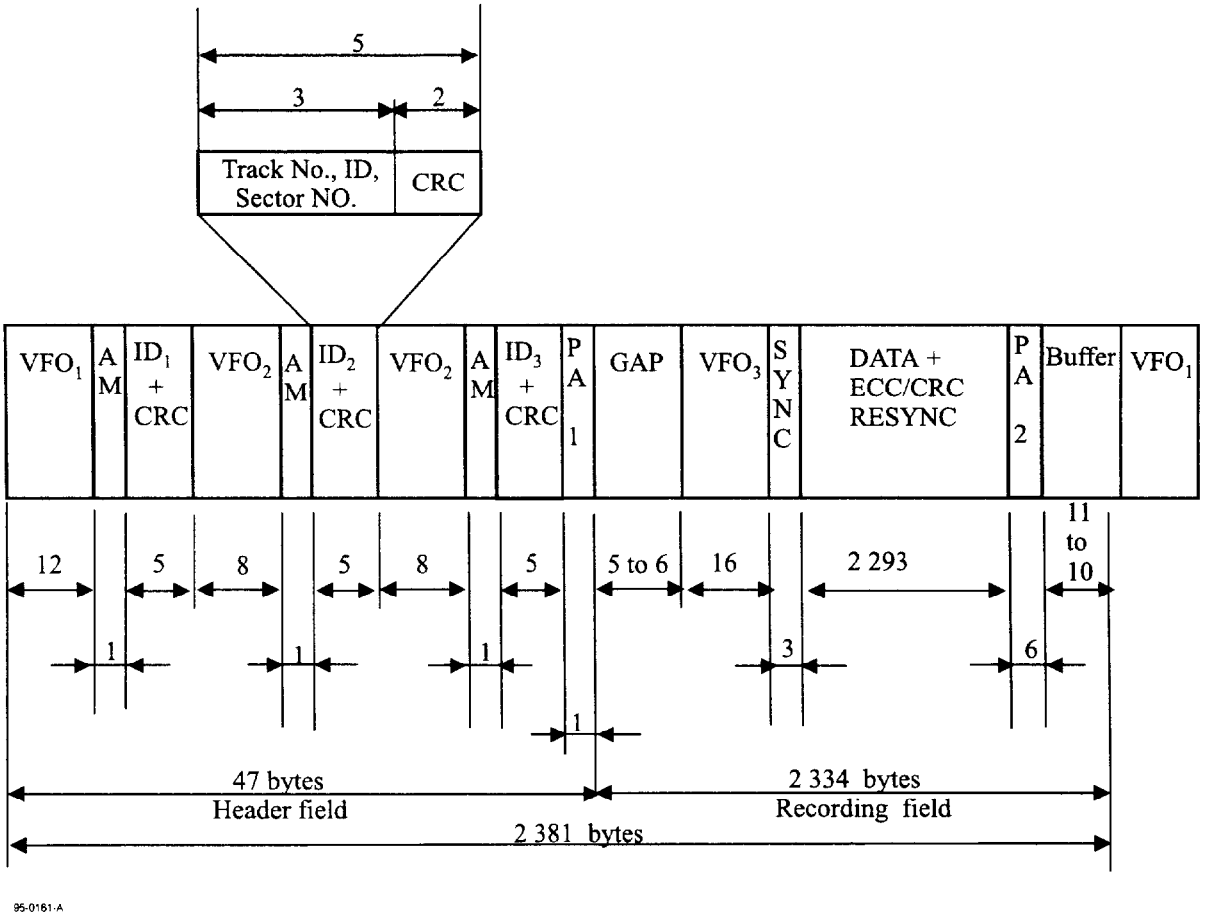


Figure 15b - Sector layout (2 048-byte sectors)

15.2 VFO_1 and VFO_2 fields

There shall be one embossed VFO_1 field and two embossed VFO_2 fields in the Header to give Channel bit synchronization to the voltage-controlled frequency oscillator of the phase-locked loop of the read channel. The VFO_1 shall have a length of 192 Channel bits. VFO_2 shall have a length of 128 Channel bits. The start of VFO_2 depends on the contents of the preceding ID field because of the closure required for the RLL(2,7) recording code (see clause 16). Therefore, VFO_2 shall consist of the appropriate one of two patterns differing only in the first Channel bit.

The continuous Channel bit pattern for the VFO_1 and VFO_2 fields shall be

VFO_1, 192 Channel bits:	0100100100100....	10010
VFO_2, 128 Channel bits:	100100100100....	10010
VFO_2, 128 Channel bits:	000100100100....	10010

15.3 Address Mark (AM)

The Address Mark shall consist of an embossed pattern that does not occur in RLL(2,7) code. The field is intended to give the drive byte synchronization for the following ID field. It shall have a length of 16 Channel bits with the following pattern:

0100 1000 0000 0100

15.4 ID fields

The three ID fields shall each contain the address of the sector, i.e. the track number and the sector number of the sector, and CRC bytes. Each field shall consist of five bytes with the following embossed contents:

1st byte	The most significant byte of the track number
2nd byte	The second most significant byte of the track number

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3rd byte	
bits 7 and 6	ID number 00 shall indicate the ID_1 field 01 shall indicate the ID_2 field 10 shall indicate the ID_3 field

512-byte sectors:

bits 5 to 4	The two least significant bits of the track number
bits 3 to 0	The sector number in binary notation

2 048-byte sectors:

bits 5 to 2	The four least significant bits of the track number
bits 1 to 0	The sector number in binary notation
4th and 5th byte	CRC field containing the CRC bits computed over the first three bytes according to annex D.

15.5 PA_1 field

The PA_1 field shall have a length of 16 Channel bits following ID_3. The PA_1 allows closure of the last byte of the preceding CRC as required by the RLL(2,7) recording code (see clause 16). The PA_1 is necessary to be able to start the following Gap field in a predictable manner.

15.6 Gap

The Gap shall be a field with a nominal length of 80 to 96 Channel bits. The nominal length of the Gap shall be varied randomly in a unit of Channel bit to shift the position of the marks formed in the Recording field. The variation of the nominal length shall be compensated by the nominal length of the Buffer field. The content of the Gap is not specified and shall be ignored in interchange, but shall not be embossed. It is the first field of the Recording field, and gives the drive some time for processing after it has finished reading the Header and before it has to write or read the VFO_3 field.

The length of the Gap has a tolerance of ± 8 Channel bits from the nominal length, i.e. the following VFO_3 field can start between 72 and 104 Channel bits after the PA_1. Moreover, it need not start exactly on a Channel bit position as extrapolated from the Header. The tolerance is subtracted from the length of the Buffer field, e.g. a Gap length of 85,3 Channel bits when the nominal length is 80 Channel bits results in a reduction of the Buffer length by 5,3 Channel bits.

15.7 VFO_3 field

There shall be a VFO_3 field to give the voltage-frequency oscillator of the phase-locked loop of the read channel Channel bit synchronization for the Recording field. The VFO_3 shall have a length of 256 Channel bits. It shall be recorded with the Channel bit pattern:

VFO_3, 256 Channel bits: 001001001001.... 10010

15.8 Sync

The Sync field is intended to allow the drive to obtain byte synchronization for the following Data field. It shall have a length of 48 Channel bits and be recorded with the Channel bit pattern

0100 0010 0100 0010 0010 0010 0100 0100 1000 0010 0100 1000

15.9 Data field

The Data field is intended for recording user data. It shall have a length of 639 bytes in case of 512-byte sectors or 2 293 bytes for 2 048-byte sectors and shall comprise:

512-byte sectors:

- 512 bytes of user data
- 4 bytes the contents of which are not specified by this International Standard and shall be ignored in interchange
- 4 bytes of CRC

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- 80 bytes of ECC, and
- 39 bytes for re-synchronization.

2 048-byte sectors:

- 2 048 bytes of user data
- 4 bytes the contents of which are not specified by this International Standard and shall be ignored in interchange
- 4 bytes set to (FF)
- 4 bytes of CRC
- 160 bytes of ECC, and
- 73 bytes for re-synchronization.

The disposition of these bytes in the Data field in each case and the contents of the last three categories is specified in annex E.

15.9.1 User data bytes

The user data bytes are at the disposal of the user for recording information.

15.9.2 CRC and ECC bytes

The Cyclic Redundancy Check bytes and Error Correction Code bytes are used by the error detection and correction system to rectify erroneous data. The ECC is a Reed-Solomon code of degree 16. The bytes shall be as specified in annex E.

15.9.3 Resync bytes

The Resync bytes enable a drive to regain byte synchronization after a large defect in the Data field. Their content and location in the Data field shall be as specified in annex E.

15.9.4 PA_2 field

The PA_2 field shall have a length of 96 Channel bits following the Data field. The PA_2 allows closure of the last byte of the preceding Data field as required by the RLL(2,7) recording code (see clause 16). The PA_2 is necessary to be able to start the following Gap field in a predictable manner.

15.10 Buffer field

The Buffer field shall have a nominal length of 96 to 112 Channel bits compensating the variation of the nominal length of the Gap field in case of 512-byte sectors. In case of 2 048-byte sectors, the nominal length of the Buffer field shall be 160 to 176 Channel bits. The Buffer field shall not contain any data. It is needed for three reasons. First, the tolerance on the Header-to-Header distance as specified in 14.2. Second, the tolerance in the start of the VFO_3 field as specified in 15.6. Third, the actual length of the written data, as determined by the runout of the track and the speed variations of the disk during writing of the data.

16 Recording code

The 8-bit bytes in the three Address fields and in the Data field, except for the Resync bytes, shall be converted to Channel bits on the disk according to table 4. All other fields in a sector have already been defined in terms of Channel bits. Each ONE Channel bit shall be recorded as a mark produced by a write pulse of the appropriate power and width.

The recording code used to record all data in the Information Zone on the disk shall be the run-length limited code known as RLL(2,7).

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Table 4 - Conversion of input bits to Channel bits

Input bits	Channel bits
10	0100
11	100100
000	00100100
010	1000
011	001000
0010	00001000
0011	000100

The coding start at the first bit of the first byte of the field to be converted. After a Resync field the RLL(2,7) coding shall start again with the first bit of the next byte of input data.

The RLL(2,7) coding can seldom be terminated at the end of the last input byte in a field, due to leftover bits which cannot be converted on their own. To achieve closure of the recording code, three pad bits are added at the end of field before converting the data to Channel bits. Table 5 defines the closure for all possible combinations of leftover bits.

The ID_1 and ID_2 fields shall lead to one of the two patterns for the VFO_2 (see table 5a).

The bytes in the Data field preceding a Resync field shall lead to the Resync pattern (table 5b).

With the exception of providing a suitable closure pattern for the ID_3 field and the last byte in the PA_1 field following the ID_3 field and the last byte in the Data field, respectively, are not specified by this International Standard and shall be ignored in interchange.

Table 5a - Transition from the end of the ID_1 and ID_2 field to the VFO_2 field

Leftover input bits	Pad bits	Channel bits of the closure pattern, leading to one of the two VFO_2 patterns	
none	010		100100100100100100.....10010
0	010	00	100100100100100100.....10010
1	010	01	000100100100100100.....10010
00	010	0001	000100100100100100.....10010
01	010	1001	000100100100100100.....10010
001	010	001001	000100100100100100.....10010
End of the ID field ⟶		End of the ID field →	⟵ VFO_2 field ⟶

Table 5b - Transition from the byte in the Data field preceding a Resync to the Resync field

Leftover input bits	Pad bits	Channel bits of the closure pattern, leading to the Resync pattern	
none	011		0010000000100100
0	011	00	0010000000100100
1	011	01	0010000000100100
00	011	0001	0010000000100100
01	011	1001	0010000000100100
001	011	001001	0010000000100100
End of the ID field ⟶		End of the ID field ⟶	⟵ Resync ⟶

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17 Format of the Information Zone

17.1 General description of the Information Zone

The Information Zone shall contain all information on the disk relevant for data interchange. The information comprises embossed tracking provisions, embossed headers, embossed data and, possibly, user-written data. In this clause, the term 'data' is reserved for the content of the data field of a sector, which, in general, is transferred to the host. This clause defines the layout of the information; the characteristics of signals obtained from this information are specified in section 4.

17.2 Division of the Information Zone

The Information Zone shall be divided in three main parts: the Lead-in Zone, the Data Zone and the Lead-out Zone. The Lead-in Zone and the Lead-out Zone contain control information for the drive and zones for performing test by manufacturers or drives. The three zones shall be sub-divided as shown below. Tables 6a and 6b show the main parameters for these zones.

Lead-in Zone

- Buffer Zone
- Outer Test Zone
  - for manufacturers
  - for drives
- Outer Control Zone

Data Zone

30 Bands in the case of 512-byte sectors
9 Bands in the case of 2 048-byte sectors

Lead-out Zone

- Inner Control Zone
- Inner Test Zone
  - for drives
  - for manufacturers
- Acquire Zone
  - Focus Tracks
  - Lead-out Tracks
- Mirror Zone

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Table 6a - Layout of the Information Zone (512-byte sectors)

Zone or Band	Nominal Radius Start-End (mm)	Number of Logical Tracks	Logical Track Number Start-End	Number of Physical Tracks	Number of Sectors per Physical Track
Lead-in Zone					
Buffer Zone	41,40 - 41,17	1 088	-1 428 - -341	256	68
Outer Test Zone :					
- for manufacturers	41,17 - 41,14	136	-340 - -205	32	68
- for drives	41,14 - 41,11	136	-204 - -69	32	68
Outer Control Zone	41,11 - 41,10	68	-68 - -1	16	68
Data Zone					
Band 0	41,10 - 40,73	1 768	0 - 1 767	416	68
Band 1	40,73 - 40,11	2 881	1 768 - 4 648	688	67
Band 2	40,11 - 39,49	2 838	4 649 - 7 486	688	66
Band 3	39,49 - 38,87	2 795	7 487 - 10 281	688	65
Band 4	38,87 - 38,25	2 752	10 282 - 13 033	688	64
Band 5	38,25 - 37,63	2 709	13 034 - 15 742	688	63
Band 6	37,63 - 37,01	2 666	15 743 - 18 408	688	62
Band 7	37,01 - 36,39	2 623	18 409 - 21 031	688	61
Band 8	36,39 - 35,77	2 580	21 032 - 23 611	688	60
Band 9	35,77 - 35,15	2 537	23 612 - 26 148	688	59
Band 10	35,15 - 34,53	2 494	26 149 - 28 642	688	58
Band 11	34,53 - 33,92	2 451	28 643 - 31 093	688	57
Band 12	33,92 - 33,30	2 408	31 094 - 33 501	688	56
Band 13	33,30 - 32,68	2 365	33 502 - 35 866	688	55
Band 14	32,68 - 32,06	2 322	35 867 - 38 188	688	54
Band 15	32,06 - 31,44	2 279	38 189 - 40 467	688	53
Band 16	31,44 - 30,82	2 236	40 468 - 42 703	688	52
Band 17	30,82 - 30,20	2 193	42 704 - 44 896	688	51
Band 18	30,20 - 29,58	2 150	44 897 - 47 046	688	50
Band 19	29,58 - 28,96	2 107	47 047 - 49 153	688	49
Band 20	28,96 - 28,34	2 064	49 154 - 51 217	688	48
Band 21	28,34 - 27,72	2 021	51 218 - 53 238	688	47
Band 22	27,72 - 27,10	1 978	53 239 - 55 216	688	46
Band 23	27,10 - 26,48	1 935	55 217 - 57 151	688	45
Band 24	26,48 - 25,87	1 892	57 152 - 59 043	688	44
Band 25	25,87 - 25,25	1 849	59 044 - 60 892	688	43
Band 26	25,25 - 24,63	1 806	60 893 - 62 698	688	42
Band 27	24,63 - 24,01	1 763	62 699 - 64 461	688	41
Band 28	24,01 - 23,39	1 720	64 462 - 66 181	688	40
Band 29	23,39 - 23,00	1 053	66 182 - 67 234	432	39
Lead-Out Zone					
Inner Control Zone	23,00 - 22,99	39	67 235 - 67 273	16	39
Inner Test Zone :					
- for drives	22,99 - 22,96	78	67 274 - 67 351	32	39
- for manufacturers	22,96 - 22,93	78	67 352 - 67 429	32	39
Acquire Zone :					
- Focus tracks	22,93 - 22,91	39	67 430 - 67 468	16	39
- Lead-out tracks	22,91 - 21,91	2 730	67 469 - 70 198	1 120	39
Mirror Zone	21,91 - 21,60	N/A	N/A	N/A	N/A

Note - The radii of a zone in the table are the nominal values of the radius of the centre of the first track and of the radius of the centre of the last track of the zone.

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Table 6b - Layout of the Information Zone (2 048-byte sectors)

Zone or Band	Nominal Radius Start-End (mm)	Number of Logical Tracks	Logical Track Number Start-End	Number of Physical Tracks	Number of Sectors per Physical Track
Lead-in Zone					
Buffer Zone	41,40 - 41,17	1 280	-1 680 - -401	256	20
Outer Test Zone :					
- for manufacturers	41,17 - 41,14	160	-400 - -241	32	20
- for drives	41,14 - 41,11	160	-240 - -81	32	20
Outer Control Zone	41,11 - 41,10	80	-80 - -1	16	20
Data Zone					
Band 0	41,10 - 39,42	9 360	0 - 9 359	1 872	20
Band 1	39,42 - 37,36	10 830	9 360 - 20 189	2 280	19
Band 2	37,36 - 35,31	10 260	20 190 - 30 449	2 280	18
Band 3	35,31 - 33,26	9 690	30 450 - 40 139	2 280	17
Band 4	33,26 - 31,21	9 120	40 140 - 49 259	2 280	16
Band 5	31,21 - 29,16	8 550	49 260 - 57 809	2 280	15
Band 6	29,16 - 27,10	7 980	57 810 - 65 789	2 280	14
Band 7	27,10 - 25,05	7 410	65 790 - 73 199	2 280	13
Band 8	25,05 - 23,00	6 840	73 200 - 80 039	2 280	12
Lead-Out Zone					
Inner Control Zone	23,00 - 22,99	44	80 040 - 80 083	16	11
Inner Test Zone :					
- for drives	22,99 - 22,96	88	80 084 - 80 171	32	11
- for manufacturers	22,96 - 22,93	88	80 172 - 80 259	32	11
Acquire Zone :					
- Focus tracks	22,93 - 22,91	44	80 260 - 80 303	16	11
- Lead-out tracks	22,91 - 21,91	3 080	80 304 - 83 383	1 120	11
Mirror Zone	21,91 - 21,60	N/A	N/A	N/A	N/A

Note - The radii of a zone in the table are the nominal values of the radius of the centre of the first track and of the radius of the centre of the last track of the zone.

The division of the Information Zone shall be as given in table 6. The tolerance on the outer radius of the Data Zone is specified in 14.1; the tolerance on other radii is determined by the tolerance on the track pitch specified in 13.3.

17.2.1 Mirror Zone

The Mirror Zone is intended to enable a drive to lock its axial tracking (focusing) servo and to enable to measure an amplitude of a signal corresponding to the reflectance of the recording layer. It shall have a flat reflective layer.

17.2.2 Acquire Zone

The Acquire Zone shall consist of two parts, each containing embossed grooves and Headers. The first part shall be a band of Lead-out tracks with no data in the Recording fields of the sectors.

The second part shall be a band of Focus tracks with a repeated Channel bit pattern 100100... embossed in the VFO_3, SYNC and the entire Data fields of the Recording field of each sector. These tracks are intended to enable a drive to remove focus offsets by maximizing the read signal from the Channel bit pattern.

17.2.3 Test Zones

There shall be an Inner Test Zone and an Outer Test Zone. The Test Zones are areas with embossed grooves, Headers and Recording fields.

The Test Zone for drives is intended for tests to enable a drive to set its write power, and shall not consist of embossed data in the case of fully overwritable or partially embossed disks. The tracks used for testing should be chosen from the Test Zone in a random way, so as to ensure a gradual degradation of the entire Test Zone due to use. Then each track in this Zone will remain representative for the characteristics of tracks in the Data Zone of the disk.

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The Test Zone for the manufacturer is intended for quality tests by the media manufacturer. The Test Zone for drives shall not be used for such tests, as they can cause serious degradation of the Test Zone.

17.2.4 Control Zones

There shall be an Inner Control Zone and an Outer Control Zone. Each Control Zone shall contain 16 physical tracks with embossed grooves and sectors formatted according to clause 15, and 5 tracks, called Buffer tracks, with embossed grooves and Headers according to clause 15. In the Inner Control Zone the Buffer tracks are tracks 67 235 to 67 239 in case of 512-byte sectors and tracks 80 040 to 80 044 in case of 2 048-byte sectors, in the Outer Control Zone track -5 to -1 are the Buffer tracks in both cases. The Data fields of all sectors in the two Control Zones, except in the Buffer tracks, shall be identical, and contain embossed Control data for the drive. The Control data in a Data field shall be as specified in annex D.

The Recording fields of all sectors of the Buffer tracks shall be unrecorded (without embossed data) for fully rewritable and partially embossed disks. For fully embossed disks these fields shall be set to (FF).

17.2.5 Data Zone

The Data Zone shall contain embossed grooves and Headers. The Recording fields can be user-written or contain embossed data, in the format of clause 15. The format of the Data Zone is specified in clause 18.

The Data Zone shall be divided into 30 bands numbered 0 to 29 in case of 512-byte sectors and 9 bands numbered 0 to 8 in case of 2 048-byte sectors. Each band shall consist of the same number of physical tracks with exceptions of the first band and, in the case of 512-byte sectors, also of the last band. These physical tracks are organized into groups called physical track groups. Each such group is further divided into logical tracks. In case of 512-byte sectors, each band has 43 physical track groups, except that the first band has 26 physical track groups and the last band has 27 physical track groups. In case of 2 048-byte sectors, each band has 570 physical track groups except that the first band has 468 physical track groups. The number of logical tracks per physical track group decreases from band to band when moving from the outer radius to the inner radius. Within any band, the angular recording density shall be constant, and physical track groups shall comprise an integral number of physical tracks and shall begin and end on the same radial line.

The hierarchy is thus:

512-byte sectors:

- 16 sectors = 1 logical track
- 68 to 39 logical tracks (16 physical tracks) = 1 physical track group
- 26 physical track groups = 1 band for band 0
- 27 physical track groups = 1 band for band 29
- 43 physical track groups = 1 band for the band in linear area
- 30 bands = the Data Zone

2 048-byte sectors:

- 4 sectors = 1 logical track
- 20 to 12 logical tracks (4 physical tracks) = 1 physical track group
- 468 physical track groups = 1 band for band 0
- 570 physical track groups = 1 band for the band in linear area
- 9 bands = the Data Zone

The Data Zone shall start with track 0 and end with track 67 234 in case of 512-byte sectors and with track 80 039 in case of 2 048-byte sectors.

17.2.6 Buffer Zone

The Buffer Zone shall contain embossed grooves and Headers.

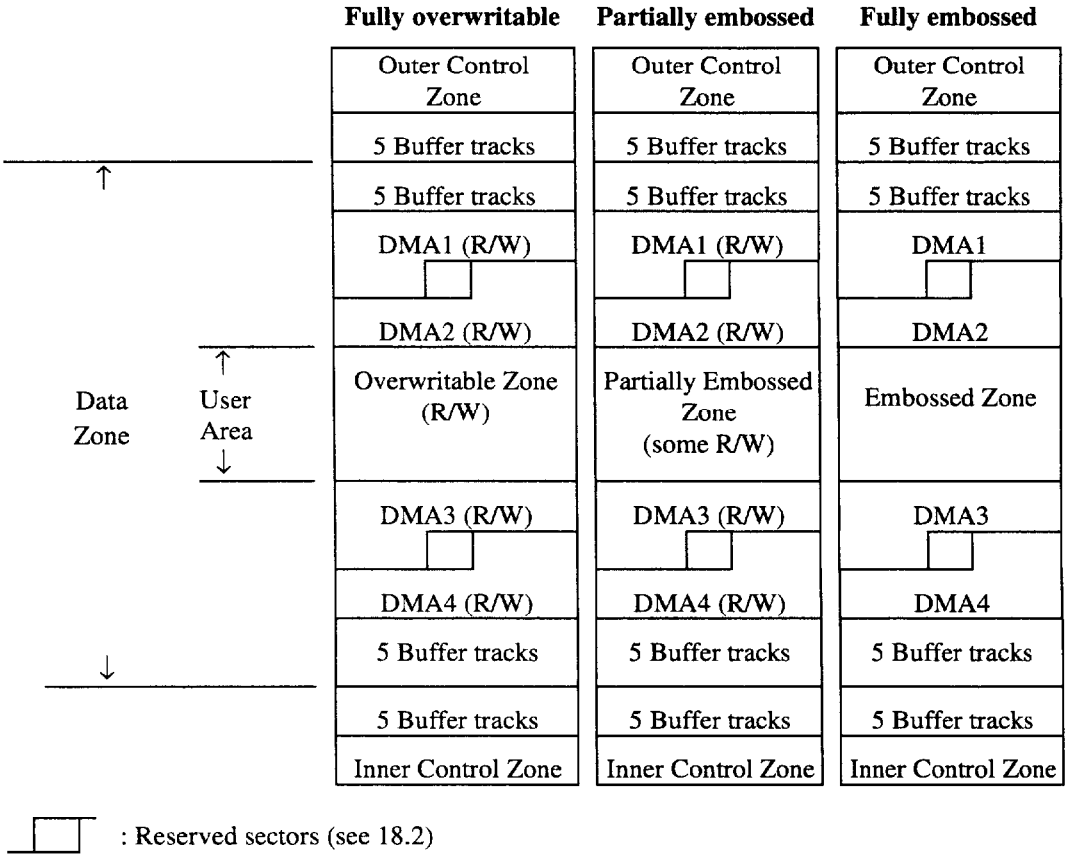
18 Format of the Data Zone

The Data Zone shall contain four Defect Management Areas (DMAs), two at the beginning of the zone after the five Buffer tracks in the Data Zone specified in 18.1 and two at the end of the zone before the five Buffer tracks. The area between the two sets of DMAs is called the User Area. The User Area shall contain an Overwritable Zone or an Embossed Zone or a Partially Embossed Zone. The User Area shall be interrupted by the Buffer tracks at each Band boundary as specified in 18.1.

The layout of the Data Zone and adjacent zones is shown in table 7, where the tracks marked R/W are rewritable.

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Table 7 - Layout of the Data Zone, the Control Zones and the Buffer tracks



18.1 Buffer tracks in the Data Zone

The five tracks at the beginning of each band and the five tracks at the end of each band of the Data Zone of any Types of disks shall be Buffer tracks. The Buffer tracks shall contain embossed grooves and Headers, and shall not be used for the user data.

- **Bands with overwritable sectors**

  The sectors of the Buffer tracks of fully overwritable disks and bands with overwritable sectors of partially embossed disks shall not contain data or embossed data in the recording field.

- **Bands with embossed sectors**

  The sectors of tracks 67 218 to 67 222 in case of 512-byte sectors or tracks 80 022 to 80 026 in case of 2 048-byte sectors of fully embossed disks and partially embossed disks shall be Buffer tracks also. The sectors of Buffer tracks of fully embossed disks and bands with embossed sectors of partially embossed disks shall contain all (FF) bytes in their data fields. However Buffer tracks 67 218 to 67 222 and 67 230 to 67 234 in case of 512-byte sectors, and Buffer tracks 80 022 to 80 026 and 80 035 to 80 039 in case of 2 048-byte sectors of partially embossed disks shall contain no embossed data in the recording field.

18.2 Defect Management Areas (DMAs)

The four Defect Management Areas contain information on the structure of the Data Zone and on the defect management. The length of each DMA shall be 50 sectors in the case of 512-byte sectors and 14 sectors in the case of 2 048-byte sectors. Two of the DMAs, DMA1 and DMA2, shall be located near the outer diameter of the disk; two others, DMA3 and DMA4, shall be located near the inner diameter of the disk. The boundaries of the DMAs are indicated in table 8a and table 8b. The Buffer tracks preceding DMA3 shall be tracks 67 218 to 67 222 in the case of 512-byte sectors and 80 022 to 80 026 in the case of 2 048-byte sectors.

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Table 8a - Locations of the DMAs for 512-byte sectors

	Beginning		Ending		Number of sectors
	Track No.	Sector No.	Track No.	Sector No.	
DMA1	5	0	8	1	50
Reserved	8	2	8	13	12
DMA2	8	14	11	15	50
DMA3	67 223	0	67 226	1	50
Reserved	67 226	2	67 226	13	12
DMA4	67 226	14	67 229	15	50

Table 8b - Locations of the DMAs for 2048-byte sectors

	Beginning		Ending		Number of sectors
	Track No.	Sector No.	Track No.	Sector No.	
DMA1	5	0	8	1	14
Reserved	8	2	9	1	4
DMA2	9	2	12	3	14
DMA3	80 027	0	80 030	1	14
Reserved	80 030	2	80 031	1	4
DMA4	80 031	2	80 034	3	14

The contents of the groups of Reserved sectors in table 8a and table 8b are not specified by this International Standard, and shall be ignored in interchange.

Each DMA shall contain a Disk Definition Structure (DDS), a Primary Defect List (PDL), and a Secondary Defect List (SDL). The contents of the four PDLs shall be identical and the contents of the four SDLs shall be identical. The only differences between the contents of the four DDSs shall be the pointers to each associated PDL and SDL.

After initialization of the disk, each DMA shall have the following content:

- The first DMA sector shall contain the DDS
- The second DMA sector shall be the first sector of the PDL for fully overwritable or partially embossed disks
- The SDL shall be located immediately after the PDL for fully overwritable or partially embossed disks.

The lengths of the PDL and SDL are determined by the number of entries in each. Fully embossed disks do not contain any PDLs or SDLs.

The content of the DMA sectors following the SDL is not specified for fully overwritable and partially embossed disks and shall be ignored in interchange. The bytes of the Data fields of the DMA sectors following the DDS for fully embossed disks shall be set to (FF).

The contents of the DDS are specified in 18.3; those of the PDL and SDL are specified in 19.1.5 and 19.1.6.

18.3 Disk Definition Structure (DDS)

The DDS shall consist of a table with a length of one sector. It specifies the method of initialization of the disk, the division of the overwritable, partially embossed and embossed zones into groups, the kind of data sectors within each band, and the start addresses of the PDL and SDL. The DDS shall be recorded in the first sector of each DMA at the end of initialization of the disk. On a fully embossed disk the DDS shall be embossed.

For partially embossed disks, values for some of the DDS parameters are specified by the manufacturer and recorded in the Control Zones.

The information on the disk structure given in table 9 shall be recorded in each of the four DDSs.

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Table 9a - Byte assignment of the Disk Definition Structure (512-byte sectors)

Byte No.	Description	Fully overwritable	Partially embossed	Fully embossed
0	DDS Identifier	(0A)	(0A)	(0A)
1	DDS Identifier	(0A)	(0A)	(0A)
2	Reserved	(00)	(00)	(00)
3	Disk is fully embossed	N/A	N/A	(00)
	Disk has been certified	(01)	(01)	N/A
	Disk has not been certified	(02)	(02)	N/A
4	Number of groups MSB	(00)	(00)	(00)
5	Number of groups LSB (1 or 30)	(01|1E)	(1E)	(01|1E)
6	Disk layout Type 0	(01)	(01)	(02)
7	Disk layout Type 1	(00|01)	(01/02)	(00|02)
8	Disk layout Type 2	(00|01)	(01/02)	(00|02)
9	Disk layout Type 3	(00|01)	(01/02)	(00|02)
10	Disk layout Type 4	(00|01)	(01/02)	(00|02)
11	Disk layout Type 5	(00|01)	(01/02)	(00|02)
12	Disk layout Type 6	(00|01)	(01/02)	(00|02)
13	Disk layout Type 7	(00|01)	(01/02)	(00|02)
14	Disk layout Type 8	(00|01)	(01/02)	(00|02)
15	Disk layout Type 9	(00|01)	(01/02)	(00|02)
16	Disk layout Type 10	(00|01)	(01/02)	(00|02)
17	Disk layout Type 11	(00|01)	(01/02)	(00|02)
18	Disk layout Type 12	(00|01)	(01/02)	(00|02)
19	Disk layout Type 13	(00|01)	(01/02)	(00|02)
20	Disk layout Type 14	(00|01)	(01/02)	(00|02)
21	Disk layout Type 15	(00|01)	(01/02)	(00|02)
22	Disk layout Type 16	(00|01)	(01/02)	(00|02)
23	Disk layout Type 17	(00|01)	(01/02)	(00|02)
24	Disk layout Type 18	(00|01)	(01/02)	(00|02)
25	Disk layout Type 19	(00|01)	(01/02)	(00|02)
26	Disk layout Type 20	(00|01)	(01/02)	(00|02)
27	Disk layout Type 21	(00|01)	(01/02)	(00|02)
28	Disk layout Type 22	(00|01)	(01/02)	(00|02)
29	Disk layout Type 23	(00|01)	(01/02)	(00|02)
30	Disk layout Type 24	(00|01)	(01/02)	(00|02)
31	Disk layout Type 25	(00|01)	(01/02)	(00|02)
32	Disk layout Type 26	(00|01)	(01/02)	(00|02)
33	Disk layout Type 27	(00|01)	(01/02)	(00|02)
34	Disk layout Type 28	(00|01)	(01/02)	(00|02)
35	Disk layout Type 29	(00|01)	(02)	(00|02)
36 to 255	(00)	(00)	(00)	(00)
256	Start Address of PDL, Track MSB	-	-	(FF)
257	Start Address of PDL	-	-	(FF)
258	Start Address of PDL, Track LSB	-	-	(FF)
259	Start Address of PDL, Sector	-	-	(FF)
260	Start Address of SDL, Track MSB	-	-	(FF)
261	Start Address of SDL	-	-	(FF)
262	Start Address of SDL, Track LSB	-	-	(FF)
263	Start Address of SDL, Sector	-	-	(FF)
264 to 511	(00)	(00)	(00)	(00)

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In table 9a

The symbol "-" means that the appropriate value is to be entered in the DDS, "N/A" means "not applicable". For bytes 6 to 35, the setting (01) means overwritable, (02) embossed and (00) not applicable.

An entry in the form (**aa**|**bb**) indicates:

aa is the value to be used when 1 group is employed, and
bb is the value to be used when 30 groups are employed.

An entry in the form (**aa/bb**) indicates:

aa is the value to be used when the band is overwritable, and
bb is the value to be used when the band is embossed.

Table 9b - Byte assignment of the Disk Definition Structure (2 048-byte sectors)

Byte No.	Description	Fully overwritable	Partially embossed	Fully embossed
0	DDS Identifier	(0A)	(0A)	(0A)
1	DDS Identifier	(0A)	(0A)	(0A)
2	Reserved	(00)	(00)	(00)
3	Disk is fully embossed	N/A	N/A	(00)
	Disk has been certified	(01)	(01)	N/A
	Disk has not been certified	(02)	(02)	N/A
4	Number of groups MSB	(00)	(00)	(00)
5	Number of groups LSB (1 or 9)	(01|09)	(09)	(01|09)
6	Disk layout Type 0	(01)	(01)	(02)
7	Disk layout Type 1	(00|01)	(01/02)	(00|02)
8	Disk layout Type 2	(00|01)	(01/02)	(00|02)
9	Disk layout Type 3	(00|01)	(01/02)	(00|02)
10	Disk layout Type 4	(00|01)	(01/02)	(00|02)
11	Disk layout Type 5	(00|01)	(01/02)	(00|02)
12	Disk layout Type 6	(00|01)	(01/02)	(00|02)
13	Disk layout Type 7	(00|01)	(01/02)	(00|02)
14	Disk layout Type 8	(00|01)	(02)	(00|02)
15 to 255	(00)	(00)	(00)	(00)
256	Start Address of PDL, Track MSB	-	-	(FF)
257	Start Address of PDL	-	-	(FF)
258	Start Address of PDL, Track LSB	-	-	(FF)
259	Start Address of PDL, Sector	-	-	(FF)
260	Start Address of SDL, Track MSB	-	-	(FF)
261	Start Address of SDL	-	-	(FF)
262	Start Address of SDL, Track LSB	-	-	(FF)
263	Start Address of SDL, Sector	-	-	(FF)
264 to 2 047	(00)	(00)	(00)	(00)

In table 9b

The symbol "-" means that the appropriate value is to be entered in the DDS, "N/A" means "not applicable". For bytes 6 to 14, the setting (01) means overwritable, (02) embossed and (00) not applicable.

An entry in the form (**aa**|**bb**) indicates:

aa is the value to be used when 1 group is employed, and
bb is the value to be used when 9 groups are employed.

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An entry in the form (**aa/bb**) indicates:

aa is the value to be used when the band is overwritable, and
bb is the value to be used when the band is embossed.

18.3.1 Fully overwritable disks

The user area of fully overwritable disks shall contain a Overwritable Zone. The Overwritable Zone is intended for the user to write data into. The data field of all sectors in this zone shall not contain any embossed data.

In case of 512-byte sectors, the Overwritable Zone shall extend from sector 0 of track 12 to the last sector of track 67 222 excluding interrupting buffer tracks. Every band of fully overwritable disks shall be recorded in bytes 6 to 35 of the DDS as being overwritable disk layout type.

In case of 2 048-byte sectors, the Overwritable Zone shall extend from sector 0 of track 13 to the last sector of track 80 026 excluding interrupting buffer tracks. Every band of fully overwritable disks shall be recorded in bytes 6 to 14 of the DDS as being overwritable disk layout type.

18.3.2 Fully embossed disks

The user area of fully embossed disks shall have an Embossed Zone. It shall contain data embossed by the manufacturer of the disk. The layout of the Data field of all sectors in this zone shall be as specified in annex E.

In case of 512-byte sectors, the Embossed Zone shall extend from sector 0 of track 12 to the last sector of track 67 222 excluding interrupting buffer tracks. Every band of fully embossed disks shall be recorded in bytes 6 to 35 of the DDS as being embossed disk layout type.

In case of 2 048-byte sectors, the Embossed Zone shall extend from sector 0 of track 13 to the last sector of track 80 026 excluding interrupting buffer tracks. Every band of fully embossed disks shall be recorded in bytes 6 to 14 of the DDS as being embossed disk layout type.

18.3.3 Partially embossed disks

The user area of partially embossed disks shall have a Partially Embossed Zone. In case of 512-byte sectors, the Partially Embossed Zone shall extend from sector 0 of track 12 to the last sector of track 67 217. Each band of partially embossed disks shall be recorded in bytes 6 to 35 of the DDS as being either overwritable disk layout type or embossed disk layout type (except band 0 which is always overwritable disk layout type and band 29 which is always embossed disk layout type). In case of 2 048-byte sectors, the Partially Embossed Zone shall extend from sector 0 of track 11 to the last sector of track 80 021. Each band of partially embossed disks shall be recorded in bytes 6 to 14 of the DDS as being either overwritable disk layout type or embossed disk layout type (except band 0 which is always overwritable disk layout type and band 8 which is always embossed disk layout type).

Band 0 of partially embossed disks shall contain only overwritable sectors. In case of 512-byte sectors, the embossed zone shall start from sector 0 of the first track in one of the bands of bands 1 to 29 and shall end at track 67 217 in band 29. In case of 2 048-byte sectors, the embossed zone shall start from sector 0 of the first track in one of the bands of bands 1 to 8 and shall end at track 80 021 in band 8. The layout of the Data field of all sectors in this zone shall be as specified in annex E.

18.4 Partitioning

18.4.1 Fully overwritable disks

During initialization of the disk, the Overwritable Zone shall be partitioned into 1 or 30 consecutive groups in case of 512-byte sectors or 1 or 9 consecutive groups in case of 2 048-byte sectors. If one group is used, it shall span the entire User Area; if 30 or 9 groups are used, each group shall span one complete band excluding the five buffer tracks at the beginning and the five buffer tracks at the end of each band with the exception of tracks 5 to 11 in band 0 and tracks 67 223 to 67 229 of band 29 in case of 512-byte sectors and tracks 5 to 12 in band 0 and tracks 80 027 to 80 034 of band 8 in case of 2 048-byte sectors. Each group shall comprise full tracks of data sectors followed by full tracks of spare sectors. The number of spare tracks per group is shown in table 10.

18.4.2 Partially embossed disks

During preparation of the embossed data for manufacturing of the disk, the disk shall be partitioned into 30 groups in case of 512-byte sectors or 9 groups in case of 2 048-byte sectors. In case of 512-byte sectors, Partially embossed disks shall have one to 29 overwritable group(s) starting from Group 0, and the rest of group(s) shall be embossed. In case of 2 048-byte sectors, Partially embossed disks shall have one to eight overwritable group(s) starting from Group 0, and the rest of group(s) shall be

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embossed. Thus, overwritable group(s) shall be located outer area and embossed group(s) shall be located inner area of Partially Embossed Zone. The data and spare (or Parity) area characteristics of a group are taken from either the overwritable or the fully embossed definition, whichever is appropriate. Each group shall comprise full tracks of data sectors followed by full tracks of spare sectors or parity sectors and shall span one complete band excluding the five buffer tracks at the beginning and the five buffer tracks at the end of each band with the exception of tracks 5 to 11 in band 0 and tracks 67 218 to 67 229 of band 29 in case of 512-byte sectors and tracks 5 to 12 in band 0 and tracks 80 022 to 80 034 of band 8 in case of 2 048-byte sectors. The number of spare sector and parity sector tracks for each band is given in table 10 below.

Bytes 0 to 35 of the DDS for the disk shall be recorded in the Control tracks in case of 512-byte sectors and bytes 0 to 14 of the DDS for the disk shall be recorded in the Control tracks in case of 2 048-byte sectors.

18.4.3 Fully embossed disks

During preparation of the embossed data for manufacturing of the disk, the disk shall be partitioned into either 1 or 30 groups in case of 512-byte sectors or 1 or 9 consecutive groups in case of 2 048-byte sectors. If one group is used, it shall span the entire User Area; if 30 or 9 groups are used, each of the 30 or 9 groups will span one band excluding the five buffer tracks at the beginning and the five buffer tracks at the end of each band with the exception of tracks 5 to 11 in band 0 and tracks 67 223 to 67 229 of band 29 in case of 512-byte sectors and tracks 5 to 12 in band 0 and tracks 80 027 to 80 034 of band 8 in case of 2 048-byte sectors. Each group shall comprise full tracks of data sectors followed by full tracks of parity sectors. The number of parity sector tracks for each band is given in table 10.

NOTES to table 10

1 - The location of the spare sectors is the same for the overwritable bands of Type P-ROM and GRP30-O/W or GRP9-O/W. The location of the parity sectors is the same for the embossed bands of Type P-ROM and GRP30-ROM or GRP9-ROM.

2 - In the case of 512-byte sectors, the total number of parity tracks of GRP1-ROM (2 028 tracks = 32 448 sectors) consists of 32 444 parity sectors and 4 consecutive unused parity sectors

3 In the case of 2 048-byte sectors, the total number of parity tracks of GPR1-ROM(6 150 tracks = 24 600 sectors) consists of 24 593 parity sectors and 7 consecutive unused parity sectors .

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Table 10a- Usage of Tracks (512-byte sectors)

GRP1-R/W

Band Number	Number of Sectors per Physical Track	Start Track	Buffer Tracks	DMA 1&2 Tracks	Data Tracks	Number of Data Tracks	Spare Tracks	Number of Spare Tracks	Buffer Tracks	DMA 3&4 Tracks	Buffer Tracks	End Track
0	68	0	0-4	5-11	12-1762	1751	-	0	-	-	1763-1767	1767
1	67	1768	1768-1772	-	1773-4643	2871	-	0	-	-	4644-4648	4648
2	66	4649	4649-4653	-	4654-7481	2828	-	0	-	-	7482-7486	7486
3	65	7487	7487-7491	-	7492-10276	2785	-	0	-	-	10277-10281	10281
4	64	10282	10282-10286	-	10287-13028	2742	-	0	-	-	13029-13033	13033
5	63	13034	13034-13038	-	13039-15737	2699	-	0	-	-	15738-15742	15742
6	62	15743	15743-15747	-	15748-18403	2656	-	0	-	-	18404-18408	18408
7	61	18409	18409-18413	-	18414-21026	2613	-	0	-	-	21027-21031	21031
8	60	21032	21032-21036	-	21037-23606	2570	-	0	-	-	23607-23611	23611
9	59	23612	23612-23616	-	23617-26143	2527	-	0	-	-	26144-26148	26148
10	58	26149	26149-26153	-	26154-28637	2484	-	0	-	-	28638-28642	28642
11	57	28643	28643-28647	-	28648-31088	2441	-	0	-	-	31089-31093	31093
12	56	31094	31094-31098	-	31099-33496	2398	-	0	-	-	33497-33501	33501
13	55	33502	33502-33506	-	33507-35861	2355	-	0	-	-	35862-35866	35866
14	54	35867	35867-35871	-	35872-38183	2312	-	0	-	-	38184-38188	38188
15	53	38189	38189-38193	-	38194-40462	2269	-	0	-	-	40463-40467	40467
16	52	40468	40468-40472	-	40473-42698	2226	-	0	-	-	42699-42703	42703
17	51	42704	42704-42708	-	42709-44891	2183	-	0	-	-	44892-44896	44896
18	50	44897	44897-44901	-	44902-47041	2140	-	0	-	-	47042-47046	47046
19	49	47047	47047-47051	-	47052-49148	2097	-	0	-	-	49149-49153	49153
20	48	49154	49154-49158	-	49159-51212	2054	-	0	-	-	51213-51217	51217
21	47	51218	51218-51222	-	51223-53233	2011	-	0	-	-	53234-53238	53238
22	46	53239	53239-53243	-	53244-55211	1968	-	0	-	-	55212-55216	55216
23	45	55217	55217-55221	-	55222-57146	1925	-	0	-	-	57147-57151	57151
24	44	57152	57152-57156	-	57157-59038	1882	-	0	-	-	59039-59043	59043
25	43	59044	59044-59048	-	59049-60887	1839	-	0	-	-	60888-60892	60892
26	42	60893	60893-60897	-	60898-62693	1796	-	0	-	-	62694-62698	62698
27	41	62699	62699-62703	-	62704-64456	1753	-	0	-	-	64457-64461	64461
28	40	64462	64462-64466	-	64467-66176	1710	-	0	-	-	66177-66181	66181
29	39	66182	66182-66186	-	66187-66592	406	66593 to 67222	630	-	67223 to 67229	67230-67234	67234
Total						66291		630				

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Table 10a - Usage of Tracks (512-byte sectors) - (continued)

GRP30-R/W

Band Number	Number of Sectors per Physical Track	Start Track	Buffer Tracks	DMA 1&2 Tracks	Data Tracks	Number of Data Tracks	Spare Tracks	Number of Spare Tracks	Buffer Tracks	DMA 3&4 Tracks	Buffer Tracks	End Track
0	68	0	0-4	5-11	12-1741	1730	1742-1762	21	-	-	1763-1767	1767
1	67	1768	1768-1772	-	1773-4622	2850	4623-4643	21	-	-	4644-4648	4648
2	66	4649	4649-4653	-	4654-7460	2807	7461-7481	21	-	-	7482-7486	7486
3	65	7487	7487-7491	-	7492-10255	2764	10256-10276	21	-	-	10277-10281	10281
4	64	10282	10282-10286	-	10287-13007	2721	13008-13028	21	-	-	13029-13033	13033
5	63	13034	13034-13038	-	13039-15716	2678	15717-15737	21	-	-	15738-15742	15742
6	62	15743	15743-15747	-	15748-18382	2635	18383-18403	21	-	-	18404-18408	18408
7	61	18409	18409-18413	-	18414-21005	2592	21006-21026	21	-	-	21027-21031	21031
8	60	21032	21032-21036	-	21037-23585	2549	23586-23606	21	-	-	23607-23611	23611
9	59	23612	23612-23616	-	23617-26122	2506	26123-26143	21	-	-	26144-26148	26148
10	58	26149	26149-26153	-	26154-28616	2463	28617-28637	21	-	-	28638-28642	28642
11	57	28643	28643-28647	-	28648-31067	2420	31068-31088	21	-	-	31089-31093	31093
12	56	31094	31094-31098	-	31099-33475	2377	33476-33496	21	-	-	33497-33501	33501
13	55	33502	33502-33506	-	33507-35840	2334	35841-35861	21	-	-	35862-35866	35866
14	54	35867	35867-35871	-	35872-38162	2291	38163-38183	21	-	-	38184-38188	38188
15	53	38189	38189-38193	-	38194-40441	2248	40442-40462	21	-	-	40463-40467	40467
16	52	40468	40468-40472	-	40473-42677	2205	42678-42698	21	-	-	42699-42703	42703
17	51	42704	42704-42708	-	42709-44870	2162	44871-44891	21	-	-	44892-44896	44896
18	50	44897	44897-44901	-	44902-47020	2119	47021-47041	21	-	-	47042-47046	47046
19	49	47047	47047-47051	-	47052-49127	2076	49128-49148	21	-	-	49149-49153	49153
20	48	49154	49154-49158	-	49159-51191	2033	51192-51212	21	-	-	51213-51217	51217
21	47	51218	51218-51222	-	51223-53212	1990	53213-53233	21	-	-	53234-53238	53238
22	46	53239	53239-53243	-	53244-55190	1947	55191-55211	21	-	-	55212-55216	55216
23	45	55217	55217-55221	-	55222-57125	1904	57126-57146	21	-	-	57147-57151	57151
24	44	57152	57152-57156	-	57157-59017	1861	59018-59038	21	-	-	59039-59043	59043
25	43	59044	59044-59048	-	59049-60866	1818	60867-60887	21	-	-	60888-60892	60892
26	42	60893	60893-60897	-	60898-62672	1775	62673-62693	21	-	-	62694-62698	62698
27	41	62699	62699-62703	-	62704-64435	1732	64436-64456	21	-	-	64457-64461	64461
28	40	64462	64462-64466	-	64467-66155	1689	66156-66176	21	-	-	66177-66181	66181
29	39	66182	66182-66186	-	66187-67201	1015	67202-67222	21	-	67223 to 67229	67230-67234	67234
Total						66291		630				

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Table 10a - Usage of Tracks (512-byte sectors)

GRP1-ROM

Band Number	Number of Sectors per Physical Track	Start Track	Buffer Tracks	DMA 1&2 Tracks	Data Tracks	Number of Data Tracks	Parity Tracks	Number of Parity Tracks	Buffer Tracks	DMA 3&4 Tracks	Buffer Tracks	End Track
0	68	0	0-4	5-11	12-1762	1751	-	0	-	-	1763-1767	1767
1	67	1768	1768-1772	-	1773-4643	2871	-	0	-	-	4644-4648	4648
2	66	4649	4649-4653	-	4654-7481	2828	-	0	-	-	7482-7486	7486
3	65	7487	7487-7491	-	7492-10276	2785	-	0	-	-	10277-10281	10281
4	64	10282	10282-10286	-	10287-13028	2742	-	0	-	-	13029-13033	13033
5	63	13034	13034-13038	-	13039-15737	2699	-	0	-	-	15738-15742	15742
6	62	15743	15743-15747	-	15748-18403	2656	-	0	-	-	18404-18408	18408
7	61	18409	18409-18413	-	18414-21026	2613	-	0	-	-	21027-21031	21031
8	60	21032	21032-21036	-	21037-23606	2570	-	0	-	-	23607-23611	23611
9	59	23612	23612-23616	-	23617-26143	2527	-	0	-	-	26144-26148	26148
10	58	26149	26149-26153	-	26154-28637	2484	-	0	-	-	28638-28642	28642
11	57	28643	28643-28647	-	28648-31088	2441	-	0	-	-	31089-31093	31093
12	56	31094	31094-31098	-	31099-33496	2398	-	0	-	-	33497-33501	33501
13	55	33502	33502-33506	-	33507-35861	2355	-	0	-	-	35862-35866	35866
14	54	35867	35867-35871	-	35872-38183	2312	-	0	-	-	38184-38188	38188
15	53	38189	38189-38193	-	38194-40462	2269	-	0	-	-	40463-40467	40467
16	52	40468	40468-40472	-	40473-42698	2226	-	0	-	-	42699-42703	42703
17	51	42704	42704-42708	-	42709-44891	2183	-	0	-	-	44892-44896	44896
18	50	44897	44897-44901	-	44902-47041	2140	-	0	-	-	47042-47046	47046
19	49	47047	47047-47051	-	47052-49148	2097	-	0	-	-	49149-49153	49153
20	48	49154	49154-49158	-	49159-51212	2054	-	0	-	-	51213-51217	51217
21	47	51218	51218-51222	-	51223-53233	2011	-	0	-	-	53234-53238	53238
22	46	53239	53239-53243	-	53244-55211	1968	-	0	-	-	55212-55216	55216
23	45	55217	55217-55221	-	55222-57146	1925	-	0	-	-	57147-57151	57151
24	44	57152	57152-57156	-	57157-59038	1882	-	0	-	-	59039-59043	59043
25	43	59044	59044-59048	-	59049-60887	1839	-	0	-	-	60888-60892	60892
26	42	60893	60893-60897	-	60898-62693	1796	-	0	-	-	62694-62698	62698
27	41	62699	62699-62703	-	62704-64456	1753	-	0	-	-	64457-64461	64461
28	40	64462	64462-64466	-	64467-65179	713	65180-66176	997	-	-	66177-66181	66181
29	39	66182	66182-66186	-	-	0	66187-67217	1031	67218-67222	67223 to 67229	67230-67234	67234
Total						64888		2028				

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Table 10a - Usage of Tracks (512-byte sectors) - (continued)

GRP30-ROM/PROM

Band Number	Number of Sectors per Physical Track	Start Track	Buffer Tracks	DMA 1&2 Tracks	Data Tracks	Number of Data Tracks	Parity Tracks	Number of Parity Tracks	Buffer Tracks	DMA 3&4 Tracks	Buffer Tracks	End Track
0	68	0	0-4	5-11	12-1707	1696	1708-1762	55	-	-	1763-1767	1767
1	67	1768	1768-1772	-	1773-4556	2784	4557-4643	87	-	-	4644-4648	4648
2	66	4649	4649-4653	-	4654-7395	2742	7396-7481	86	-	-	7482-7486	7486
3	65	7487	7487-7491	-	7492-10191	2700	10192-10276	85	-	-	10277-10281	10281
4	64	10282	10282-10286	-	10287-12944	2658	12945-13028	84	-	-	13029-13033	13033
5	63	13034	13034-13038	-	13039-15654	2616	15655-15737	83	-	-	15738-15742	15742
6	62	15743	15743-15747	-	15748-18321	2574	18322-18403	82	-	-	18404-18408	18408
7	61	18409	18409-18413	-	18414-20945	2532	20946-21026	81	-	-	21027-21031	21031
8	60	21032	21032-21036	-	21037-23528	2492	23529-23606	78	-	-	23607-23611	23611
9	59	23612	23612-23616	-	23617-26066	2450	26067-26143	77	-	-	26144-26148	26148
10	58	26149	26149-26153	-	26154-28561	2408	28562-28637	76	-	-	28638-28642	28642
11	57	28643	28643-28647	-	28648-31013	2366	31014-31088	75	-	-	31089-31093	31093
12	56	31094	31094-31098	-	31099-33422	2324	33423-33496	74	-	-	33497-33501	33501
13	55	33502	33502-33506	-	33507-35788	2282	35789-35861	73	-	-	35862-35866	35866
14	54	35867	35867-35871	-	35872-38111	2240	38112-38183	72	-	-	38184-38188	38188
15	53	38189	38189-38193	-	38194-40393	2200	40394-40462	69	-	-	40463-40467	40467
16	52	40468	40468-40472	-	40473-42630	2158	42631-42698	68	-	-	42699-42703	42703
17	51	42704	42704-42708	-	42709-44824	2116	44825-44891	67	-	-	44892-44896	44896
18	50	44897	44897-44901	-	44902-46975	2074	46976-47041	66	-	-	47042-47046	47046
19	49	47047	47047-47051	-	47052-49083	2032	49084-49148	65	-	-	49149-49153	49153
20	48	49154	49154-49158	-	49159-51148	1990	51149-51212	64	-	-	51213-51217	51217
21	47	51218	51218-51222	-	51223-53172	1950	53173-53233	61	-	-	53234-53238	53238
22	46	53239	53239-53243	-	53244-55151	1908	55152-55211	60	-	-	55212-55216	55216
23	45	55217	55217-55221	-	55222-57087	1866	57088-57146	59	-	-	57147-57151	57151
24	44	57152	57152-57156	-	57157-58980	1824	58981-59038	58	-	-	59039-59043	59043
25	43	59044	59044-59048	-	59049-60830	1782	60831-60887	57	-	-	60888-60892	60892
26	42	60893	60893-60897	-	60898-62637	1740	62638-62693	56	-	-	62694-62698	62698
27	41	62699	62699-62703	-	62704-64401	1698	64402-64456	55	-	-	64457-64461	64461
28	40	64462	64462-64466	-	64467-66124	1658	66125-66176	52	-	-	66177-66181	66181
29	39	66182	66182-66186	-	66187-67184	998	67185-67217	33	67218-67222	67223 to 67229	67230-67234	67234
Total						64858		2058				

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Table 10b - Usage of Tracks (2 048-byte sectors)

GRP1-R/W

Band Number	Number of Sectors per Physical Track	Start Track	Buffer Tracks	DMA 1&2 Tracks	Data Tracks	Number of Data Tracks	Spare Tracks	Number of Spare Tracks	Buffer Tracks	DMA 3&4 Tracks	Buffer Tracks	End Track
0	20	0	0-4	5-12	13-9354	9342	-	0	-	-	9355-9359	9359
1	19	9360	9360-9364	-	9365-20184	10820	-	0	-	-	20185-20189	20189
2	18	20190	20190-20194	-	20195-30444	10250	-	0	-	-	30445-30449	30449
3	17	30450	30450-30454	-	30455-40134	9680	-	0	-	-	40135-40139	40139
4	16	40140	40140-40144	-	40145-49254	9110	-	0	-	-	49255-49259	49259
5	15	49260	49260-49264	-	49265-57804	8540	-	0	-	-	57805-57809	57809
6	14	57810	57810-57814	-	57815-65784	7970	-	0	-	-	65785-65789	65789
7	13	65790	65790-65794	-	65795-73194	7400	-	0	-	-	73195-73199	73199
8	12	73200	73200-73204	-	73205-78775	5571	78776-80026	1251	-	80027 to 80034	80035-80039	80039
Total						78683		1251				

Table 10b - Usage of Tracks (2 048-byte sectors) - (continued)

GRP9-R/W

Band Number	Number of Sectors per Physical Track	Start Track	Buffer Tracks	DMA 1&2 Tracks	Data Tracks	Number of Data Tracks	Spare Tracks	Number of Spare Tracks	Buffer Tracks	DMA 3&4 Tracks	Buffer Tracks	End Track
0	20	0	0-4	5-12	13-9215	9203	9216-9354	139	-	-	9355-9359	9359
1	19	9360	9360-9364	-	9365-20045	10681	20046-20184	139	-	-	20185-20189	20189
2	18	20190	20190-20194	-	20195-30305	10111	30306-30444	139	-	-	30445-30449	30449
3	17	30450	30450-30454	-	30455-39995	9541	39996-40134	139	-	-	40135-40139	40139
4	16	40140	40140-40144	-	40145-49115	8971	49116-49254	139	-	-	49255-49259	49259
5	15	49260	49260-49264	-	49265-57665	8401	57666-57804	139	-	-	57805-57809	57809
6	14	57810	57810-57814	-	57815-65645	7831	65646-65784	139	-	-	65785-65789	65789
7	13	65790	65790-65794	-	65795-73055	7261	73056-73194	139	-	-	73195-73199	73199
8	12	73200	73200-73204	-	73205-79887	6683	79888-80026	139	-	80027 to 80034	80035-80039	80039
Total						7868		1251				

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Table 10b - Usage of Tracks (2 048-byte sectors)

GRP1-ROM

Band Number	Number of Sectors per Physical Track	Start Track	Buffer Tracks	DMA 1&2 Tracks	Data Tracks	Number of Data Tracks	Parity Tracks	Number of Parity Tracks	Buffer Tracks	DMA 3&4 Tracks	Buffer Tracks	End Track
0	20	0	0-4	5-12	13-9354	9342	-	0	-	-	9355-9359	9359
1	19	9360	9360-9364	-	9365-20184	10820	-	0	-	-	20185-20189	20189
2	18	20190	20190-20194	-	20195-30444	10250	-	0	-	-	30445-30449	30449
3	17	30450	30450-30454	-	30455-40134	9680	-	0	-	-	40135-40139	40139
4	16	40140	40140-40144	-	40145-49254	9110	-	0	-	-	49255-49259	49259
5	15	49260	49260-49264	-	49265-57804	8540	-	0	-	-	57805-57809	57809
6	14	57810	57810-57814	-	57815-65784	7970	-	0	-	-	65785-65789	65789
7	13	65790	65790-65794	-	65795-73194	7400	-	0	-	-	73195-73199	73199
8	12	73200	73200-73204	-	73205-73871	667	73872-80021	6150	80022-80026	80027 to 80034	80035-80039	80039
Total						73779		6150				

Table 10b - Usage of Tracks (2 048-byte sectors) - (continued)

GRP9-ROM/PROM

Band Number	Number of Sectors per Physical Track	Start Track	Buffer Tracks	DMA 1&2 Tracks	Data Tracks	Number of Data Tracks	Parity Tracks	Number of Parity Tracks	Buffer Tracks	DMA 3&4 Tracks	Buffer Tracks	End Track
0	20	0	0-4	5-12	13-8634	8622	8635-9354	720	-	-	9355-9359	9359
1	19	9360	9360-9364	-	9365-19351	9987	19352-20184	833	-	-	20185-20189	20189
2	18	20190	20190-20194	-	20195-29653	9459	29654-30444	791	-	-	30445-30449	30449
3	17	30450	30450-30454	-	30455-39388	8934	39389-40134	746	-	-	40135-40139	40139
4	16	40140	40140-40144	-	40145-48553	8409	48554-49254	701	-	-	49255-49259	49259
5	15	49260	49260-49264	-	49265-57145	7881	57146-57804	659	-	-	57805-57809	57809
6	14	57810	57810-57814	-	57815-65170	7356	65171-65784	614	-	-	65785-65789	65789
7	13	65790	65790-65794	-	65795-72622	6828	72623-73194	572	-	-	73195-73199	73199
8	12	73200	73200-73204	-	73205-79495	6291	79496-80021	526	80022-80026	80027 to 800034	80035-80039	80039
Total						73767		6162				

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19 Defect management

19.1 Overwritable groups: Spare sectors

Defective sectors in the Overwritable Zone shall be replaced by good sectors according to the defect management method described below. The disk shall be initialized before use. This International Standard allows initialization with or without certification. The total number of spare sectors shall not be greater than 10 080 for 512-byte sectors or 5004 for 2 048-byte sectors. If 30 groups are used in case of 512-byte sectors, each group shall have 21 spare tracks. If 9 groups are used in case of 2 048-byte sectors, each group shall have 139 spare tracks.

Defective sectors are handled by a Linear Replacement Algorithm and a sector Slipping Algorithm. The total number of defective sectors listed in PDL and SDL by both algorithms shall not be greater than 3 068.

19.1.1 Initialization of the disk

During initialization of the disk, the four DMAs are recorded prior to the first use of the disk. The Overwritable Zone shall be partitioned either into 1 or 30 groups in case of 512-byte sectors or into 1 or 9 groups in case of 2 048-byte sectors if the disk is fully overwritable. If the disk is partially embossed, the number of groups shall be 30 in case of 512-byte sectors or 9 in case of 2 048-byte sectors. Each overwritable group shall contain a number of full tracks for data sectors followed by a number of full tracks for spare sectors. The spare sectors can be used as replacements for defective data sectors. Initialization can include a certification of the overwritable groups whereby defective sectors are identified and skipped.

All DDS parameters shall be recorded in the four DDS sectors. The PDL and SDL shall be recorded in the four DMAs. The requirements for the recording of the PDLs and SDLs are stated in tables 11 and 12.

19.1.2 Certification

If the disk is certified, the certification shall be applied to the data sectors and to the spare sectors in the groups. The method of certification is not stated by this International Standard. It may involve overwriting and reading the sectors in the groups. Defective sectors found during certification shall be handled by the Slipping Algorithm. Defective sectors shall not be used for reading or writing. Guidelines for replacing defective sectors are given in annex M.

19.1.2.1 Slipping Algorithm

The Slipping Algorithm shall be applied individually to each and every group in the Overwritable Zone in case of certification is performed.

A defective data sector found during certification shall be replaced by the first good sector following the defective sector, and so causes a slip of one sector towards the end of the group. The last data sectors will slip into the spare sector area of the group. The address of the defective sector is written in the PDL. If no defective sectors are found during certification, an empty PDL is recorded.

The addresses of spare sectors, beyond the last data sector slipped into the spare area (if any), which are found to be defective during certification shall be recorded in the PDL. Thus, the number of available spare sectors is diminished accordingly.

If the spare sector area of a group becomes exhausted during certification, the certification shall be regarded as a failure.

19.1.2.2 Linear Replacement Algorithm

The Linear Replacement Algorithm is used to handle both of defective sectors and deteriorated sectors found after certification.

The defective sector shall be replaced by the first available good spare sector of the group. If there are no spare sectors left in the group, this shall be recorded in SDL, and the defective sector shall be replaced by the first available good spare sector of another group. The address of the defective sector and the address of its last replacement sector shall be recorded in the SDL.

The indication that there are no spare sectors left in the group shall be recorded in the SDL. Bit 0 of byte 29 when set to ONE indicates that there are no spare sectors left in group 0. When set to ZERO, this bit indicates that there are still spare sectors left in group 0. Bit 0 of byte 29 corresponds to group 0, bit 1 of byte 29 corresponds to group1, bit 0 of byte 28 corresponds to group 8, and so on.

The addresses of sectors already recorded in the PDL shall not be recorded in the SDL.

If a data sector is found to be defective after certification, it shall be regarded as a defective sector and it shall be listed in the SDL with a new entry.

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If a replacement sector listed in the SDL is later found to be defective, the direct pointer method shall be applied for a registration into the SDL. In this method, the SDL entry in which the defective replaced sector has been registered shall be modified by changing the address of the replacement sector from the defective one to a new one.

19.1.3 Disks not certified

The Linear Replacement Algorithm is also used to handle sectors found defective on disks which have not been certified.

A defective sector shall be replaced by the first available good spare sector of the group. If there are no spare sectors left in the group, this shall be recorded in SDL, and the defective sector shall be replaced by the first available good spare sector of another group. The address of the defective sector and the address of its last replacement sector shall be recorded in the SDL.

The indication that there are no spare sectors left in the group shall be recorded in the SDL. Bit 0 of byte 29 when set to ONE indicates that there are no spare sectors left in group 0. When set to ZERO, this bit indicates that there are still spare sectors left in group 0. Bit 0 of byte 29 corresponds to group 0, bit 1 of byte 29 corresponds to group1, bit 0 of byte 28 corresponds to group 8, and so on.

If there exists a list of addresses of the defective sectors in the PDL, these sectors shall be skipped for use even if the disks are not certified. This process is same as the process specified in 19.1.2.1 for the certified disks.

19.1.4 Write procedure

When writing data in the sectors of a group, a defective sector listed in the PDL shall be skipped, and the data shall be written in the next data sector, according to the Slipping Algorithm. If a sector to be written is listed in the SDL, the data shall be written in the spare sector pointed to by the SDL, according to the Linear Replacement Algorithm.

19.1.5 Primary Defect List (PDL)

A PDL shall always be recorded; it may be empty.

A list of defective sectors may be obtained by means other than certification of the disk.

The PDL shall contain the addresses of all defective sectors identified at initialization. The addresses shall be listed in ascending order. The PDL shall be recorded in the minimum number of sectors necessary, and it shall begin in the first user data byte of the first sector. All unused bytes of the last sector of the PDL shall be set to (FF). The information in table 10 shall be recorded in each PDL.

In the case of multiple-sector PDL, the list of addresses of the defective sectors shall continue with the first byte of the second and subsequent sectors. Thus, the PDL Identifier and the Number of Addresses of the PDL shall be present only in the first sector.

In an empty PDL bytes 2 and 3 shall be set to (00) and bytes 4 to 511 shall be set to (FF) in case of 512-byte sectors, and bytes 4 to 2 047 shall be set to (FF) in case of 2 048-byte sectors.

Table 11 - Content of the PDL

Byte	PDL content
0	(00), PDL Identifier
1	(01), PDL Identifier
2	Number of Addresses in the PDL, MSB
3	Number of Addresses in the PDL, LSB (If bytes 2 and 3 are set to (00), byte 3 is the end of the PDL)
4	Address of the First Defective Sector (Track Number, MSB)
5	Address of the First Defective Sector (Track Number)
6	Address of the First Defective Sector (Track Number, LSB)
7	Address of the First Defective Sector (Sector Number)
⋮	⋮
x-3	Address of the Last Defective Sector (Track Number, MSB)
x-2	Address of the Last Defective Sector (Track Number)
x-1	Address of the Last Defective Sector (Track Number, LSB)
x	Address of the Last Defective Sector (Sector Number)

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19.1.6 Secondary Defect List (SDL)

The Secondary Defect List (SDL) is created during initialization and used after certification. All disks with a Overwritable Zone shall have an SDL recorded during initialization.

The SDL shall contain entries in the form of addresses of defective data sectors and addresses of the spare sectors which replace them. Each entry in the SDL contains 8 bytes, viz. four each for the address of a defective sector and for the address of its replacement sector.

The list of addresses shall contain the addresses of the defective sectors and their replacement sectors. The addresses of the defective sectors shall be in ascending order.

The SDL shall be recorded in the minimum number of sector necessary, and it shall begin in the first user data byte of the first sector. All unused bytes of the last sectors of the SDL shall be set to (FF). The following information shall be recorded in each of the four SDLs.

The addresses of sectors already recorded in the PDL shall not be recorded in the SDL.

If a replacement sector listed in the SDL is later found to be defective, the direct pointer method shall be applied for a registration into the SDL. In this method, the SDL entry in which the defective replaced sector has been registered shall be modified by changing the address of the replacement sector from the defective replaced sector to a new one. Therefore, the number of entries in the SDL shall remain unchanged by deteriorated sectors.

In the case of a multiple-sector SDL, the list of addresses of defective and of replacement sectors shall continue with the first byte of the second and subsequent sectors. Thus, the contents of bytes 0 to 31 in table 12 shall be present only in the first sector.

Table 12 - Content of the SDL

Byte	SDL content
0	(00), SDL Identifier
1	(02), SDL Identifier
2	(00)
3	(01)
4	List Length in bytes in the SDL, MSB
5 to 6	List Length in bytes in the SDL, LSB
7	(00)
8	(02)
9	(01)
10 to 13	(00)
14 to 25	(00)
26 to 29	Flags indicating that all spare sectors of a zone have been used
30	Number of Entries in the SDL, MSB
31	Number of Entries in the SDL, LSB
	(each entry is 8 bytes long)
32	Address of the First Defective Sector (Track Number, MSB)
33	Address of the First Defective Sector (Track Number)
34	Address of the First Defective Sector (Track Number, LSB)
35	Address of the First Defective Sector (Sector Number)
36	Address of the First Replacement Sector (Track Number, MSB)
37	Address of the First Replacement Sector (Track Number)
38	Address of the First Replacement Sector (Track Number, LSB)
39	Address of the First Replacement Sector (Sector Number)
⋮	⋮
y-7	Address of the Last Defective Sector (Track Number, MSB)
y-6	Address of the Last Defective Sector (Track Number)
y-5	Address of the Last Defective Sector (Track Number, LSB)
y-4	Address of the Last Defective Sector (Sector Number)
y-3	Address of the Last Replacement Sector (Track Number, MSB)
y-2	Address of the Last Replacement Sector (Track Number)
y-1	Address of the Last Replacement Sector (Track Number, LSB)
y	Address of the Last Replacement Sector (Sector Number)

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19.2 Embossed groups: Parity sectors

The embossed parity sectors provide an error correction system for embossed data over the user data bytes and bytes 513 to 516 / 2 049 to 2 056 of each sector in addition to the ECC over the Data field and the control bytes of each sector. One embossed parity sector shall be allocated to one parity unit. The parity unit shall consist of plural tracks, i.e., 2 tracks in case of 512-byte sectors and 3 tracks in case of 2 048-byte sectors. They allow the drive to correct one sector on tracks in a parity unit that cannot be corrected by the ECC, assuring a high data integrity. If more than one sector on tracks in a parity unit cannot be corrected by ECC, then it is not possible to recover any of these defective sectors by the use of parity sectors.

The Data field of a parity sector contains 516 / 2 056 parity bytes (PB), calculated as an Exclusive OR ($\oplus$) over the user data bytes and bytes 513 to 516 / 2 049 to 2 056 (DB), of the data sectors on tracks in one parity unit of the group.

The algorithm shall be

$$PB_{T,n} = DB_{t,0,n} \oplus DB_{t,1,n} \oplus \ldots DB_{t,j,n} \oplus \ldots \oplus DB_{t,N-1,n}$$
$$\oplus DB_{t+1,0,n} \oplus DB_{t+1,1,n} \oplus \ldots DB_{t+1,j,n} \oplus \ldots \oplus DB_{t+1,N-1,n}$$
$$\vdots$$
$$\oplus DB_{t+U-1,0,n} \oplus DB_{t+U-1,1,n} \oplus \ldots DB_{t+U-1,j,n} \oplus \ldots \oplus DB_{t+U-1,N-1,n}$$

where

U is the number of tracks in a parity unit, i.e., 2 for 512-byte sectors and 3 for 2 048-byte sectors

N is the number of sectors per track, i.e., 16 for 512-byte sectors and 4 for 2 048-byte sectors

$0 \le T < n_2 / (N \times U)$

$0 \le t < n_2 / N$ and $t = U \times T$

(n_2 is number of embossed data sectors in the group)

$0 \le j \le N$

$1 \le n \le 516$ for 512-byte sectors

$1 \le n \le 2\,056$ for 2 048-byte sectors

$PB_{T,n}$ is byte A_n of parity sector T, and $DB_{t,j,n}$ is byte A_n of sector j on track t of the group. A_n is defined in annex E. The parity bytes are calculated over the User data bytes and bytes 513 to 516 / 2 049 to 2 056, excluding the Resync bytes. The CRC, ECC, and Resync bytes as defined in annex E shall be required with each parity sector.

The parity sectors for tracks in each parity unit of the group shall be stored consecutively in the sectors allocated to them in each group, staring with the first sector. The first parity sector of a group is associated with the tracks in the first parity unit with the data sectors of the same group, the second parity sector is associated with the tracks in the second parity unit with the data sectors, and so on until tracks in all parity units with the data sectors have an associated parity sector. The contents of the Data field of the unused parity sectors shall be set to (FF) and shall contain data complying with the layout as given in table E.1.

The Buffer tracks in the Data Zone shall not have associated parity sectors.

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Section 4 - Characteristics of embossed information

20 Method of testing

The format of the embossed information on the disk is defined in clauses 13 to 18. Clauses 21 to 23 specify the requirements for the signals from grooves with no written marks, Headers and embossed data, as obtained when using the Reference Drives defined in clause 9.

Clauses 21 to 23 specify only the average quality of the embossed information. Local deviations from the specified values, called defects, can cause tracking errors, erroneous Headers or errors in the Data fields. These errors are covered by section 6.

20.1 Environment

All signals in clauses 21 to 23 shall be within their specified ranges with the cartridge in any environment in the range of allowed operating environments defined in 8.1.2.

20.2 Use of the Reference Drive

All signals specified in clauses 21 to 23 shall be measured in the indicated channels of the Reference Drive. The drive shall have the following characteristics for the purpose of these tests.

20.2.1 Optics and mechanics

The focused optical beam shall have the properties defined in 9.2 a) to g). The disk shall rotate as specified in 9.5.

20.2.2 Read power

For the wavelength 685 nm, the optical power incident on the entrance surface of the disk (used for reading the information) shall be 1,0 mW ± 0,1 mW.

20.2.3 Read channels

The drive shall have a read channel, in which the total amount of light in the exit pupil of the objective lens is measured. This channel can have the implementation as given by Read Channel in 9.3.

20.2.4 Tracking

During the measurement of the signals, the axial tracking error between the focus of the optical beam and recording layer shall not exceed

$$e_{max}(\text{axial}) = 0{,}6\ \mu\text{m}$$

and the radial tracking error between the focus of the optical beam and the centre of a track shall not exceed

$$e_{max}(\text{radial}) = 0{,}05\ \mu\text{m}$$

The radial tracking servo used for this measurement requires a higher performance than that specified in 11.4.8.

20.3 Definition of signals

All signals are linearly related to currents through a photo-diode detector, and are therefore linearly related to the optical power falling on the detector.

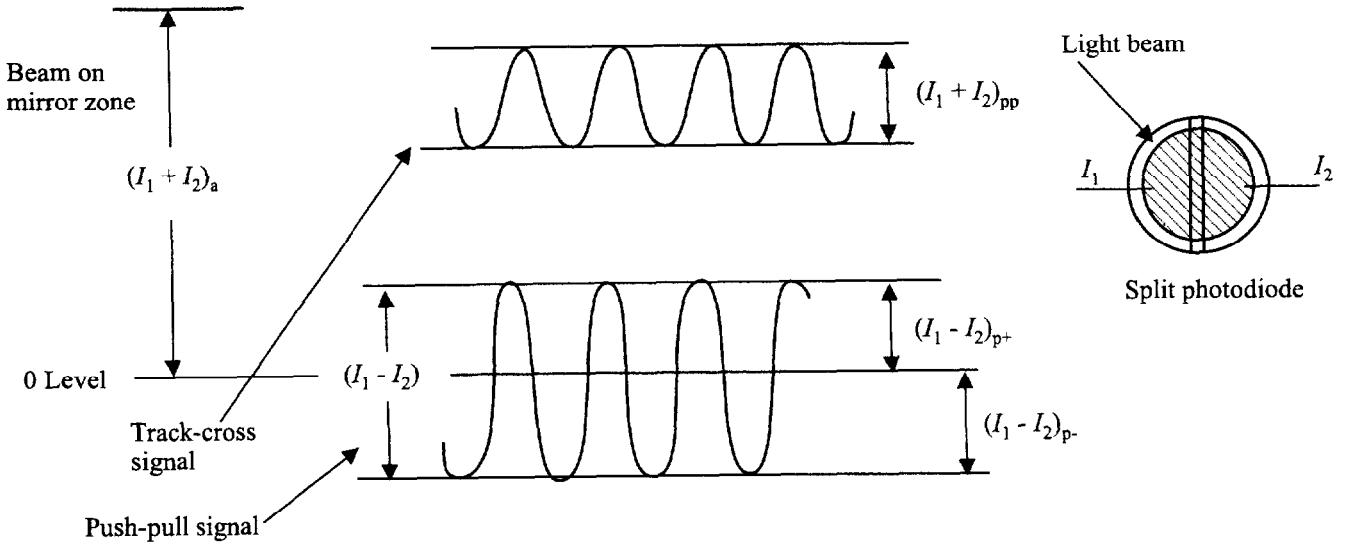
The signals from the two halves of the split photo-diode detector in the tracking channel are indicated by I_1 and I_2. The signals in the tracking channel are referenced to the signal $(I_1 + I_2)_a$, which is the sum of the signals obtained from the Mirror Zone

The signals in Read Channel are referenced to the signal I_0, which is the signal in Read Channel from the Mirror Zone.

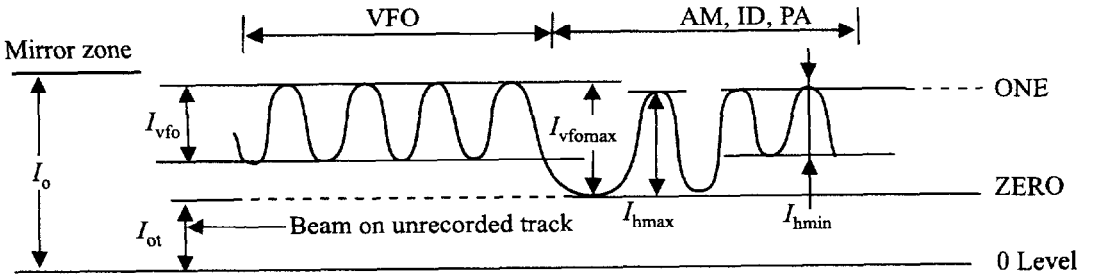
Figure 16 shows the signals specified in clauses 21, 22 and 23.

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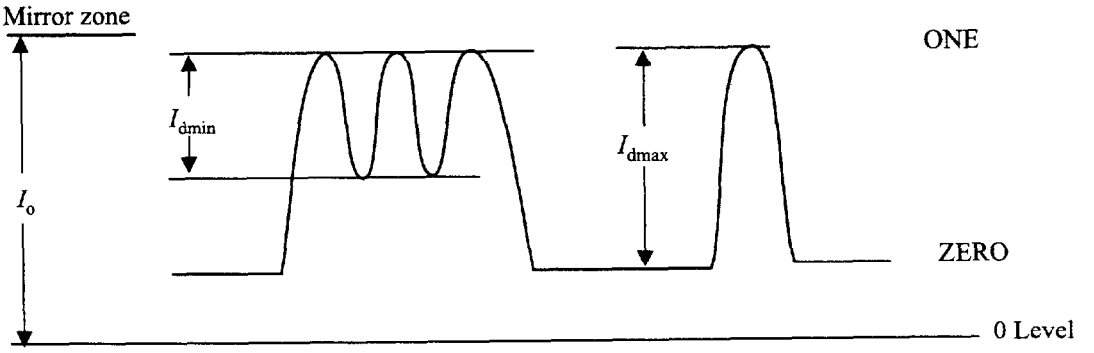
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Signals from grooves in the tracking channel



Signals from Headers in the Read Channel



Signals from embossed recording fields in the Read Channel

95-0121-A

Figure 16 - Signals from embossed areas

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21 Signals from grooves

The signals $(I_1 + I_2)$ and $(I_1 - I_2)$ shall be filtered in order that frequencies above 3 MHz are attenuated by least 40 dB thereby eliminating the effect of modulation due to embossed marks. This condition shall not be applied to the measurement of the signal $(I_1 + I_2)_a$.

The shape of the grooves and the embossed information shall be such that the following requirements are met (see annex J).

21.1 Push-pull signal

The push-pull signal is the sinusoidal difference signal $(I_1 - I_2)$ in the tracking channel, when the focus of the optical beam crosses the tracks. The signal can be used by the drive for radial tracking. The peak-to-peak value of the push-pull signal shall meet the following requirements:

a) in grooved areas with embossed data in the Information Zone:

$$0{,}22 \leq \frac{(I_1 - I_2)_{pp}}{(I_1 + I_2)_a} \leq 0{,}45$$

b) in grooved areas in the Information Zone without embossed Recording fields:

$$0{,}35 \leq \frac{(I_1 - I_2)_{pp}}{(I_1 + I_2)_a} \leq 0{,}65$$

c) in all grooved areas:

$$\left| \frac{(I_1 - I_2)_{p+} - (I_1 - I_2)_{p-}}{(I_1 - I_2)_{p+} + (I_1 - I_2)_{p-}} \right| \leq 0{,}07$$

21.2 Divided push-pull signal

The first term of the divided push-pull signal is the peak-to-peak amplitude derived from the instantaneous level of the differential output $(I_1 - I_2)$ from the split photo diode detector when the light beam crosses the unrecorded or preformatted data area of grooved tracks divided by the instantaneous level of the sum output $(I_1 + I_2)$ from the split photo diode detector when the light beam crosses these areas.

The second term of the divided push-pull signal is the ratio of the minimum peak-to-peak amplitude derived from the instantaneous level of the differential output $(I_1 - I_2)$ divided by the instantaneous level of the sum output $(I_1 + I_2)$ from the split photo diode detector when the light beam crosses the preformatted data area of grooved tracks to the maximum peak-to-peak amplitude derived from the instantaneous level of the differential output $(I_1 - I_2)$ divided by the instantaneous level of the sum output $(I_1 + I_2)$ from the split photo diode detector when the light beam crosses the preformatted data area of grooved tracks.

The split photo diode detector separator shall be parallel to the projected track axis. In this measurement, the I_1 and I_2 signals shall be provided by the split photo diode detector. The tracking servo shall be operating in open-loop mode during this measurement.

The first term shall meet the following requirements:

a) in grooved areas in the Information Zone without embossed Recording fields:

$$0{,}70 \leq \left[\frac{(I_1 - I_2)}{(I_1 + I_2)} \right]_{pp} \leq 1{,}00$$

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b) in grooved areas with embossed data in the Information Zone:

$$0{,}35 \leq \left[\frac{(I_1 - I_2)}{(I_1 + I_2)}\right]_{pp} \leq 0{,}60$$

The second term shall satisfy:

$$\frac{\left[\frac{(I_1 - I_2)}{(I_1 + I_2)}\right]_{pp\ min}}{\left[\frac{(I_1 - I_2)}{(I_1 + I_2)}\right]_{pp\ max}} \geq 0{,}70$$

21.3 Phase depth

The phase depth of the grooves shall be less than 180°.

21.4 Track location

The tracks are located at those radii on the disk where the push-pull signal equals 0 and the sum output (I_1+I_2) has its minimum value.

21.5 On-track signal

The on-track signal I_{ot} is the signal in Read Channel when tracking in a grooved area without embossed data.

The measured value I_{ot} shall be obtained under the conditions a) to g) of 9.2. Measurement shall be made in the unrecorded grooved area in the Information Zone.

The on-track signal I_{ot} shall meet the following requirement:

$$0{,}45 \leq I_{ot} / I_0 \leq 0{,}65$$

The measured maximum and minimum values of I_{ot} shall meet the following requirement:

$$\frac{I_{ot\ max} - I_{ot\ min}}{I_{ot\ max} + I_{ot\ min}} \leq 0{,}12$$

22 Signals from Headers

The signals obtained from the embossed Headers shall be measured in Read Channel of the Reference Drive.

The signal from an embossed mark in the recording layer is defined as the peak-to-peak value of the modulation of the signal in Read Channel caused by the mark when the beam follows a recorded track (see annex J).

The level of all signals from embossed marks shall be higher than Iot.

22.1 VFO_1 and VFO_2

The signal I_{vfo} from the marks in the VFO_1 and VFO_2 fields shall meet the following requirements:

$$I_{vfo} / I_0 \geq 0{,}12$$

In addition the condition

$$I_{vfo} / I_{hmax} \geq 0{,}40$$

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shall be satisfied within each Header, where I_{hmax} is the maximum signal from marks of that Header in the fields defined in 22.2.

22.2 Address Mark, ID field and Postamble

The signals from marks in the Address Mark, ID and Postamble fields shall meet the following requirements:

$$I_{hmin} / I_0 \geq 0,12$$

$$I_{vfo}/I_{vfomax} \geq 0,40$$

$$I_{hmax} / I_{vfomax} \geq 0,80$$

$$I_{hmin} / I_{hmax} \geq 0,40$$

The last requirement applies over any Header. I_{vfomax}, I_{hmin} and I_{hmax} are the signals with minimum and maximum amplitude in those fields of a sector mentioned above.

23 Signals from embossed Recording fields

If the disk has an embossed zone, the Recording field of all sectors in this zone shall contain embossed marks. The signals from these marks shall be measured in Read Channel (see 9.3 and annex J). Acceptable defects of the marks are specified in section 6. The signal from all embossed Recording fields is defined as the peak-to-peak value of the modulation of the signal.

The signals I_{dmin} and $I_{dmax}$from marks in the Recording fields of the embossed zone shall meet the following requirements:

$$I_{dmin} / I_0 \geq 0,12$$

$$I_{dmin} / I_{dmax} \geq 0,40$$

The last requirement applies over Recording fields. I_{dmin} and I_{dmax} are the signals with minimum and maximum amplitude in the Recording field of a sector.

For the focus tracks in the acquire zone, only I_{dmin} / I_0 is defined.

Section 5 - Characteristics of the recording layer

24 Method of testing

Clauses 25 to 26 describe a series of tests to assess the phase-change properties of the recording layer, as used for writing and erasing data. The tests shall be performed only in the Recording field of the sectors in the Rewritable Zone. If there is no Rewritable Zone for user recording, clauses 25 to 26 shall not apply. The overwrite and read operations necessary for the tests shall be made on the same Reference Drive.

Clauses 25 to 26 specify only the average quality of the recording layer. Local deviations from the specified values, called defects, can cause overwrite problems. These defects are covered by section 6.

24.1 Environment

All signals in clauses 25 to 26 shall be within their specified ranges with the cartridge in any environment in the range of allowed operating environments defined in 8.1.2.

24.2 Reference Drive

The overwrite test described in clauses 25 to 26 shall be measured in Read Channel of the Reference Drive. The drive shall have the following characteristics for the purpose of these tests.

24.2.1 Optics and mechanics

The focused optical beam shall have the properties defined in 9.2 a) to g). The disk shall rotate as specified in 9.5.

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24.2.2 Read power

The optical power incident on the entrance surface of the disk and used for reading the information shall be in the range 1,0 mW ± 0,1 mW.

24.2.3 Read channel

The Reference Drive shall have a read channel which can detect phase-change marks in the recording layer. This channel shall have an implementation equivalent to that given by the Read Channel in 9.3.

24.2.4 Tracking

During the measurement of the signals, the focus of the optical beam shall follow the tracks as specified in 20.2.4.

24.3 Overwrite conditions

Marks are overwritten on the disk by pulses of optical power superimposed on an erase power.

24.3.1 Overwrite pulse

The shape of the overwrite pulse shall be as given in figure 17.

The rise and fall times T_{r1},T_{f1} and T_{r2}, T_{f2} shall each meet the following requirements:

$$T_{r1},T_{f1} \leq (0,1\ T_p + 5)\ \text{ns}$$

$$T_{r2}, T_{f2} \leq (0,1\ T_o + 5)\ \text{ns}$$

24.3.2 Overwrite power and pulse width

The write power is the optical power incident on the entrance surface of the disk and used for overwriting marks.

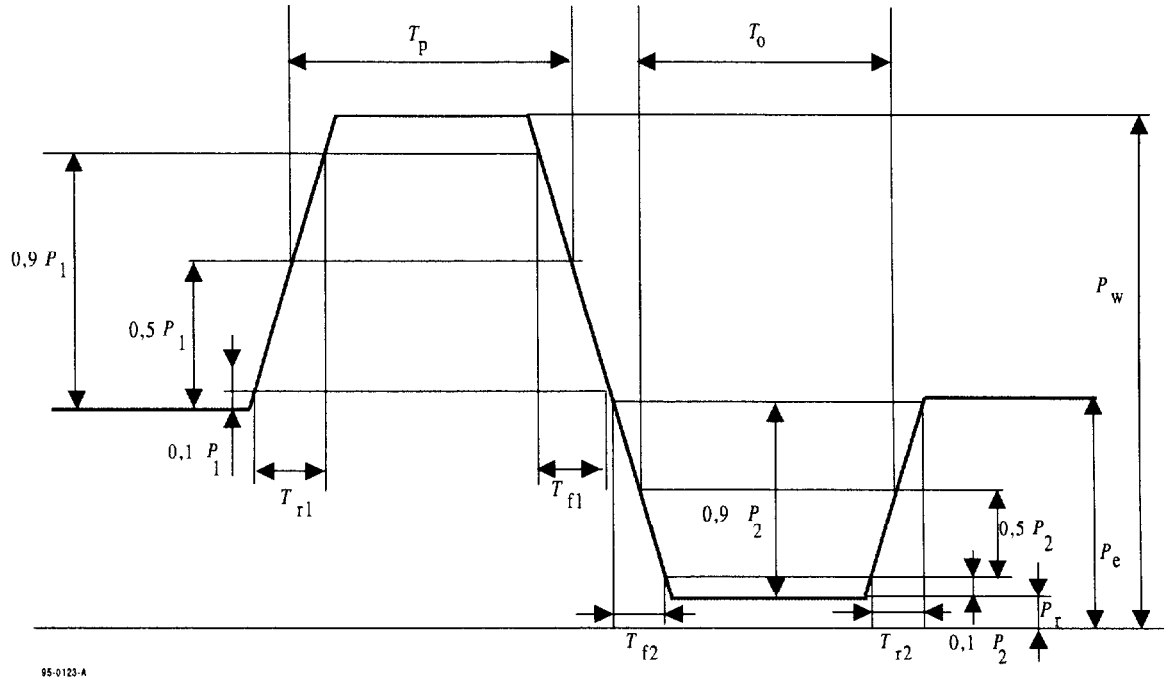
The read power P_r shall be set between 0,9 mW and 1,1 mW.

The tests shall be carried out at a temperature of 23 °C ± 2 °C, at one of the overwrite conditions, a write pulse width T_p, an off pulse width T_o, a write power P_w and an erase power P_e appropriate to the bands, as specified by bytes 22 to 33 of the Control data (see annex D),

For bands other than those specified, the values shall be linearly interpolated. The actual power and the pulse width used shall be within 5 % of those selected.

The maximum write power shall not exceed 15 mW. The maximum erase power shall not exceed 12 mW.

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P_w : write power | P_e: erase power | P_r: read power

T_{r1} , T_{r2} : rise time | T_{f1}, T_{f2} : fall time | T_p: write pulse width

T_o: off pulse width | P_1: P_w - P_e | P_2: P_e - P_r

Figure 17 - Shape of the overwrite pulse

24.4 Definition of signals

The signals in Read Channel are linearly related to the currents through the detector J, and are therefore linearly related to the optical power falling on the detector (see 9.1).

25 Overwrite characteristics

25.1 Resolution

The resolution is the ratio of the signal amplitude from a high-density pattern of marks to the signal amplitude from a low-density pattern of marks. It shall be measured as follows.

Write two series of marks, one spaced eight Channel bits apart and one spaced three Channel bits apart, in the Recording field of a sector. The write conditions shall be as specified in 24.3.

Read the signals in Read Channel under the conditions specified in 24.2.2 and 24.2.3. I_L is the peak-to-peak value of the signal obtained from the widely spaced marks, I_H is the peak-to-peak value of the signal obtained from the narrowly spaced marks (see figure 18).

The resolution I_H / I_L shall not be less than 0,3 within any sector in the Overwritable Zone. It shall not vary more than 0,2 over a track.

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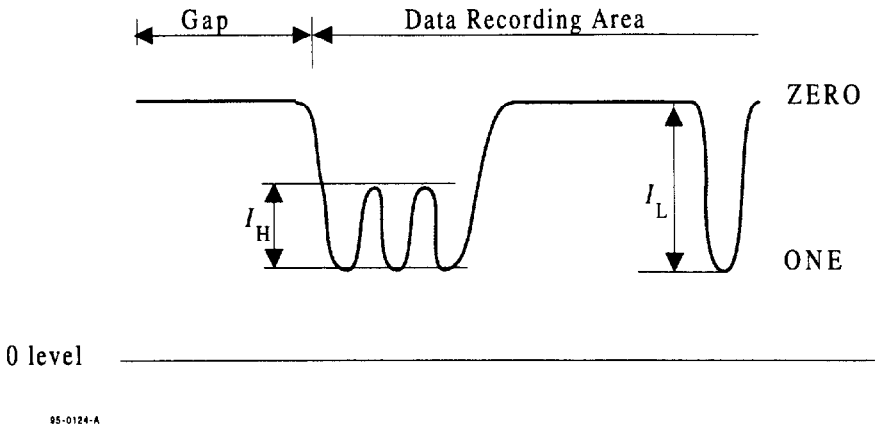


Figure 18 - Definition of I_H, I_L

25.2 Narrow-band signal-to-noise ratio

The narrow-band signal-to-noise ratio is the ratio of the signal level to the noise level of a specified pattern, measured in a 30 kHz bandwidth. It shall be determined as follows.

Write a series of marks spaced three Channel bits apart in the Recording fields of a series of sectors. The write conditions shall be as specified in 24.3.

Read the Recording fields in the Read Channel under the conditions specified in 24.2.2 and 24.2.3, using a spectrum analyser with a bandwidth of 30 kHz. Measure the amplitudes of the signal obtained from narrowly spaced marks at the frequency appropriate to the band and the noise at this frequency as indicated in figure 19. The measurements shall be corrected for the effect of the Header fields, in order to obtain the value for the Recording field only. The narrow-band signal-to-noise ratio is

$$20 \log_{10}\left[\frac{\text{signal level}}{\text{noise level}}\right]$$

The narrow-band signal-to-noise ratio shall be greater than 45 dB in any sector in the Rewritable Zone in the optical system as defined in 9.1.

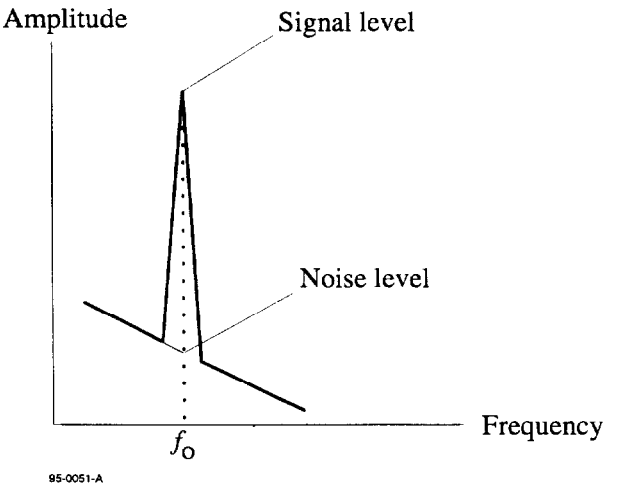


Figure 19 - Spectrum analyser display

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25.3 Cross-talk

The test on cross-talk shall be carried out on any group of five adjacent unrecorded tracks, designated (*n*-2), (*n*-1), *n*, (*n*+1), (*n*+2), in the Rewritable Zone according to the following procedure:

- Erase the Recording field of each of the sectors in these tracks.
- Write a series of marks spaced eight Channel bits apart in the Recording fields of the sectors in track *n*. The write conditions shall be as specified in 24.3.
- Read the Recording fields of the sectors in the tracks (*n*-1), *n* and (*n*+1) under the conditions specified in 24.2.2 and 24.2.3.

The cross-talk from a track *n* to track (*n*-1) and to track (*n*+1) shall be lower than -26 dB.

26 Erase characteristics

Procedure:

a) Overwrite a series of marks spaced three Channel bits apart in the Recording fields of any series of sectors in the Overwritable Zone. The overwrite conditions shall be as specified in 24.3.

b) Read the Recording fields under the conditions specified in 24.2.2 and 24.2.3, using a spectrum analyser with a bandwidth of 30 kHz. Note the amplitude of the signal (as specified in 25.2).

c) Overwrite a series of marks spaced eight Channel bits apart in the recording fields of any series of sectors in the Overwritable Zone. The overwrite conditions shall be as specified in 24.3.

d) Repeat a) and c) 1 000 times.

e) Repeat a).

f) Note the amplitude of the signal and the noise (as specified in 25.2), and the amplitude of the residual signal of the marks spaced eight Channel bits apart and the amplitude of the overwritten marks spaced three Channel bits apart.

The erase ratio is

$$20 \log_{10} \left[\frac{\text{Residual signal amplitude of marks spaced eight Channel bits apart}}{\text{Signal amplitude of the overwritten marks spaced three Channel bits apart}} \right]$$

Requirements:

1) The narrow-band signal-to-noise ratio calculated from the readings in f) shall be greater than 45 dB.

2) The erase ratio in f) shall be less than -20 dB.

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Section 6 - Characteristics of user data

27 Method of testing

Clauses 28 and 29 describes a series of measurements to test conformance of the user data on the disk with this International Standard. It checks the legibility of both embossed and user-written data. The data is assumed to be arbitrary. The user-written data may have been written by any drive in any environment. The read tests shall be performed on the Reference Drive.

Whereas clauses 20 to 26 disregard defects, clauses 28 and 29 include them as an unavoidable deterioration of the read signals. The gravity of a defect is determined by the correctability of the ensuing errors by the error detection and correction circuit in the read channel defined below. The requirements in clauses 28 and 29 define a minimum quality of the data, necessary for data interchange.

27.1 Environment

All signals in clauses 28 to 29 shall be within their specified ranges with the cartridge in any environment in the range of allowed operating environments defined in 8.1.2. 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.

27.2 Reference Drive

All signals specified in clauses 28 to 29 shall be measured in the indicated channels of the Reference Drive. The drive shall have the following characteristics for the purpose of these tests.

27.2.1 Optics and mechanics

The focused optical beam shall have the properties already defined in 9. 2a) to g). The disk shall rotate as specified in 9.5.

27.2.2 Read power

The optical power incident on the entrance surface of the disk (used for reading the information) shall be defined in 24.2.2.

27.2.3 Read amplifiers

The read amplifiers after the photo detectors in Read Channel shall be as specified in 9.3.

27.2.4 Analog-to-binary converters

The signals from read amplifiers shall be converted from analog-to-binary with a peak detector.

The converter for Read Channel shall operate correctly for analog signals from embossed marks with amplitudes as determined by clauses 22 and 23.

The converter for Read Channel shall operate correctly for analog signals from user-written marks with an amplitude as determined by clause 25.

27.2.5 Error correction

Correction of errors in the data bytes shall be carried out by an error detection and correction system based on the definition in E.3 of annex E. There shall be an additional correction system for the embossed data, based on the Parity Sectors as defined in 18.4.3.

27.2.6 Focusing and tracking

During the measurement of the signals, the focus of the optical beam shall follow the tracks as specified in 20.2.4.

28 Minimum quality of a sector

This clause specifies the minimum quality of the Header and Recording field of a sector as required for interchange of the data contained in that sector. The quality shall be measured on the Reference Drive specified in 27.2

A byte error occurs when one or more bits in a byte have a wrong setting, as detected by the ECC and/or CRC circuits.

28.1 Headers

28.1.1 ID fields

At least one of the three ID fields in a Header read in Read Channel shall not have any byte errors, as checked by the CRC in the field.

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28.2 User-written data

The user-written data in a sector as read in Read Channel shall not contain any byte errors that cannot be corrected by the error correction defined in 27.2.5.

28.3 Embossed data

The embossed data in a sector as read in Read Channel shall not contain any byte errors that cannot be corrected by the error correction defined in 27.2.5.

29 Data interchange requirements

A disk offered for interchange of data shall comply with the following requirements.

29.1 Tracking

The focus of the optical beam shall not jump tracks unintentionally.

29.2 User-written data

Any sector written in the Overwritable Zone that does not comply with 28.1 and 28.2 shall have been replaced according to the rules of the defect management as defined in clause 19.

29.3 Embossed data

Any sector in the Embossed Zone that does not comply with 28.1 and 28.3 shall be correctable by the error correction based on the Parity Sectors as defined in 18.4.3.

29.4 Quality of the disk

The quality of the disk is reflected in the number of replaced sectors in the Overwritable Zone. This International Standard allows a maximum of 3 068 replaced sectors.

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Annex A

(normative)

Edge distortion test

A.1 The distortion test checks if the case is free from unacceptable distortions and protrusions along its edges. The test is made by causing the cartridge to pass through the vertical slot of a gauge while applying a specified force including the gravitational pull.

A.2 The gauge shall be made of a suitable material, e.g. of chrome-plated carbon steel. The inner surfaces shall be polished to a surface finish of 5 µm peak-to-peak.

A.3 The dimensions shall be as follows (see figure A.1):

L_a = 96,0 mm min.

L_b = 91,0 mm ± 0,1 mm

L_c = 8,6 mm $^{+0,1\ mm}_{-0,0\ mm}$

L_d = 5,30 mm ± 0,01 mm

L_e = 6,80 mm min.

A.4 When the cartridge is inserted vertically into the gauge, a vertical downward force F of 0,8 N maximum applied to the centre of the top edge of the cartridge shall cause the cartridge to pass through the gauge.

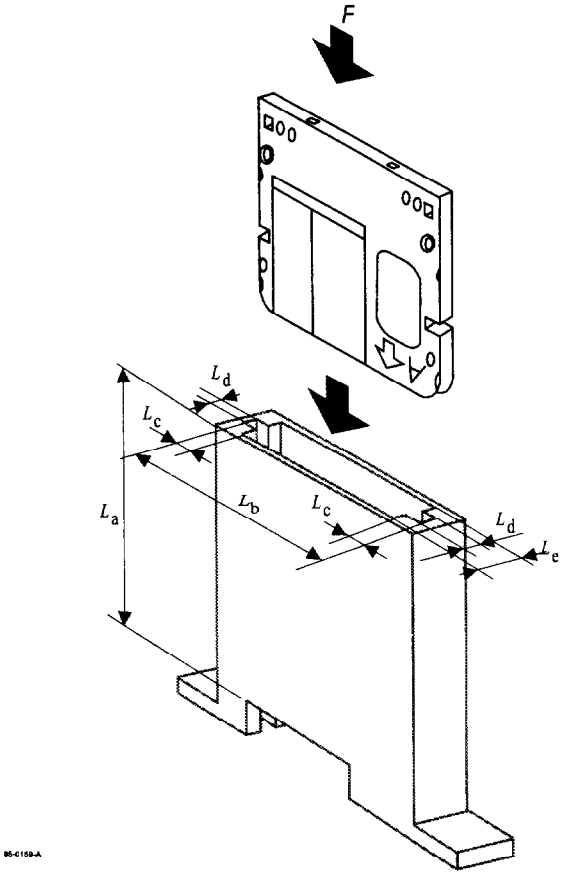


Figure A.1 - Distortion Gauge

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Annex B

(normative)

Compliance test

B.1 The compliance test checks the flatness and flexibility of the case by forcing the eight reference surfaces of the case into a plane. The test is made by placing the cartridge on the supports of a gauge and applying forces on the cartridge opposite to the supports.

B.2 The locations of the eight reference surfaces S1 to S8 are specified in 10.3.4 and figure 4.

B.3 The test gauge consists of a base plate on which eight posts P1, P2, P3, P4, P5, P6, P7 and P8 are fixed so as to correspond to the eight surfaces S1, S2, S3, S4, S5, S6, S7 and S8, respectively (see figure B.1). The dimensions are as follows (see figure B.2).

Posts P1 and P2

$D_a = 6{,}50$ mm ± 0,01 mm

$D_b = 3{,}50\ ^{+\ 0{,}00\ \text{mm}}_{-\ 0{,}02\ \text{mm}}$

$H_a = 1{,}0$ mm ± 0,1 mm

$H_b = 2{,}0$ mm max.

$H_f = 1{,}0$ mm ± 0,1 mm

$H_g = 2{,}0$ mm max.

$H_h = 0{,}95$ mm min.

Posts P3 and P4

$D_c = 5{,}50$ mm ± 0,01 mm.

The top area (H_b - H_a) of posts P1 and P2 has a chamfer.

Posts P5, P6, P7 and P8

$D_e = 4{,}50$ mm ± 0,01 mm

After assembly, the upper annular surfaces of the eight posts shall lie between two horizontal planes spaced 0,01 mm apart.

B.4 The cartridge shall be placed with its reference surfaces onto the posts of the horizontal gauge. A vertical downward force F of 0,4 N shall be exerted on the cartridge opposite each of the eight posts.

B.5 Requirements

Under the conditions of B.4, three of the four surfaces S1 to S4 shall be in contact with the annular surface of their respective posts, and any gap between the remaining surface S and the annular surface of its post shall not exceed 0,1 mm. Under the conditions of B.4, three of the four surfaces S5 to S8 shall be in contact with the annular surface of their respective posts, and any gap between the remaining surface S and the annular surface of its post shall not exceed 0,1 mm.

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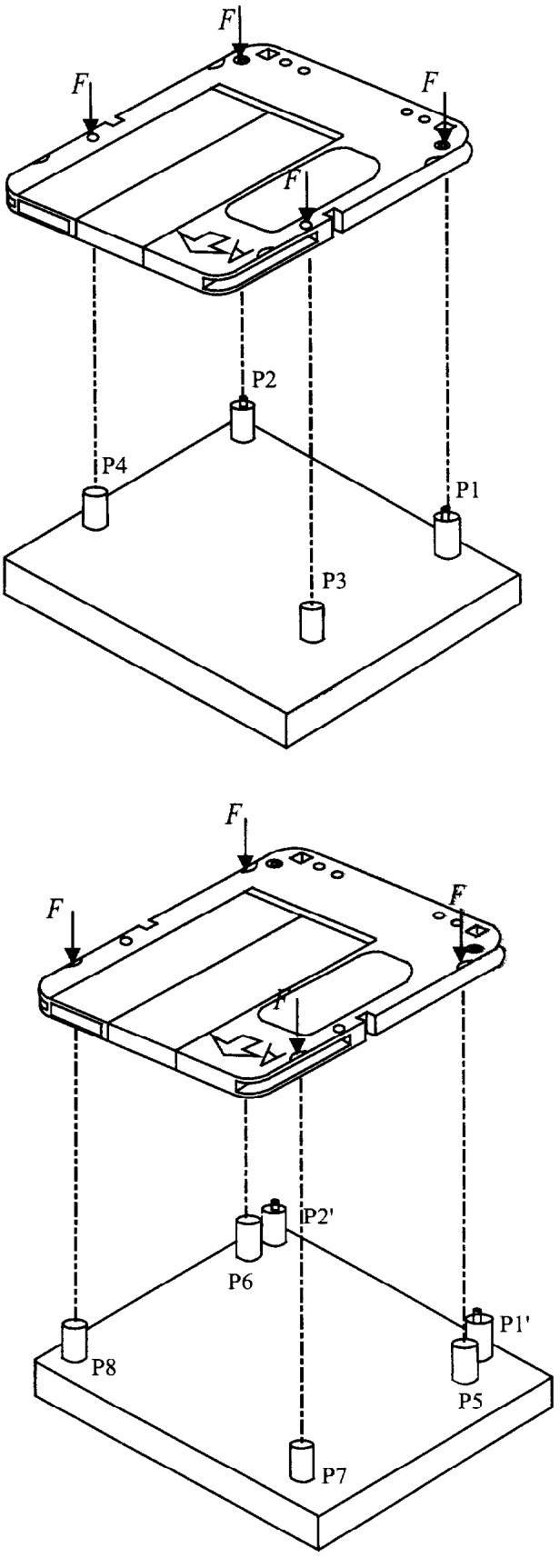


Figure B.1 - Compliance gauge

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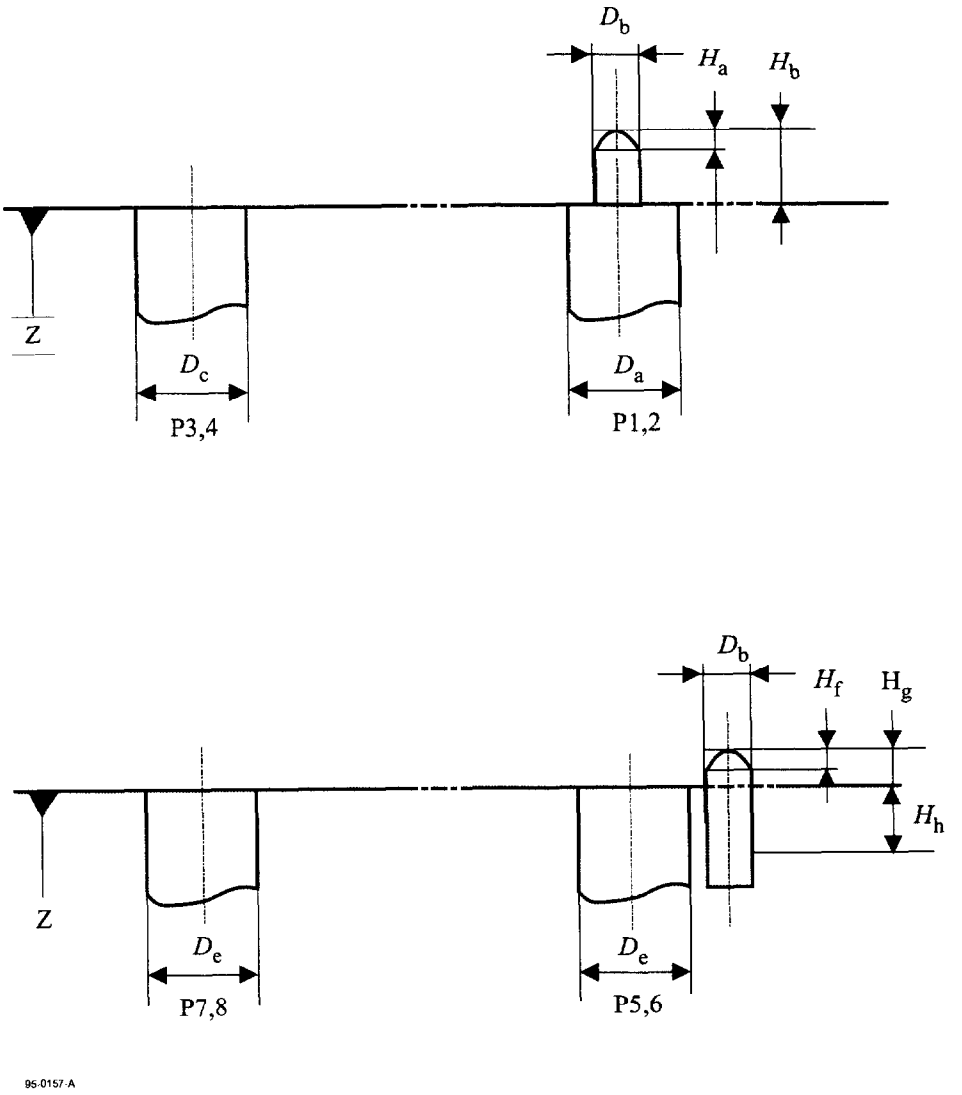


Figure B.2 - Detail of posts

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Annex C

(normative)

CRC for ID fields

The 16 check bits of the CRC of the ID field shall be computed over the first three bytes of this field. The generator polynomial shall be

$$G(x) = x^{16} + x^{12} + x^5 + 1$$

The residual polynomial is defined by

$$R_c(x) = \left(\sum_{i=8}^{i=23} \overline{b_i} x^i + \sum_{i=0}^{i=7} b_i x^i \right) x^{16} \bmod G(x)$$

where b_i denotes a bit of the first three bytes and $\overline{b_i}$ an inverted bit. Bit b_{13} is the highest order bit of the first byte.

The contents of the 16 check bits c_k of the CRC are defined by

$$R_c(x) = \sum_{k=0}^{k=15} c_k x^k$$

where c_{15} is recorded in the highest order bit of the fourth byte in the ID field.

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Annex D

(normative)

Contents of the Control Zones

Each sector in the two Control Zones shall contain the same Control data provided by the manufacturer of the media. The Control data is divided into four groups in the following way.

1. The media characterization data gives a general characterization of the disk. It specifies the type of disk, the ECC, the tracking method, etc. The data is recorded in bytes 0 to 17. Bytes 0 to 13 are mandatory for all media.
2. The Recording Control data specifies the settings of the drive for reading and overwriting. Space is allocated for the following sets of data:
   - a wavelength L_1,
   - for this wavelength the reflectance R of the disk,
   - for this wavelength two rotational frequencies N_1 and N_2,
   - for each value of N:
     - the maximum read power
     - one set of erase conditions
     - three sets of write conditions: viz. two sets for write pulse width and one set for pulse width of Off-pulse and one set for write power (each set may contain three values for the inner, middle and outer radius of the Information Zone).

   2a) Bytes 18 to 33

   The conformance test data specify the settings for the Reference Drive, and can also be used as reference data for user drives. These bytes are mandatory for Types R/W and P-ROM.

   2b) Bytes 48 to 61

   These bytes specify the same parameters as bytes 20 to 33 for a rotational speed N_2. Recording of this data is optional. These bytes shall either contain this data or be set to (FF).

   2c) Bytes 34 to 47 and 62 to 379

   These bytes are reserved for future standardization. They shall be set to (FF).
3. The System data shall be recorded in bytes 380 to 479

   3a) Bytes 380 to 399

   These bytes are mandatory for all Types.

   3b) Bytes 400 to 423

   These bytes are mandatory for Type P-ROM. They shall be set to (FF) for Types R/W and O-ROM.

   3c) Bytes 424 to 479

   These bytes are reserved for future standardization. They shall be set to (FF).
4. The last group of bytes contains unspecified data in bytes 480 to 511. The contents of these bytes shall be ignored in interchange.

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D.1 Media characterization data

Byte 0: Format Descriptor 1

This byte shall be set to 01100000, indicating Continuous Composite Servo tracking, Logical ZCAV Rotational Recording mode, (2,7) RLL mark position Recording code.

Byte 1: Format Descriptor 2

In case of 512-byte sectors, this byte shall be set to 00010001, indicating Reed-Solomon Long Distance Error Correction Code of degree 16 with a 5-way interleave, 512 bytes user data per sector. In case of 2 048-byte sectors, this byte shall be set to 00000011, indicating Reed-Solomon Long Distance Error Correction Code of degree 16 with a 10-way interleave, 2 048 bytes user data per sector.

Byte 2: Sectors per track

In case of 512-byte sectors, this byte shall be set to 00010000, indicating 16 sectors per track. In case of 2 048-byte sectors, this byte shall be set to 00000100, indicating 4 sectors per track.

Byte 3: Reflectance

This byte shall specify the disk manufacturer's specification of the reflectance R of the disk, expressed as a fraction, when measured at a nominal wavelength of 685 nm. It is specified as a number n such that

$$n = 100\,R$$

Byte 4: On-land or in-groove recording

This byte shall be set to 10100000, indicating in-groove recording, low-to-high polarity of embossed marks and high-to-low polarity of overwritable marks.

Byte 5: Reserved

This byte shall be set to (FF).

Byte 6: Maximum read power

This byte shall specify the lowest of the values specified in Bytes 21, 135 and 249 of the Control Zones. It specifies the maximum read power P_r, in milliwatts, permitted for reading the Control Zones. It is specified as a number n such that

$$n = 20\,P_r$$

Byte 7: Media type

The allowed settings of this byte shall be

0000 0000:	indicates fully embossed media
0011 0000:	indicates fully overwritable, phase change media
1011 0000:	indicates overwritable, phase change media with partially embossed data

Other settings of this byte are prohibited by this International Standard, they are reserved for future standardization (see annex R).

Bytes 8 to 10: Last sector in the Data Zone

In case of 512-byte sectors, these bytes shall be set to 00010000, 01101010 and 00011111, respectively, indicating the MSB to LSB of the concatenated track number and sector number of the last sector in the Data Zone, viz. 1 075 743. In case of 2 048-byte sectors, these bytes shall be set to 00000100, 11100010 and 10011011, respectively, indicating the MSB to LSB of the concatenated track number and sector number of the last sector in the Data Zone, viz. 320 155.

Byte 11: Reserved

This byte shall be set to(FF) .

Byte 12: Track pitch

This byte shall specify the track pitch in µm times 100. It shall be set to (5A) representing a track pitch of 0,9 µm.

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Byte 13: Reserved

This byte shall be set to (FF).

Bytes 14 to 17: Unspecified

These bytes may be used for manufacturer identification. They shall be ignored in interchange.

D.2 Recording control data

Byte 18: Wavelength

This byte shall specify the wavelength L_1, in nanometres, of the drive as a number n such that

$$n = 1/5\ L_1.$$

This byte shall be set to $n = 137$.

Byte 19: Reflectance

This byte shall specify the reflectance R_1 of the disk measured at wavelength L_1 as a number n such that

$$n = 100\ R_1.$$

The value of n shall be equal to that recorded in byte 3.

Byte 20: Rotational frequency

This byte shall specify the rotational frequency N_1 in hertz of the disk as a number n such that

$$n = N_1.$$

This byte shall be set to $n = 50$.

Byte 21: Read power

This byte shall specify the maximum read power P_r, in milliwatts, in the Information Zone under condition L_1 and N_1, expressed as a number n such that

$$n = 20\ P_r$$

where $n = 20$.

Bytes 22 to 24: Write pulse width

Bytes 22 to 24 shall specify the write pulse width T_p, in nanoseconds, at a write power P_w for respective Band under condition L_1 and N_1. T_p is expressed as a number n such that

$$n = T_p$$

Byte 22 Write pulse width at Band 0
Byte 23 Write pulse width at Band 15 in case of 512-byte sectors or Band 4 in case of 2 048-byte sectors
Byte 24 Write pulse width at Band 29 in case of 512-byte sectors or Band 8 in case of 2 048-byte sectors

Bytes 25 to 27: Pulse width of Off-pulse

Bytes 25 to 27 shall specify the pulse width of the Off-pulse T_o, in nanoseconds, at a write pulse width T_p and write power P_w for respective Band under condition L_1 and N_1. T_o is expressed as a number n such that

$$n = T_o$$

Byte 25 Pulse width of the Off-pulse at Band 0
Byte 26 Pulse width of the Off-pulse at Band 15 in case of 512-byte sectors or Band 4 in case of 2 048-byte sectors
Byte 27 Pulse width of the Off-pulse at Band 29 in case of 512-byte sectors or Band 8 in case of 2 048-byte sectors

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Bytes 28 to 30: Write power

Bytes 28 to 30 shall specify the write powers P_w, in milliwatts, at a write pulse width T_p and pulse width of the Off-pulse T_o for respective Band under condition L_1 and N_1. P_w is expressed as a number n such that

$$n = 5 P_w$$

Byte 28 Write power at Band 0
Byte 29 Write power at Band 15 in case of 512-byte sectors or Band 4 in case of 2 048-byte sectors
Byte 39 Write power at Band 29 in case of 512-byte sectors or Band 8 in case of 2 048-byte sectors

Bytes 31 to 33: Erase power

Bytes 31 to 33 shall specify erase powers P_e, in milliwatts for respective Band, under condition L_1 and N_1. P_e is expressed in the same way as P_w in bytes 28 to 30.

Byte 31 Erase power at Band 0
Byte 32 Erase power at Band 15 in case of 512-byte sectors or Band 4 in case of 2 048-byte sectors
Byte 33 Erase power at Band 29 in case of 512-byte sectors or Band 8 in case of 2 048-byte sectors

Bytes 34 to 47: Reserved

These bytes shall be set to (FF).

Byte 48: Rotational frequency

This byte shall specify the rotational frequency N_2, in hertz, of the disk, expressed in the same way as N_1 in byte 20.

If this byte is not set to (FF), n shall be set to 60.

Bytes 49 to 75

These bytes shall specify the same parameters as in bytes 21 to 47, but under the condition L_1 and N_2, except bytes 62 to 75 which shall be set to (FF).

Bytes 76 to 359: Reserved

These bytes shall be set to (FF).

Bytes 360 to 379: Reserved

These bytes shall be set to (FF).

Summary of recording control data

Table D.1 summarizes the requirements for bytes 18 to 359. In this table:

– numbers on light shaded background are those of the bytes containing mandatory data, see 2a);

– numbers on darkly shaded background are those of the bytes which shall always be set to (FF), see 2c);

– numbers on white background are those of the bytes the content of which is optional. These bytes shall either contain the value specified for them in D.1 or be set to (FF) (see 2b).

D.3 System data

Bytes 380 to 399 are mandatory for all Types and bytes 400 to 479 are mandatory for Type P-ROM.

Bytes 380 and 385: Reserved

These bytes shall be set to (FF).

Byte 386: Linearity of data Band capacity

In the case of 512-byte sectors, this byte shall be set to 00000011, indicating the first data Band capacity and the last data Band capacity are not aligned to linear relationship of the other data Bands. In the case of 2 048-byte sectors, this byte shall be set to 00000001, indicating the first data Band capacity is not aligned to linear relationship of the other data Bands.

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Byte 387: Reserved

This byte shall be set to (FF).

Bytes 388 and 389: Number of Tracks in the first data Band in the linear relationship

In the case of 512-byte sectors, these bytes shall be set to 00001011 and 01000001, respectively, indicating the MSB, LSB of the number of tracks in the first data Band in the linear relationship, viz. 2 881. The number includes DMA tracks.

In the case of 2 048-byte sectors, these bytes shall be set to 00101010 and 01001110, respectively, indicating the MSB, LSB of the number of tracks in the first data Band in the linear relationship, viz. 10 830. The number includes DMA tracks.

Byte 390: Number of Bands in the linear relationship

In the case of 512-byte sectors, this byte shall be set to 00011100, indicating the number of bands in the linear relationship is 28.

In the case of 2 048-byte sectors, this byte shall be set to 00001000, indicating the number of bands in the linear relationship is 8.

Byte 391: Banding Constant for the Media

In the case of 512-byte sectors this byte shall be set to 00101011, indicating the banding constant for the media is 43.

In the case of 2 048-byte sectors, this byte shall be set to (00), indicating that actual value for the banding constant for the media is contained in bytes 398 to 399.

Bytes 392 to 393: Number of Revolutions per data Band in the linear relationship

In the case of 512-byte sectors, these bytes shall be set to 00000010 and 10110000, respectively, indicating the MSB, LSB of the number of revolutions in the first data Band in the linear relationship, viz. 688.

In the case of 2 048-byte sectors, these bytes shall be set to 00001000 and 11101000, respectively, indicating the MSB, LSB of the number of revolutions in the first data Band in the linear relationship, viz. 2 280.

Bytes 394 to 395: Number of tracks in the first data Band

In the case of 512-byte sectors, these bytes shall be set to 00000110 and 11101000, respectively, indicating the MSB, LSB of the number of tracks in the first data Band, viz. 1 768.

In the case of 2 048-byte sectors, these bytes shall be set to 00100100 and 10010000, respectively, indicating the MSB, LSB of the number of tracks in the first data Band, viz. 9 360.

Bytes 396 to 397: Number of tracks in the last data Band

In the case of 512-byte sectors, these bytes shall be set to 00000100 and 00011101, respectively, indicating the MSB, LSB of the number of tracks in the last data Band, viz. 1 053.

In the case of 2 048-byte sectors, these bytes shall be set to 00011010 and 10111000, respectively, indicating the MSB, LSB of the number of tracks in the last data Band, viz. 6 840.

Bytes 398 to 399: Banding constant for the media (two-byte extension)

In the case of 512-byte sectors, these bytes shall be set to (FF).

In the case of 2 048-byte sectors, these bytes shall be set to 00000010 and 00111010, indicating the banding constant for the media is 570.

Bytes 400 to 423: Control bytes for partially embossed disks

This information is required for partially embossed disks and contains parameter values for bytes 0 to 23 of the DDS. These control bytes shall be defined by the manufacturer at the time the disk is manufactured. Bytes 416 to 423, which represent addresses of the PDL and SDL, shall be set to (FF). The control bytes can be used by the user as input to the format process and to recover the contents of the DDS if lost through machine error or if inadvertently overwritten. For fully rewritable and fully embossed disks, these bytes shall be set to (FF).

Bytes 424 to 479: Reserved

These bytes shall be set to (FF).

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D.4 Unspecified data

Bytes 480 to 511

The contents of these bytes are not specified in this International Standard. They may contain an identification of the manufacturer. They shall be ignored in interchange.

Table D.1 - Summary of recording control data

	L_1 N_1	L_1 N_2	L_1 N_3	L_1 N_4	L_2 N_1	L_2 N_2	L_2 N_3	L_2 N_4	L_3 N_1	L_3 N_2	L_3 N_3	L_3 N_4
L	18				132				246			
R	19				133				247			
N	20	48	76	104	134	162	190	218	248	276	304	332
Max. P_{read}	21	49	77	105	135	163	191	219	249	277	305	333
T_p	22	50	78	106	136	164	192	220	250	278	306	334
T_p	23	51	79	107	137	165	193	221	251	279	307	335
T_p	24	52	80	108	138	166	194	222	252	280	308	336
T_o	25	53	81	109	139	167	195	223	253	281	309	337
T_o	26	54	82	110	140	168	196	224	254	282	310	338
T_o	27	55	83	111	141	169	197	225	255	283	311	339
P_w	28	56	84	112	142	170	198	226	256	284	312	340
P_w	29	57	85	113	143	171	199	227	257	285	313	341
P_w	30	58	86	114	144	172	200	228	258	286	314	342
P_e	31	59	87	115	145	173	201	229	259	287	315	343
P_e	32	60	88	116	146	174	202	230	260	288	316	344
P_e	33	61	89	117	147	175	203	231	261	289	317	345
Reserved	34	62	90	118	148	176	204	232	262	290	318	346
Reserved	35	63	91	119	149	177	205	233	263	291	319	347
Reserved	36	64	92	120	150	178	206	234	264	292	320	348
Reserved	37	65	93	121	151	179	207	235	265	293	321	349
Reserved	38	66	94	122	152	180	208	236	266	294	322	350
Reserved	39	67	95	123	153	181	209	237	267	295	323	351
Reserved	40	68	96	124	154	182	210	238	268	296	324	352
Reserved	41	69	97	125	155	183	211	239	269	297	325	353
Reserved	42	70	98	126	156	184	212	240	270	298	326	354
Reserved	43	71	99	127	157	185	213	241	271	299	327	355
Reserved	44	72	100	128	158	186	214	242	272	300	328	356
Reserved	45	73	101	129	159	187	215	243	273	301	329	357
Reserved	46	74	102	130	160	188	216	244	274	302	330	358
Reserved	47	75	103	131	161	189	217	245	275	303	331	359

Mandatory: Bytes set to (FF) Mandatory data Optional data

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Annex E

(normative)

Format of the Data field of a sector

E.1 Contents of Data field

The notation int[x] denotes the largest integer not greater than x; (x mod y) denotes the remainder of the integer division x/y.

The order of the user data bytes D_n is the same as the order in which they are input into the controller of the drive, i.e. D_1 comes first. The Resync bytes are not included in A_n.

E.1.1 Contents of 512-byte sectors

The bytes in the Data field constitute an ordered sequence A_n. The elements of A_n are, depending on the value of n:

$1 \le n \le 512$: $A_n = D_n$	user data bytes
$513 \le n \le 516$: $A_n = F_m$	bytes with non-specified content
$517 \le n \le 520$: $A_n = C_k$	CRC check bytes
$521 \le n \le 600$: $A_n = E_{st}$	ECC check bytes

where

$m = n - 512$

$k = n - 516$

$s = [(n - 521) \bmod 5] + 1$

$$t = \text{int}\left[\frac{n - 521}{5}\right] + 1$$

E.1.2 Contents of 2 048-byte sectors

$1 \le n \le 2\,048$: $A_n = D_n$	user data bytes
$2\,049 \le n \le 2\,056$: $A_n = F_m$	bytes with non-specified content
$2\,057 \le n \le 2\,060$: $A_n = C_k$	CRC check bytes
$2\,061 \le n \le 2\,220$: $A_n = E_{st}$	ECC check bytes

where

$m = n - 2\,048$

$k = n - 2\,056$

$s = [(n - 2\,061) \bmod 10] + 1$

$$t = \text{int}\left[\frac{n - 2\,061}{10}\right] + 1$$

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E.2 Interleaving

E.2.1 512-byte sectors

Before the ECC and CRC bytes are calculated, the bytes in the Data field are five-way interleaved. For that purpose, the first three sub-groups of A_n are mapped onto a two-dimensional matrix B_{ij} with 104 rows and 5 columns (see table E.1). Thus

for $1 \le n \le 520$: $B_{ij} = A_n$,

where

$$i = 103 - \text{int}\left[\frac{n-1}{5}\right]$$

$j = (n - 1) \bmod 5$

E.2.2 2 048-byte sectors

Before the ECC and CRC bytes are calculated, the bytes in the Data field are ten-way interleaved. For that purpose, the first three sub-groups of A_n are mapped onto a two-dimensional matrix B_{ij} with 206 rows and 10 columns (see table E.1). Thus

for $1 \le n \le 2\,060$: $B_{ij} = A_n$,

where

$$i = 205 - \text{int}\left[\frac{n-1}{10}\right]$$

$j = (n - 1) \bmod 10$

E.3 CRC and ECC

E.3.1 General

The CRC and ECC shall be computed over the Galois field based on the primitive polynomial

$G_p(x) = x^8 + x^5 + x^3 + x^2 + 1$

The elements of the field are $\alpha^i = (\beta^i)^{88}$, where β is a primitive root of $G_p(x)$. The value of the n-th bit in a byte is the coefficient of the n-th power of β, where $0 \le n \le 7$, when β is expressed on a polynomial basis.

E.3.2 CRC for 512-byte sectors

The generator polynomial for the CRC bytes shall be

$$G_c(x) = \prod_{i=136}^{i=139}\left(x + \alpha^i\right)$$

The four check bytes of the CRC shall be computed over the user data and the four F_m bytes. The information polynomial shall be

$$I_c(x) = \left[\sum_{i=1}^{i=103}\sum_{j=0}^{j=4} B_{ij}\, x^i\right] + B_{0,0}\, x^0$$

The contents of the four check bytes C_k of the CRC are defined by the residual polynomial

$R_c(x) = I_c(x)\, x^4 \bmod G_c(x)$

The storage locations for the coefficients of the polynomial are specified by

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$$R_c(x) = \sum_{k=1}^{k=4} C_k x^{4-k}$$

E.3.3 CRC for 2 048-byte sectors

The generator polynomial for the CRC bytes shall be

$$G_c(x) = \prod_{i=136}^{i=139} (x + \alpha^i)$$

The four check bytes of the CRC shall be computed over the user data and the eight F_m bytes. The information polynomial shall be

$$I_c(x) = \left[\sum_{i=1}^{i=205} \sum_{j=0}^{j=9} B_{ij} x^i \right] + \left[\sum_{j=0}^{j=5} B_{0,j} x^0 \right]$$

The contents of the four check bytes C_k of the CRC are defined by the residual polynomial

$$R_c(x) = I_c(x)\, x^4 \bmod G_c(x)$$

The storage locations for the coefficients of the polynomial are specified by

$$R_c(x) = \sum_{k=1}^{k=4} C_k x^{4-k}$$

E.3.4 ECC for 512-byte sectors

The primitive polynomial and the elements shall be as specified in E.3.1. The generator polynomial for the check bytes of the ECC shall be

$$G_e(x) = \prod_{i=120}^{i=135} (x + \alpha^i)$$

The 80 check bytes of the ECC shall be computed over the user data, the four F_m bytes and the four CRC bytes. The corresponding five information polynomials shall be

$$I_{ej}(x) = \sum_{i=0}^{i=103} B_{ij} x^i$$

where $0 \le j \le 4$

The contents of the 16 check bytes E_{st} for each polynomial $I_{ej}(x)$ are defined by the five residual polynomials

$$R_{ej}(x) = I_{ej}(x)\, x^{16} \bmod G_e(x)$$

The storage locations for the coefficients of the polynomials are specified by

$$P_{ej}(x) = \sum_{t=1}^{t=16} \overline{E}_{(j+1),t} x^{16-t}$$

The bits of the computed check bytes shall be inverted before they are encoded into Channel bits, as indicated by the use of $\overline{E}$ in the above formula and E in table E.1.

E.3.5 ECC for 2 048-byte sectors

The primitive polynomial and the elements shall be as specified in E.3.1. The generator polynomial for the check bytes of the ECC shall be

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$$G_e(x) = \prod_{i=120}^{i=135}(x + \alpha^i)$$

The 160 check bytes of the ECC shall be computed over the user data, the eight F_m bytes and the four CRC bytes. The corresponding ten information polynomials shall be

$$I_{e,j}(x) = \sum_{i=0}^{i=205} B_{i,j}\, x^i$$

where $0 \le j \le 9$

The contents of the 16 check bytes $E_{s,t}$ for each polynomial $I_{e,j}(x)$ are defined by the ten residual polynomials

$$R_{e,j}(x) = I_{e,j}(x)\, x^{16} \bmod G_e(x)$$

The storage locations for the coefficients of the polynomials are specified by

$$R_{e,j}(x) = \sum_{t=1}^{t=16} \overline{E}_{(j+1),t}\; x^{16-t}$$

The bits of the computed check bytes shall be inverted before they are encoded into Channel bits, as indicated by the use of $\overline{E}$ in the above formula and E in table E.2.

E.4 Resync

The Resync fields shall be inserted in the Data field to prevent loss of byte synchronization and to limit the propagation of errors in the user data. Whilst they are numbered consecutively, all Resync fields are identical. They contain the following pattern in Channel bits which does not occur in user data

0010 0000 0010 0100.

In the case of 512-byte sectors, the Resync field RS_n shall be inserted between bytes A_{15n} and A_{15n+1}, where $1 \le n \le 39$.

In the case of 2 048-byte sectors, the Resync field RS_n shall be inserted between bytes A_{30n} and A_{30n+1}, where $1 \le n \le 73$.

E.5 Recording Sequence

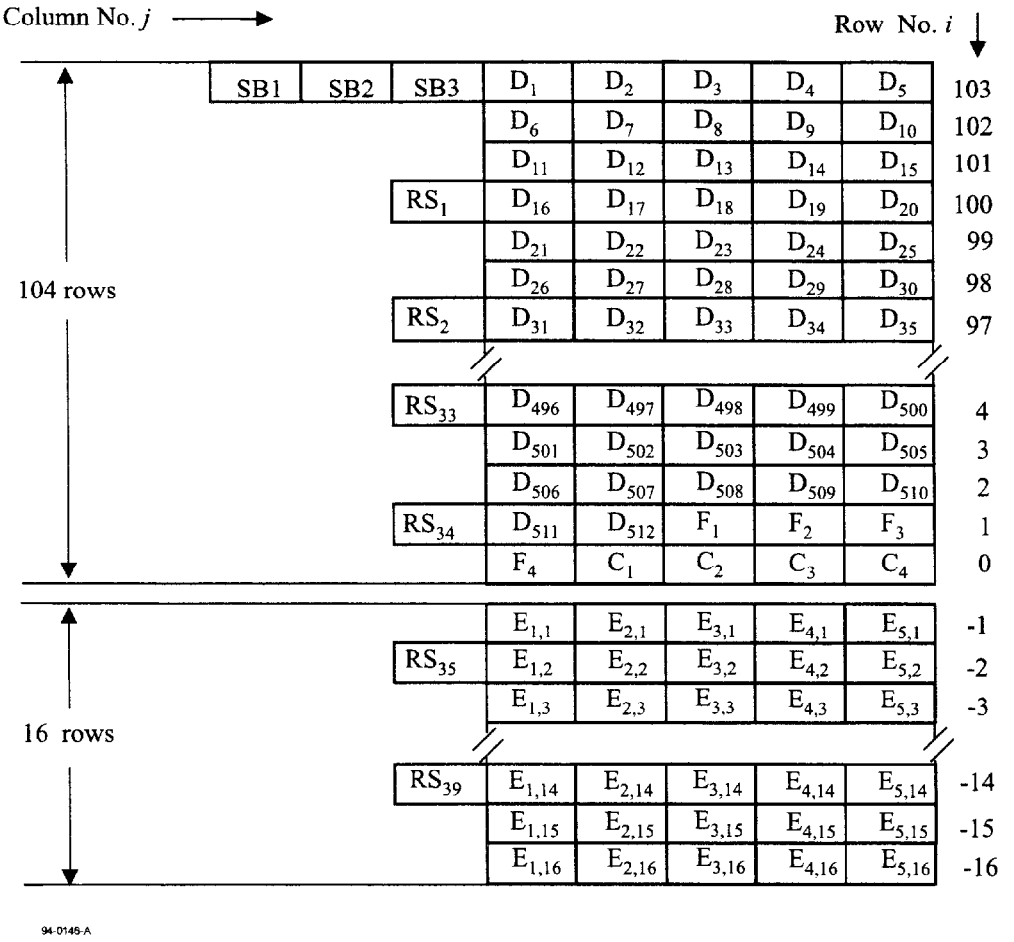
The bytes of the Data field shall be recorded on the disk immediately after the Sync field. Their order shall be according to the sequence A_n with the Resync bytes inserted as specified in E.4.

Table E.1 shows in matrix form the arrangement of the bytes. The sequence of recording is from left to right and top to bottom. The first three bytes SB1, SB2 and SB3 form the Data Sync field, which precedes the Data field. The first 104 rows of the Data field contain user data and a few bytes with unspecified contents and CRC data. The last 16 rows contain the ECC check bytes.

Table E.2 shows in matrix form the arrangement of the bytes. The sequence of recording is from left to right and top to bottom. The first three bytes SB1, SB2 and SB3 form the Data Sync field, which precedes the Data field. The first 206 rows of the Data field contain user data and a few bytes with unspecified contents and CRC data. The last 16 rows contain the ECC check bytes.

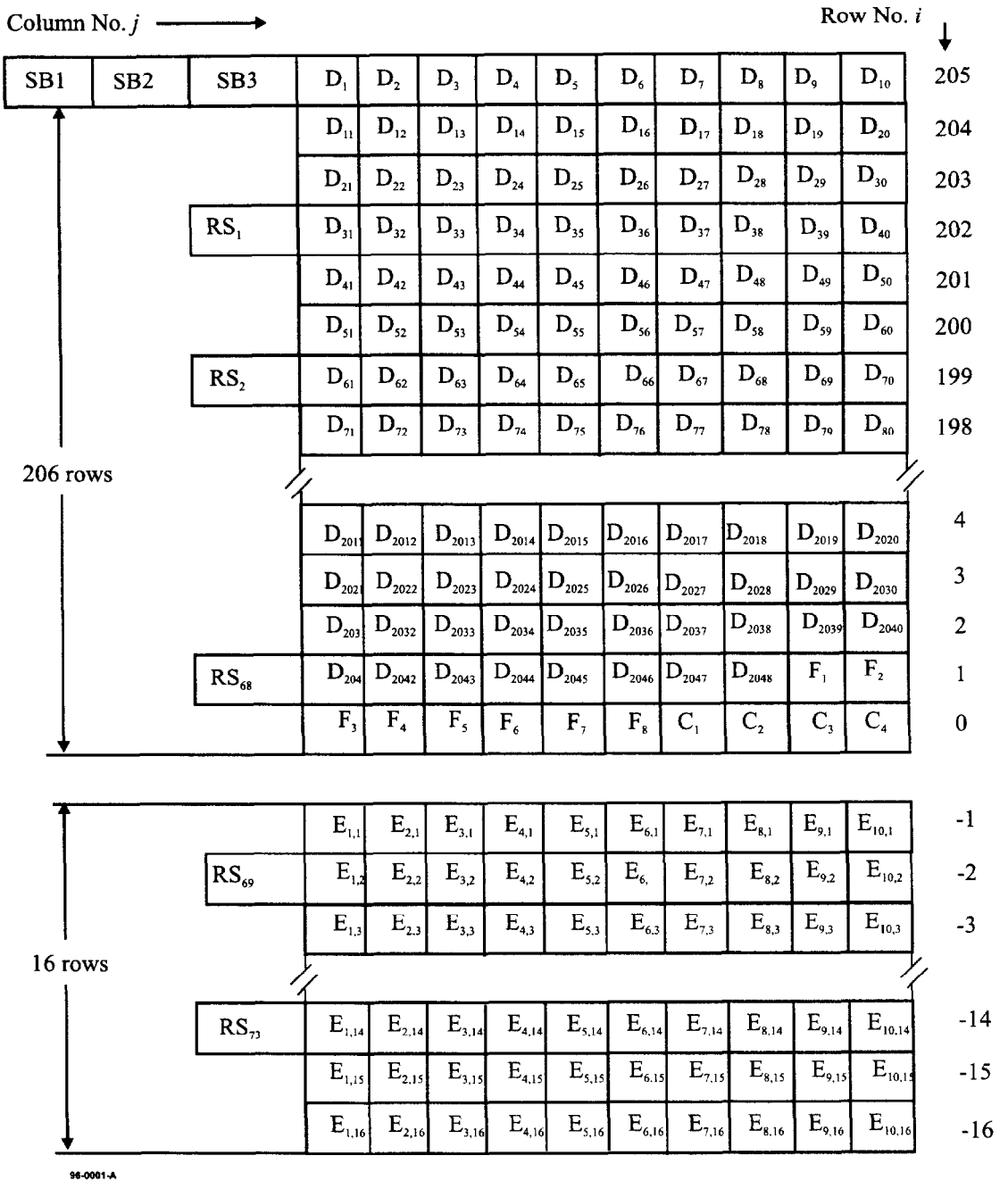
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Table E.1 - Data field configuration, 512-byte sectors, ECC with 5-way interleave



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Table E.2 - Data field configuration, 2 048-byte sectors, ECC with 10-way interleave



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Annex F

(normative)

Test method for measuring the adsorbent force of the hub

F.1 Purpose

The purpose of this test is to determine the magnetic characteristic of the magnetizable material of the hub.

F.2 Test device

The test device (see figure F.1) consists of a spacer, a magnet, a back yoke and a centre shaft. The dimensions of the test device are as follows:

D_d = 7,0 mm ± 0,1 mm

D_e = 14,0 mm ± 0,1 mm

D_f = 13,0 mm max.

$D_g = 3{,}9\ \text{mm}\ {}^{+0{,}0\ \text{mm}}_{-0{,}1\ \text{mm}}$

H_c = 0,40 mm ± 0,01 mm

H_d = 1,00 mm ± 0,05 mm (Typical, to be adjusted to meet the requirement of F.4)

F.3 Material of the test device

Magnet	: Sm-Co
Back yoke	: Any suitable magnetizable material
Spacer	: Non-magnetizable material or air gap
Centre shaft	: Non-magnetizable material

F.4 Characteristics of the magnet with back yoke

Number of poles : 4 (Typical)

Maximum energy product (BHmax) :175 kJ/m^3 ± 16 kJ/m^3 (Typical)

The characteristics of the magnet with back yoke shall be adjusted by the use of a pure nickel plate with the following dimensions (see figure F.2), and the adsorbent force of this plate at the point of H_c = 0,4 mm when spaced from the magnet surface shall be 3,3 N ± 0,2 N.

D_h = 6,0 mm ± 0,1 mm

D_i = 15,0 mm ± 0,1 mm

H_e = 1,00 mm ± 0,05 mm

F.5 Requirement for temperature

The temperature shall be as specified in 8.1.1.

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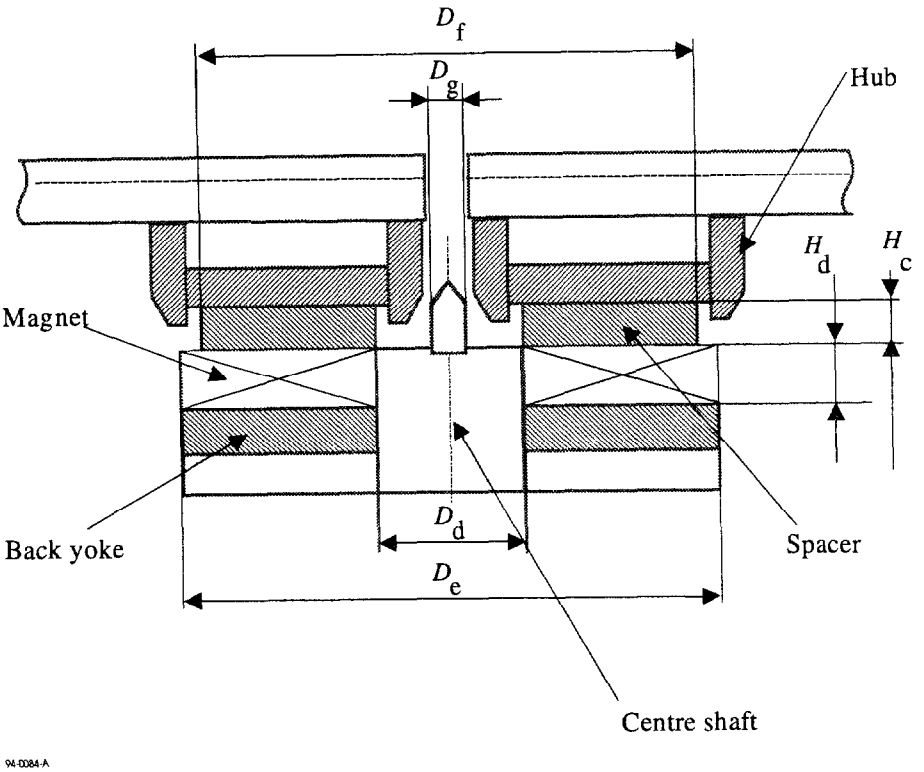


Figure F.1 - Test device for the clamping characteristic of the hub

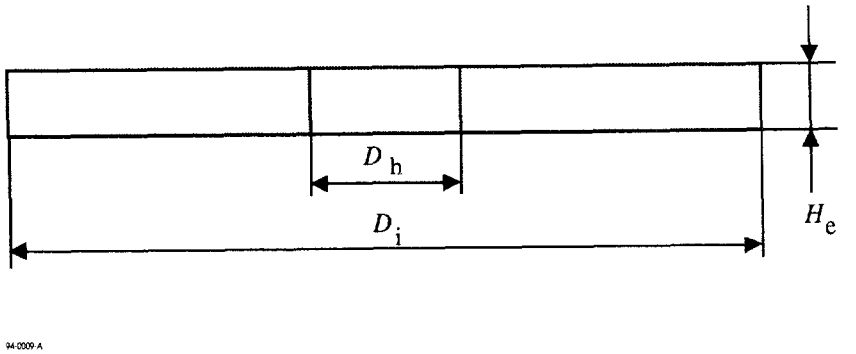


Figure F.2 - Calibration plate of the test device

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Annex G

(normative)

Air cleanliness class 100 000

The classification of air cleanliness is based on a particle count with a maximum allowable number of specified minimum sized particles per unit volume, and on a statistical average particle size distribution.

G.1 Definition

The particle count shall not exceed a total of 3 500 000 particles per cubic metre of a size 0,5 μm and larger.

The statistical average particle size distribution is given in figure G.1. Class 100 000 means that 3 500 000 particles per cubic metre of a size of 0,5 μm and larger are allowed, but only 25 000 particles per cubic metre of a size of 5,0 μm and larger.

It should be recognized that single sample distribution may deviate from this curve because of local or temporary conditions. Counts below 350 000 particles per cubic metre are unreliable except when a large number of samplings is taken.

G.2 Test method

For particles in the size range of 0,5 μm to 5,0 μm, equipment employing light-scattering principles shall be used. The air in the controlled environment is sampled at a known flow rate. Particles contained in the sampled air are passed through an illuminated sensing zone in the optical chamber of the instrument. Light scattered by individual particles is received by a photo detector which converts the light pulses into electrical current pulses. An electronic system relates the pulse height to particle size and counts the pulses such that the number of particles in relation to particle size is registered or displayed.

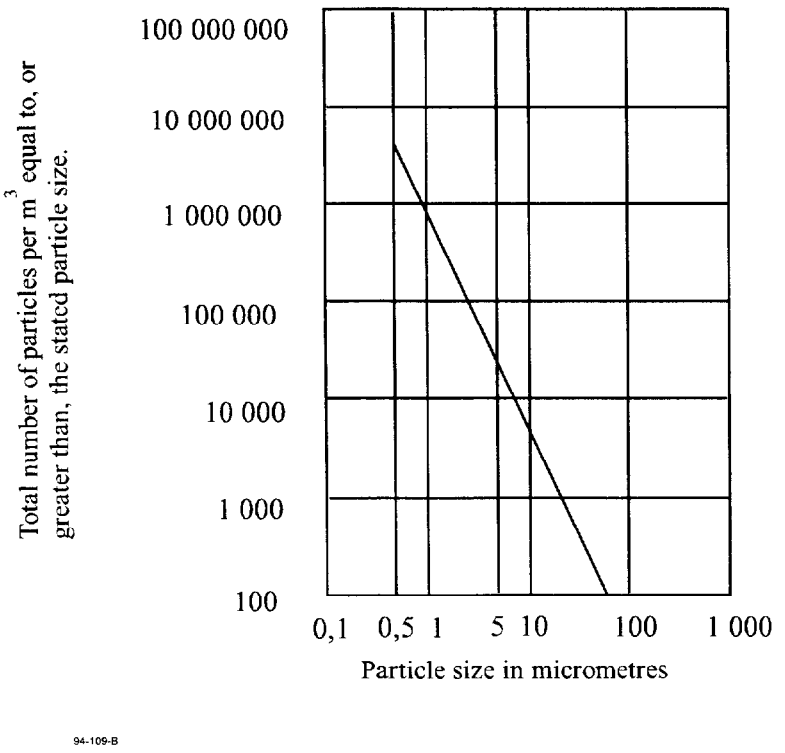


Figure G.1 - Particle size distribution curve

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Annex H

(normative)

Position of the cartridge relative to the reference planes

This annex shows the position of the cartridge relative to the reference planes X, Y and Z, as specified in 10.2.

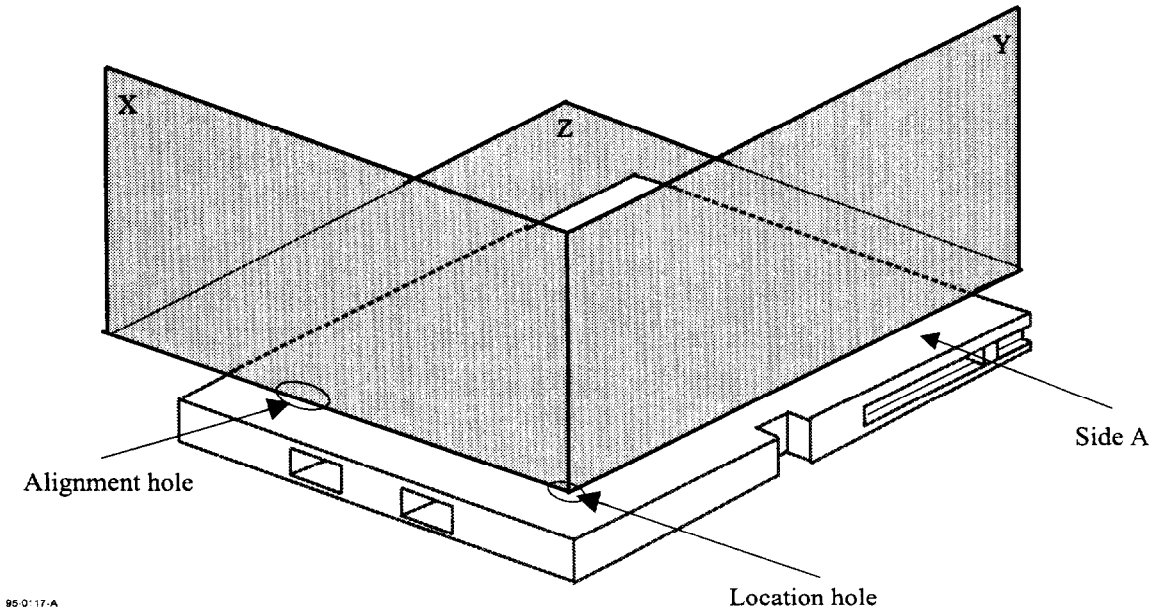


Figure H.1 - Position of the cartridge

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Annex J

(normative)

Relaxation by zones of the requirements for signals

Table J.1 shows the zones in which the requirements specified in the body of this International Standard shall be satisfied and those in which they are relaxed.



indicates the zones in which the values of the signals shall be within the range specified.



indicates the zones in which the range is extended from 80 % of the lower limit to 120 % of the upper limit.

No marking indicates the zones for which the requirements are not applicable.

Table J.1 - Requirements for signals in each zone

CLAUSE	SIGNAL	ZONES										
		MIRROR	ACQUIRE		INNER TEST		INNER	DATA	OUTER	OUTER TEST		BUFFER
			LEAD	FOCUS	MFG.	DRIVE	CONTROL		CONTROL	DRIVE	MFG.	
11.5.4	Reflectance											
21.1.a	PP											
21.1.b	PP											
21.1.c	PP											
21.2	DPP (first)											
21.2	DPP (second)											
21.5	On Track											
22.1	VFO_1, VFO_2											
22.2	AM, ID, PA											
23	Embossed Data											
24.3.2	Overwrite Power											
25.1	Resolution											
25.2	NBSN											
25.3	Cross Talk											
26	Erase Char.											

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Annex K

(informative)

Track deviation measurement

The deviation of a track from its nominal location is measured in the same way as a drive sees a track, i.e. through a tracking servo. The strength of the reference servo used for the test is in general less than the strength of the same servo in a normal drive. The difference in strength is intended for margins in the drive. The deviation of the track is related to the tracking error between the track and the focus of the optical beam, remaining after the reference servo. The tracking error directly influences the performance of the drive, and is the best criterion for testing track deviations.

The specification of the axial and radial track deviations can be described in the same terms. Therefore, this annex applies to both axial and radial track deviations.

K.1 Relation between requirements

The acceleration required by the motor of the tracking servo to make the focus of the optical beam follow the tracks on the disk (see 11.4.6 and 11.4.8) is a measure for the allowed deviations of the tracks. An additional measure is the allowed tracking error between the focus and the track (see 20.2.4). The relation between both is given in figure K.1, where the maximum allowed amplitude of a sinusoidal track deviation is given as function of the frequency of the deviation. It is assumed in the figure that there is only one sinusoidal deviation present at a time.

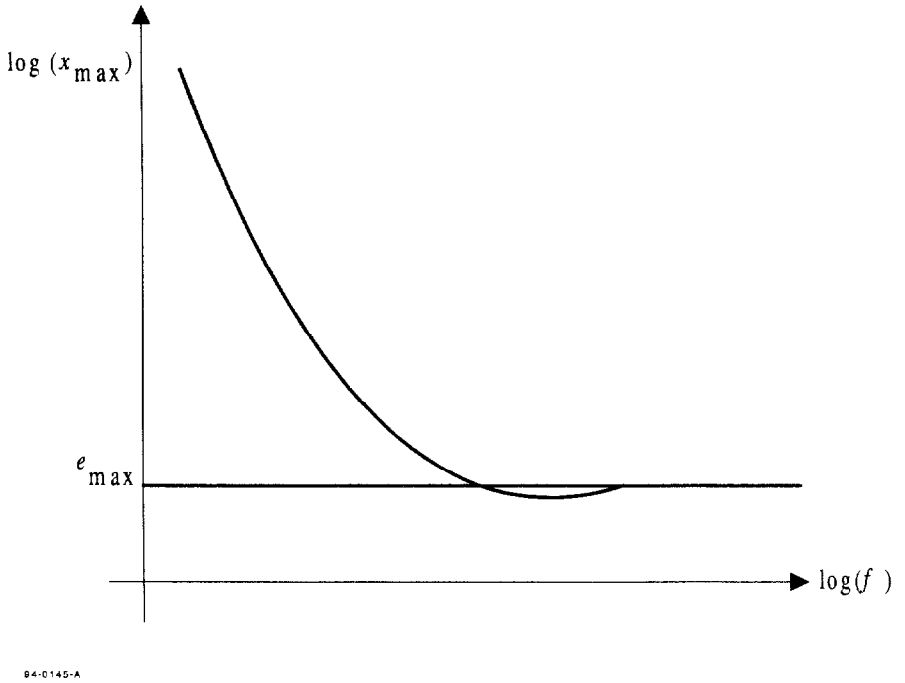


Figure K.1 - Maximum allowed amplitude of a single, sinusoidal track deviation

At low frequencies, the maximum allowed amplitude x_{max} is given by

$$x_{max} = a_{max} / (2\pi f)^2 \quad (1)$$

where a_{max} is the maximum acceleration of the servo motor. At high frequencies we have

$$x_{max} = e_{max} \quad (2)$$

where e_{max} is the maximum allowed tracking error. The connection between both frequency regions is given in K.3.

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K.2 Reference Servo

The above restriction of the track deviations is equal to the restriction of the track deviations for a Reference Servo. A Reference Servo has a well-defined transfer function, and reduces a single, sinusoidal track deviation with amplitude x_{max} to a tracking error e_{max} as in figure K.1.

The open-loop transfer function of the Reference Servo shall be

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

where $i = \sqrt{-1}$, $\omega = 2\pi f$ and $\omega_0 = 2\pi f_0$, with f_0 the 0 dB frequency of the open-loop transfer function. The constant c gives the cross-over frequencies of the lead-lag network of the servo: the lead break frequency $f_1 = f_0 / c$ and the lag break frequency $f_2 = f_0 \times c$. The reduction of a track deviation x to a tracking error e by the reference servo is given by

$$\frac{e}{x} = \frac{1}{1 + H_s} \qquad (4)$$

If the 0 dB frequency is specified as

$$\omega_0 = \sqrt{\frac{a_{max} c}{e_{max}}} \qquad (5)$$

then a low-frequency track deviation with an acceleration a_{max} will be reduced to a tracking error e_{max}, and a high-frequency track deviation will not be reduced. The curve in figure K.1 is given by

$$x_{max} = e_{max} \mid 1 + H_s \mid \qquad (6)$$

The maximum acceleration required from the motor of this reference servo is

$$a_{max}(\text{motor}) = e_{max}\, \omega^2 \mid 1 + H_s \mid \qquad (7)$$

At low frequencies ($f < f_0 / c$) applies

$$a_{max}(\text{motor}) = a_{max}(\text{track}) = \frac{\omega_0^2 e_{max}}{c} \qquad (8)$$

Hence, it is permitted to use a_{max}(motor) as specified for low frequencies in 11.4.6 and 11.4.8 for the calculation of ω_0 of a reference servo.

K.3 Requirement for track deviations

The track deviations shall be such that, when tracking with a Reference Servo on a disk rotating at the specified frequency, the tracking error shall not be larger than e_{max} during more than 12 µs.

The open-loop transfer function of the Reference Servo for axial and radial tracking shall be given by equation (3) within an accuracy such that $|1 + H|$ does not differ by more than ± 20 % from its nominal value in a bandwidth from 50 Hz to 170 kHz. The constant c shall be 3. The 0 dB frequency $\omega_0 / (2\pi)$ shall be given by equation (5), where a_{max} and e_{max} for axial and radial tracking are specified in 20.2.4, 11.4.6 and 11.4.8.

K.4 Measurement implementation

Three possible implementations for an axial or radial measurement system have been given below. H_a is the open-loop transfer function of the actual tracking servo of the drive, H_s is the transfer function for the Reference Servo as given in equation (3). x and y are the position of the track and the focus of the optical beam. e_s is the tracking error after a Reference Servo, which signal has to be checked according to the previous paragraph.

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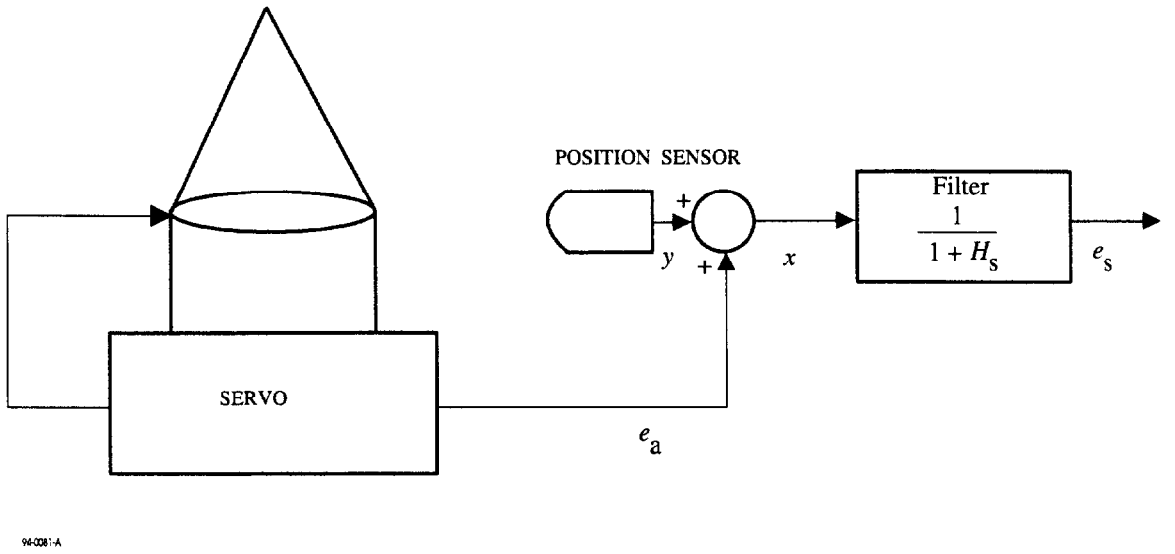


Figure K.2 - Implementation of a Reference Servo by filtering the track position signal with the reduction characteristics of the Reference Servo

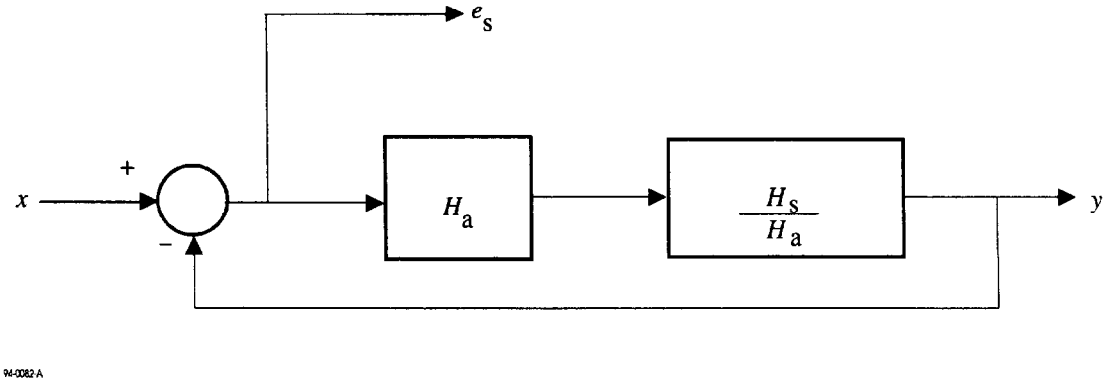


Figure K.3 - Implementation of a Reference Servo by changing the transfer function of the actual servo

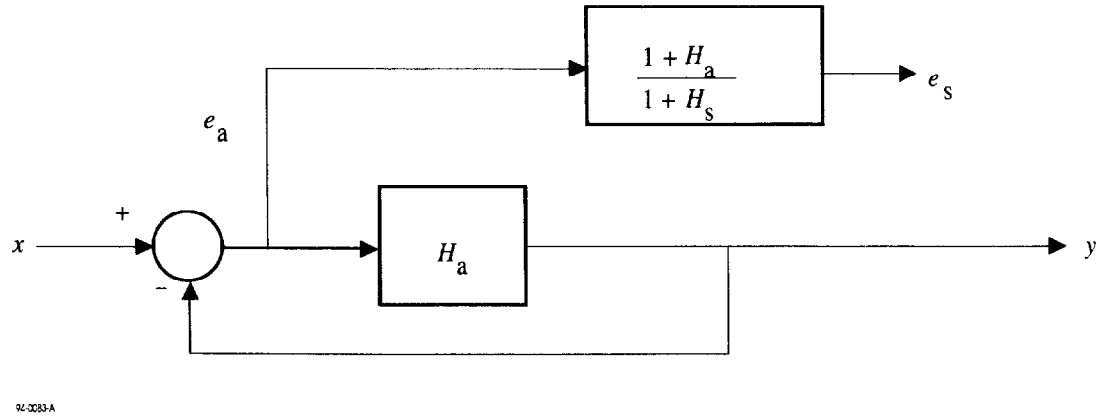


Figure K.4 - Implementation of a Reference Servo by changing the tracking error of the actual servo

The optimum implementation depends on the characteristics of H_a and H_S. Good results for motors in leaf springs are often obtained by using separate circuits in a low and high frequency channel. The implementation of figure K.2 is used in the low-frequency channel, while that of figures K.3 or K.4 is used in the high-frequency channel. The signals from both channels are added with a reversed cross-over filter to get the required tracking error. In the low-frequency channel one can also use the

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current through the motor as a measure of the acceleration of the motor, provided the latter is free from hysteresis. The current must be corrected for the transfer function of the motor and then be converted to a tracking error with a filter with a transfer function $e/a = e/x\omega^2$, derived from equation (4).

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Annex L

(informative)

Derivation of the operating climatic environment

This annex gives some background on how some of the conditions of the operating environment in 8.1.2 have been derived.

L.1 Standard climatic environment classes

The conditions of the ODC operating environment are, with a few exceptions mentioned below, based on parameter values of the IEC standard climatic environment class 3K3 described in IEC publication 721-3-3:1987[1]. This publication defines environmental classes for stationary use of equipment at weather-protected locations.

The IEC class 3K3 refers to climatic conditions which

"... may be found in normal living or working areas, e.g. living rooms, rooms for general use (theatres, restaurants, etc.), offices, shops, workshops for electronic assemblies and other electrotechnical products, telecommunication centres, storage rooms for valuable and sensitive products."

L.2 Overtemperature considerations

While IEC class 3K3 defines the limits for the room climate only, the ODC operating environment specification in this International Standard takes into consideration also system and drive overtemperature. This means that when inserted in a drive, the ODC will sense a temperature which is above the ambient room temperature. The figures in the operating environment specification have been calculated from the assumption that this overtemperature may be up to 20 °C.

L.3 Absolute humidity

The introduction of the parameter

absolute humidity [unit: g water / m^3 of air]

is very useful when studying overtemperature. When the temperature rises inside a drive, the relative humidity goes down but the absolute humidity remains substantially constant. So, making room for overtemperature in the operating environment specification affects not only the upper temperature limit but also the lower relative humidity limit. The relationship between these parameters is shown in the climatogram (the relative humidity versus temperature map) of the ODC operating environment, figure L.1.

The absolute humidity restrictions influence the operating environment in the following two ways:

a) Combinations of high temperatures and high relative humidities are excluded. Such combinations could have negative influence on the performance and the life of ODCs.

b) Combinations of low temperatures and low relative humidities are excluded. Such combinations are very unlikely to occur in world-wide normal office environments.

L.4 Deviations from the IEC standard environment class

Apart from the changes introduced by the overtemperature considerations mentioned above, there are a few more parameter values which are not based on IEC class 3K3. These are:

– Atmospheric pressure

  The IEC class 3K3 lower limit of 70 kPa has been extended to 60 kPa. ODCs according to this International Standard show no intrinsic pressure sensitivity and 70 kPa excludes some possible markets for ODCs.

---

[1] *Classification of environmental conditions - Part 3: Classification of groups of environmental parameters and their severities. Stationary use at weatherprotected locations.*

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- Absolute humidity

  The IEC class 3K3 value for the upper limit of 25 g/m^3 has been raised to 30 g/m^3 in view of some expected operation in portable devices outside the controlled office environment.

- Temperature

  The maximum temperature around the ODC, i.e. room temperature plus overtemperature, has been limited to 55 °C (while IEC class 3K3 + 20 °C would have become 60 °C). For ODCs according to this International Standard, however, the 55 °C limit is considered to be a physical limit above which operation is not safe.

  This means that equipment designers may want to ensure adequate cooling inside the drive especially when the room temperature approaches the upper IEC class 3K3 limit of 40 °C.

- Further

  The rates of change (the gradients) of temperature and relative humidity are not according to IEC class 3K3.

L.5 Wet bulb temperature specifications

Instead of specifying limits for the absolute humidity, some of the earlier standards for ODCs as well as those for other digital data storage media often used restrictions of the parameter

wet bulb temperature [unit: °C]

in order to avoid too severe combinations of high temperatures and high relative humidities.

In order to facilitate comparisons between different specifications, figure L.2 and table L.1 show wet bulb temperatures of interest for the ODC operating environment, as well as for the testing and storage environments. Since wet bulb temperatures vary slightly with the atmospheric pressure, the diagram is valid for the normal pressure of 101,3 kPa only.

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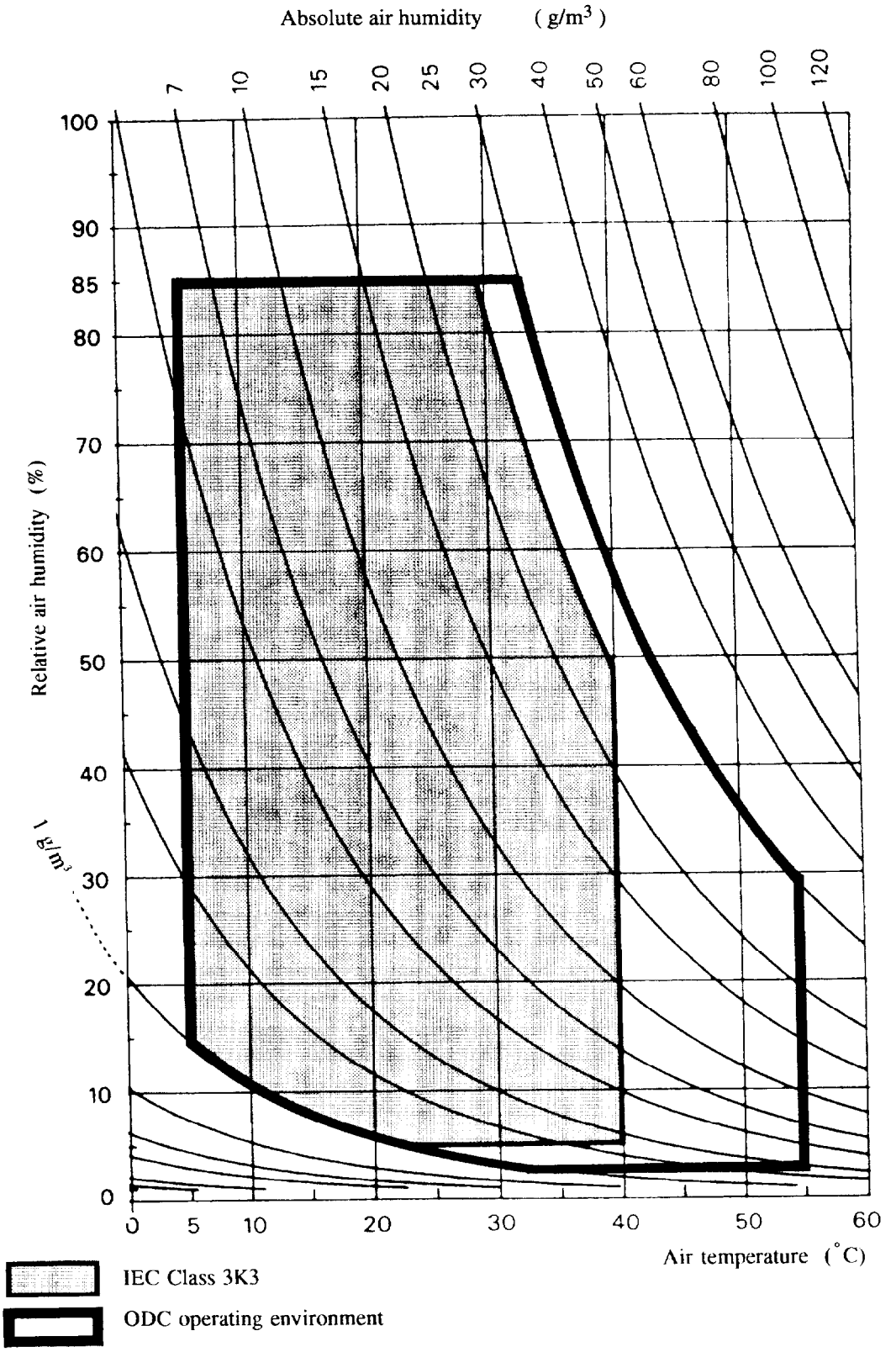


Figure L.1 - Climatogram of IEC Class 3K3 and the ODC operating environment

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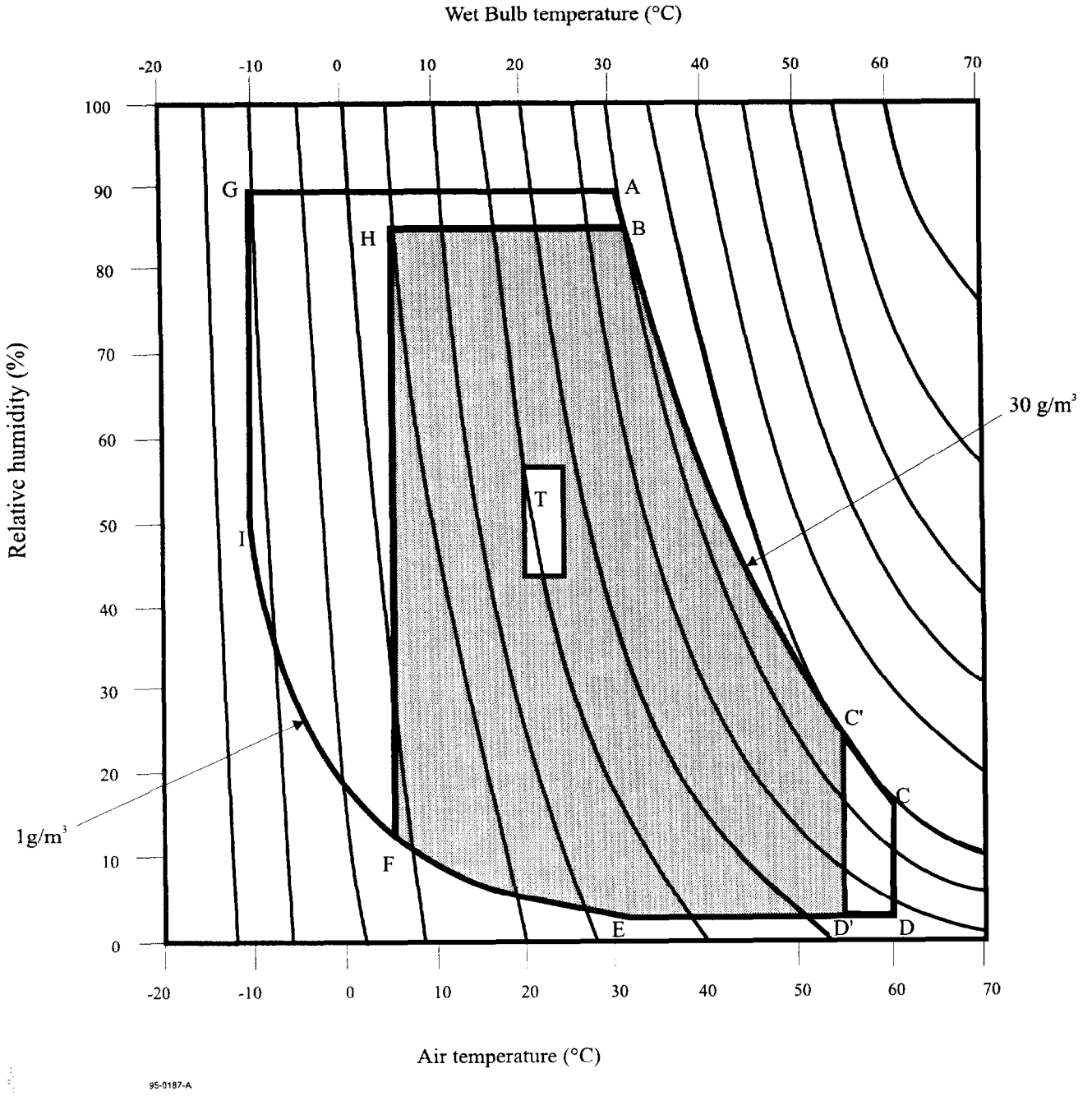


Figure L.2 - Wet bulb temperatures of the operating and storage environments (see the position of points A to I and of area T in table L.1)

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Table L.1 - Position of the main points of figure L.2

Position	Air temperature	Relative humidity	Wet bulb temperature
A	31,7 °C	90,0 %	30,3 °C
B	32,8 °C	85,0 %	30,6 °C
C	60,0 °C	23,1 %	36,6 °C
C'	55,0 °C	28,8 %	35,5 °C
D	60,0 °C	3,0 %	24,2 °C
D'	55,0 °C	3,0 %	22,2 °C
E	31,7 °C	3,0 %	12,1 °C
F	5,0 °C	14,7 %	- 1,4 °C
G	- 10,0 °C	90,0 %	- 10,3 °C
H	5,0 °C	85,0 %	3,9 °C
I	- 10,0 °C	46,8 %	- 11,6 °C
Test environment (T)	23,0 °C ± 2,0 °C	50,0 % ± 5,0 %	---------
Storage environment	is determined by A-B-C-D-E-F-I-G		
Operating environment	is determined by B-C'-D'-E-F-H		

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Annex M

(informative)

Guidelines for sector replacement

Clause 19 assumes that a sector is defective and will be replaced by the defect management, for instance when any of the following conditions exist:

a) a sector has at least two of its three ID fields with each an error as detected by the CRC check;

b) a column in the Data field (see table E.1 and E.2) contains more than three defective bytes A_n.

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Annex N

(informative)

Definition of one-beam overwrite

The laser power is modulated according to the information signals when the laser beam reaches the place to record information in the waveform as shown in figure N.1 (a) between the crystallizing (erase) power level higher than the read power level and the amorphizing (write) power level. Figure N.1 shows, as an example, the laser power modulated according to the digital signal of 1000001001001, in which the temperature of the recording layer in the light beam spot varies as shown in figure N.1 (b) between a little higher temperature than the melting point and a lower one in which the crystallization speed is high.

Amorphous and crystalline state coexists on the recording track passed by the light beam spot, because usually the disk have already recorded information. Whichever the state before an overwriting may be, the recording layer amorphizes when the irradiated area is molten and rapidly cooled by the falling of laser power to the crystallizing power level or by passing away of the light beam spot. When a part on the track is irradiated by a beam of crystallizing power level, the part becomes crystalline state anyway, because the parts in a crystalline state before the irradiation remains as they are and the parts in an amorphous state crystallizes. (The situation of this overwriting is shown in the upper part of figure N.1)

Thus, the sector with old information converts its state into a state with new information by passing once under the light beam. The method described above in which the information is rewritten by an overwriting without a prior erasing using one laser beam is called one-beam overwrite.

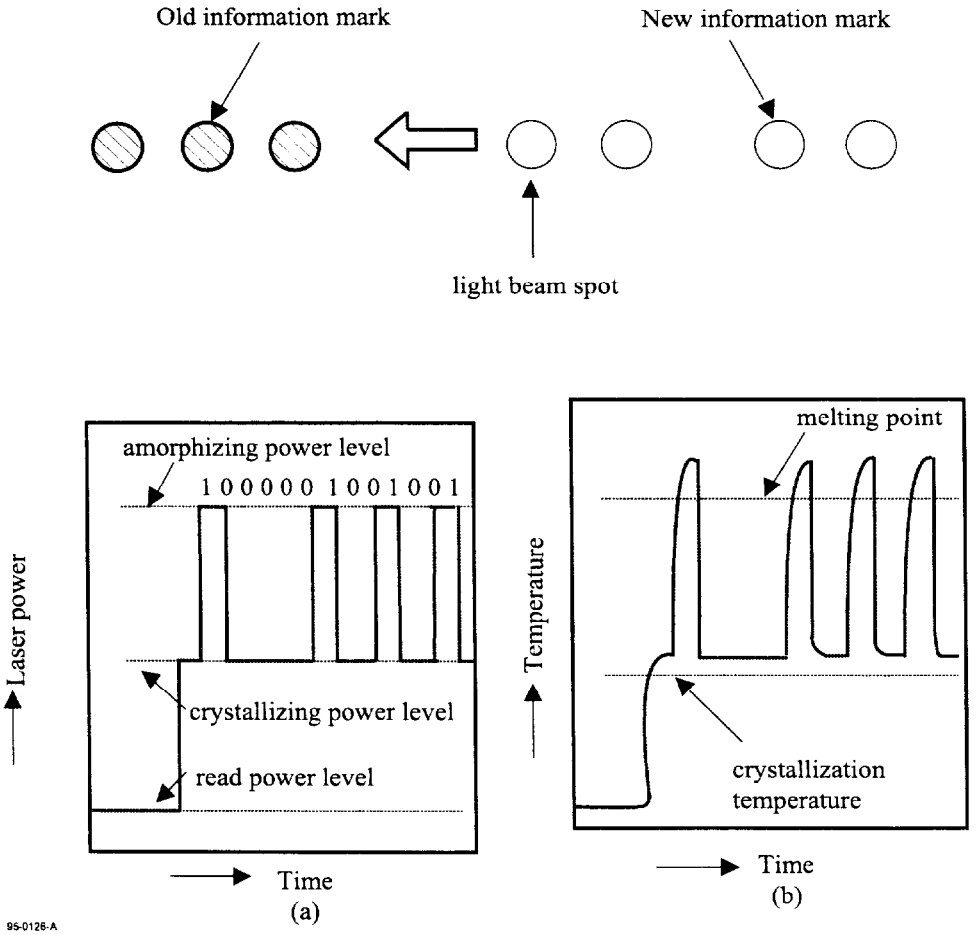


Figure N.1 - Schematic waveform of one-beam overwrite

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Annex P

(informative)

Transportation

P.1 General

As transportation occurs under a wide range of temperature and humidity variations, for differing periods, by many methods of transport and in all parts of the world it is not possible to specify conditions for transportation or for packaging.

P.2 Packaging

The form of packaging should be agreed between sender and recipient or, in the absence of such agreement, is the responsibility of the sender. It should take account of the following hazards.

P.2.1 Temperature and humidity

Insulation and wrapping should be designed to maintain the conditions for storage over the estimated period of transportation.

P.2.2 Impact loads and vibration

a) Avoid mechanical loads that would distort the shape of the cartridge.
b) Avoid dropping the cartridge.
c) Cartridges should be packed in a rigid box containing adequate shock-absorbent material.
d) The final box should have a clean interior and a construction that provides sealing to prevent the ingress of dirt and moisture.

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Annex Q

(informative)

Office environment

Due to their construction and mode of operation optical disk cartridges have considerable resistance to the effects of dust particles around and inside the disk drive. Consequently it is not generally necessary to take special precaution to maintain a sufficiently low concentration of dust particles.

Operation in heavy concentrations of dust should be avoided, e.g. in a machine shop or on a building site.

Office environment implies an environment in which personnel may spend a full working day without protection and without suffering temporary or permanent discomfort.

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Annex R

(informative)

Values to be implemented in existing and future standards

This International Standard specifies values for bytes which identify optical cartridges which conform to this International Standard. It is expected that other types of optical disk cartridges will be developed in future. It is therefore recommended that the following values be used for these other cartridges.

R.1 Byte 0 of the Control Track

The setting of bits 6 to 4 have the indicated meaning.

000	Constant Angular Velocity (CAV)
001	Constant Linear Velocity (CLV)
010	Zoned Constant Angular Velocity (ZCAV)
011	Zoned Constant Linear Velocity (ZCLV)
110	Logical Zoned Constant Angular Velocity (Logical ZCAV)

R.2 Byte 4 of the Control Track

The settings of bits 7 and 6 have the indicated meaning.

00	On-land recording
10	In-groove recording
11	On-land and in-groove recording

R.3 Byte 7 of the Control Track

The following bit patterns have the indicated meaning.

0000 0000	Read-only ODCs (ROM)
0001 0000	Write-once ODCs
0001 0001	Write-once ODCs using MO recording
0010 0000	Rewritable ODCs using MO recording
0011 0000	Rewritable ODCs using Phase Change recording
1001 0000	Partial ROM of Write-once ODCs
1010 0000	Partial ROM of MO
1011 0000	Partial ROM of Phase Change

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Annex S

(informative)

Measurement of birefringence

S.1 Optical condition

Optical conditions are those in 9.2 a) to h).

S.2 Measuring set-up

There are two possible set-ups for measurement of birefringence. In either case, the design of the optical system shall be such that the detected light reflected from the entrance surface is minimized, so as not to influence the accuracy of the measurement.

S.2.1 First set-up

The first set-up for measuring birefringence of B is shown in figure S.1.

The light power which is emitted from the laser diode A is I. After passing through a beam splitter B and a polarizing beam splitter E, the light is converted to right-handed circularly polarized light by a quarter-wave plate F.

Approximately $(1/2)I$ reaches the disk. If the reflectivity of the disk is R, $(1/2)IR$ is reflected back. Due to the birefringence of the disk, the reflected light is composed of a fraction $(1 - B)$ of the left-handed circularly polarized light and a fraction B of right-handed circularly polarized light.

Then, $(1/2)\ RI\ (1 - B)$ arrives at the detector K_2 and $(1/4)\ RIB$ at the detector K_1. The conversion factor from light intensity to current is given by C_1 and C_2 for the photo diode K_1 and K_2, respectively.

The value of B can be estimated from the following equation:

$$B = \frac{D_1}{D_1 + D_2} = \frac{(1/4)C_1B}{(1/4)C_1B + (1/2)C_2(1-B)}$$

The last equality holds when $C_1 = 2C_2$. Any losses in the optical paths can be compensated for by fine-tuning the ratio C_1/C_2. The optical components shall be aligned such that in the absence of birefringence. D_2 is at the maximum value and D_1 as close to zero as possible.

S.2.2 Second set-up

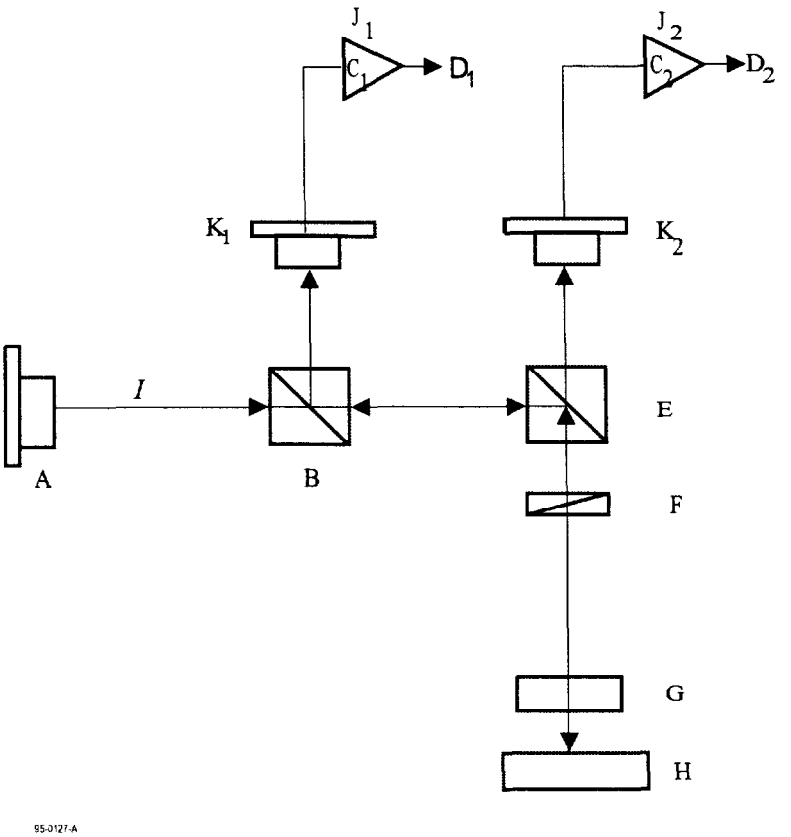
The second set-up for measuring birefringence of B is shown in figure S.2.

The component shall be aligned in such a way that, in the absence of birefringence, D_2 is at the maximum value and D_1 is at the minimum value. P is a linear polarizer. The amount of light reaching D_1 in the absence of birefringence is $(1/8)\ RIB$ and that of D_2 is $(1/8)\ RI\ (1 - B)$, assuming all non-polarizing beam splitters to be fifty-fifty splitters. The conversion factor are set to $C_1 = C_2$.

The value of B is estimated from the following equation:

$$B = \frac{D_1}{D_1 + D_2} = \frac{C_1B}{C_1B + C_2(1-B)}$$

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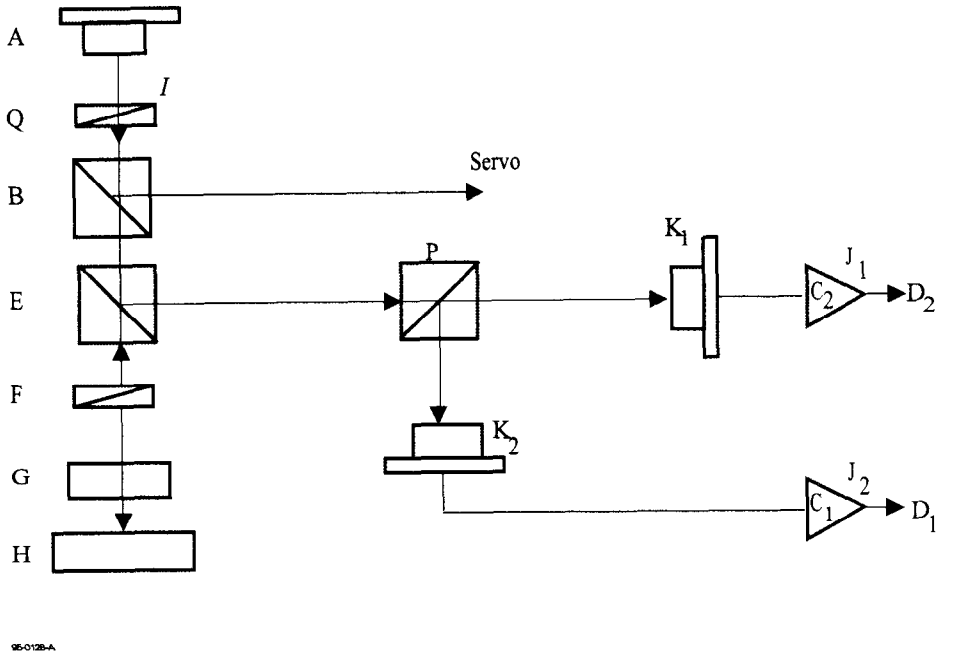
A:	Laser diode	G:	Objective lens
B:	Beam splitter	H:	Optical disk
E:	Polarizing beam splitter	J_1, J_2:	d.c.-coupled amplifiers
F:	Quarter-wave plate	K_1, K_2:	Photo diode detectors

Figure S.1 - Optical system of the birefringence measurement 1

S.2.3 Calibration method

There are two methods of calibration. Insert a sample with known amount of birefringence in parallel beam, and adjust C_1 and C_2 to give B the required value. In the second method, such an amount of birefringence is inserted, that D_2 falls to half its value of non-birefringence case. C_1 and C_2 should be adjusted to make $B = 0{,}5$.

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A	Laser diode	H	Optical disk
B	Beam splitter	J_1, J_2	d.c.-coupled amplifiers
E	Beam splitter	K_1, K_2	Photo diode detectors
F	Quarter-wave plate	P	Polarizing beam splitter
G	Objective lens	Q	Polarizer

Figure S.2 - Optical system of the birefringence measurement 2

S.2.4 Conversion to the retardation

The retardation d of the measured value B is given by the following equation:

$$B = \sin^2\left(\frac{\pi d}{\lambda}\right)$$

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