Standard ECMA-239

June 1996

ECMA

Standardizing Information and Communication Systems

Data Interchange on 90 mm Optical Disk Cartridges - HS-1 Format - Capacity: 650 Megabytes per Cartridge

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Brief History

ECMA Technical Committee TC31 was established in 1984 for the standardization of Optical Disk Cartridges (ODCs). Since its establishment, the Committee has made major contributions to ISO/IEC JTC1/SC23 toward the development of International Standards for 90 mm, 120 mm, 130 mm and 300 mm ODCs. Numerous ODC standards have been developed by ECMA TC31 and published as ECMA Standards, many of which have been adopted by ISO/IEC under the fast track procedure.

In April 1995 a group of three companies proposed to ECMA the development of a new standard with ECMA TC31 for 90 mm ODCs using a format known as “Hyper-Storage (HS-1)” and having a storage capacity of 650 Megabytes per cartridge. Receiving unanimous support from its members, ECMA TC31 began work to bring the specification into a form suitable for an ECMA Standard. The 1st draft standard was introduced at the July 1995 meeting of TC31 held in Sapporo, Japan.

The standard was evolved through six subsequent drafts, culminating in the production of this final draft during April 1996. During that process, according to ECMA TC31 operating guidelines, all technical requirements of this standard were verified by at least two member organizations of TC31 and ODCs according to this standard were made available.

This ECMA Standard has been adopted by the ECMA General Assembly of June 1996.

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Section 1 - General

1 Scope

This ECMA Standard specifies the characteristics of 90 mm Optical Disk Cartridges (ODC) with a capacity of 650 Mbytes per Cartridge. The Standard specifies three related, but different implementations of such cartridges, viz.

Type R/W Provides for data to be written and read many times over the recording surface of the disk using the thermo-magnetic and magneto-optical effects.

Type P-ROM Provides for a part of the recording surface of the disk to be embossed by stamping or other means. This part of the disk is read without recourse to the magneto-optical effect. The part which is not embossed provides for data to meet the requirements of Type R/W.

Type O-ROM Provides for the recording surface of the disk to be embossed and reproduced by stamping or other means. This type of disk is read without recourse to the magneto-optical effect.

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

This ECMA Standard specifies

– the conditions for conformance testing and the Reference Drive;

– the environments in which the cartridges are to be operated and stored;

– 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, called HS-1 (HS stands for “Hyper-Storage”), including the physical disposition of the tracks and sectors, the error correction codes, and the recording method used;

– the characteristics of the embossed information on the disk;

– the magneto-optical characteristics of the disk, enabling processing systems to write data onto the disk;

– the minimum quality of user-written data on the disk, enabling data processing systems to read data from the disk.

This ECMA 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 ECMA Standard shall specify its Type. An ODC shall be in conformance if it meets all mandatory requirements specified herein for that Type.

2.2 Generating system

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

2.3 Receiving system

A claim of conformance with this ECMA Standard shall specify which Type(s) is (are) supported. A system receiving an ODC for interchange shall be in conformance with this ECMA Standard if it is able to process any recording made on the cartridge in accordance with 2.1 for the Type(s) specified.

2.4 Compatibility statement

A claim of conformance by a Generating or Receiving system with this ECMA Standard shall include a statement listing any other ECMA and International Standards supported. 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 writing.

3 Reference

ECMA-129 (1994) Information Technology Equipment - Safety

4 Definitions

For the purpose of this ECMA 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 smallest element for the representation of data on a disk. It is recorded as either a space or a mark.

4.4 clamping zone

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

4.5 control zone

A zone containing the information on media parameters and format necessary for writing and reading the remaining tracks of the optical disk.

4.6 Cyclic Redundancy Check (CRC)

A method for detecting errors in data.

4.7 data clock

A clock for data detection and data recording, generated by a PLL synchronized to servo marks.

4.8 defect management

A method for handling the defective areas on the disk.

4.9 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.

4.10 embossed mark

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

4.11 entrance surface

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

4.12 Error Correction Code (ECC)

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

4.13 field

A subdivision of a segment

NOTE 1

Subdivisions of a sector which are named ‘field’ are not fields in the sense of this definition.

4.14 format

The arrangement of information on the disk.

4.15 frame

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

4.16 flyable zone

A part of the protective coating area over which the slider with a magnetic head can fly.

4.17 groove

See 4.24.

4.18 Gray code Encoded Part (GEP)

Tracks containing a portion of control information for a drive which can be detected without tracking servo.

4.19 hub

The central feature on the disk which interacts with the spindle of the disk drive to provide radial centring.

4.20 interleaving

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

4.21 Kerr rotation

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

4.22 land and groove

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

4.23 magnetic field modulation

A technique for recording encoded information on the disk by switching a recording magnetic field between two opposite directions.

4.24 mark

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

NOTE 2

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

4.25 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.

4.26 optical disk cartridge (ODC)

A device consisting of a case containing an optical disk.

4.27 polarization

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

NOTE 3

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

4.28 protective coating

A layer coated on top of the recording layer to protect from environmental influences and emergency landing of magnetic head.

4.29 read power

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

4.30 recording magnetic field

The magnetic field that switches between two opposite directions (both perpendicular to the disk surface) according to the encoded information. When the focus spot of a laser beam heats the disk sufficiently, this magnetic field causes a permanent magnetic domain in the magneto-optical layer on the disk.

4.31 recording layer

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

4.32 Reed-Solomon code

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

4.33 servo clock

A clock generated with embossed wobble pits in servo field on disk.

4.34 sector

The smallest unit of a track in the Information Zone of a disk for reading and writing that comprises a number of segments.

4.35 segment

A subdivision of a frame.

4.36 spindle

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

4.37 substrate

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

4.38 track

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

4.39 track pitch

The distance between adjacent track centre lines, measured in a radial direction.

4.40 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 of + 0,01, and a negative tolerance of - 0,02 allows a range of measured values from 1,235 to 1,275.

- Letters and digits in parentheses represent numbers in hexadecimal notation.
- The setting of a bit is denoted by ZERO or ONE.
- Numbers in binary notation and bit combinations are represented by strings of 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 numbered 0 and is recorded first, the most significant bit (numbered 7 in an 8-bit byte) is recorded last. This order of recording applies also to the data input of the Error Detection and Correction circuits and to their output.

5.2 Names

The names of entities, e.g. specific tracks, fields etc., have a capital initial.

6 List of acronyms

ALPC	Auto Laser Power Control
CAV	Constant Angular Velocity
CRC	Cyclic Redundancy Check
DCB	Data Channel Bit
DDS	Disk Definition Structure
DMA	Defect Management Area
ECC	Error Correction Code
FA1	Functional Area 1
FA2	Functional Area 2
GEP	Gray code Encoded Part of the Control Zone
ID	Identifier
LSB	Least Significant Byte
MO	Magneto-Optical
MSB	Most Significant Byte
NRZI	Non Return to Zero Inverted
ODC	Optical Disk Cartridge
O-ROM	Optical Read Only Memory
PDL	Primary Defect List
P-ROM	Partial Read Only Memory
R/W	Rewritable
R-S	Reed-Solomon(code)
R-S/LDC	Reed-Solomon Long Distance Code
SCB	Servo Channel Bit
SDL	Secondary Defect List
SFP	Standard Formatted Part of the Control Zone
SIP	Sector Interleave Parity (2nd ECC for embossed user data)
UD	User-Defined bytes
ZCAV	Zoned Constant Angular Velocity

7 General description of the optical disk cartridge

The optical disk cartridge which is the subject of this ECMA 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.

The optical disk is recordable on one side. Data can be written onto the disk as marks in the form of magnetic domains in the recording layer and can be overwritten with new data with a focused optical beam, using the thermo-magnetic effect. The data can be read with a focused optical beam, using the magneto-optical effect. 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 can be read using the diffraction of the optical beam by the embossed pits.

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 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 J)

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 shall 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

This ECMA Standard requires that an optical disk cartridge which meets all requirements of this ECMA 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 U)
magnetic field strength at the recording layer for any condition under which a beam is in focus	: 24 000 A/m max.
magnetic field strength at the recording layer during any other condition	: 48 000 A/m max.

No condensation on or in the 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 S).

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 the environment where the air immediately surrounding the optical disk cartridge has the following properties:

temperature	: -10 °C to 55 °C
relative humidity	: 3 % to 90 %
absolute humidity	: 1 g/m^3 to 30 g/m^3
atmospheric pressure	: 60 kPa to 106 kPa
temperature gradient	: 15 °C/h max.
relative humidity gradient	: 10 %/h max.
air cleanliness	: Office environment (see annex U)
magnetic field strength at the recording layer	: 48 000 A/m max.

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

8.1.4 Transportation

This ECMA Standard does not specify requirements for transportation; guidance is given in annex T.

8.2 Temperature shock

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

8.3 Safety requirements

The cartridge shall satisfy the safety requirements of Standard ECMA-129, when used in the intended manner or in any foreseeable use in an information processing system.

8.4 Flammability

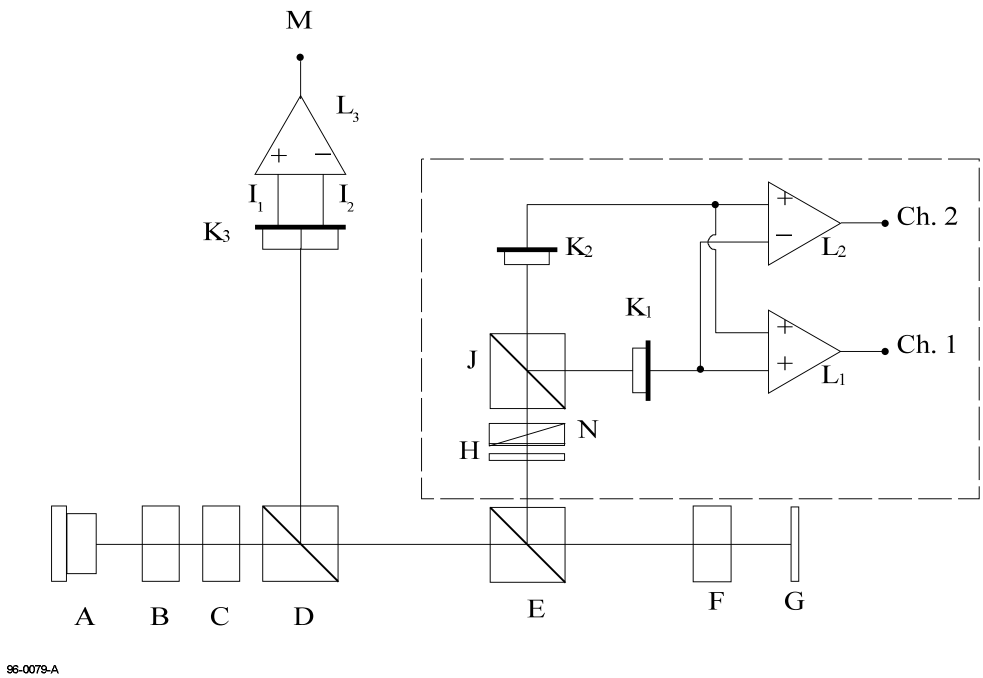
The cartridge and its components shall be made from materials that comply with the flammability class for HB materials, or better, as specified in Standard ECMA-129.

9 Reference Drive

The Reference Drive is a drive several critical components of which have well defined properties and which is used to test write and read parameters of the disk for conformance to this ECMA 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 write and read parameters is shown in figure 1. Different components and locations of components are permitted, provided that the performance remains the same as that of the set-up in figure 1. The optical system shall be such that the detected light reflected from the entrance surface of the disk is minimized so as not to influence the accuracy of the measurements.



A	Laser diode	H	Optional half-wave plate
B	Collimator lens	I_1 , I_2	Push-pull Channels
C	Optional shaping prism	J	Polarizing beam splitter
Ch.1	Channel 1	K_1 , K_2	Photodiodes for Channels 1 and 2
Ch.2	Channel 2	K_3	Split photodiode
D	Beam splitter	L_1 , L_2 , L_3	d.c. -coupled amplifiers
E	Polarizing beam splitter	M	Track centre detection signal
F	Objective lens	N	Phase retarder
G	Optical disk		

Figure 1 - Optical system of the Reference Drive

In the absence of polarization changes in the disk, the polarizing beam splitter J shall be aligned to make the signal of detector K_1 equal to that of detector K_2. The direction of polarization in this case is called the neutral direction.

The phase retarder N shall be adjusted such that the optical system does not have more than 2,5° phase retardation between the neutral polarization and the polarization perpendicular to it. This position of the retarder is called the neutral position.

The phase retarder can be used for the measurement of the Overwrite characteristics (see clause 28).

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

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

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

$$\sqrt{\frac{R_S \cdot R_P'}{R_P \cdot R_S'}}$$

to make it correspond to the nominal beam splitter E.

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

9.2 Optical beam

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

a) Wavelength (λ) — $685 \text{ nm} \begin{smallmatrix} +10 \text{ nm} \\ -10 \text{ nm} \end{smallmatrix}$

b) Wavelength (λ) divided by the numerical aperture of the objective lens (NA)

λ/NA = 1,245 µm ± 0,018 µm

c) Filling D/W of the aperture of the objective lens
radial 1,30 ± 0,03
tangential 0,64 ± 0,03

d) Variance of the wavefront of the optical beam near the recording layer, after passing through an ideal substrate
0 to λ^2 / 180

e) Polarization — Perpendicular to the track

f) Extinction ratio — 0,01 max.

g) The optical power for writing and reading, and the magnetic field shall be as specified in 21.2.2, 26.2.2, 26.3 and 29.2.2.

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.

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

9.3 Read channels

Two read channels shall be provided to generate signals from the marks in the recording layer. Channel 1 shall be used for reading the embossed marks, using the diffraction of the optical beam by the marks. Channel 2 shall be used for reading the user-written marks, using the rotation of the polarization of the optical beam due to the magneto-optical effect of the marks. The read amplifiers after the photo-detectors in Channel 1 and Channel 2 shall have a flat response within 1 dB from d.c. to 13 MHz.

9.4 Tracking

Channel 1 shall be used for generating the tracking error signals to control the servos for the axial and radial tracking of the optical beam. The method of generating the axial tacking error is not specified for the Reference Drive. The radial tracking error is the difference between the signal levels obtained from the centres of two Wobble Marks.

The requirements for the accuracy with which the focus of the optical beam must follow the tracks is specified in 21.2.4.

9.5 Rotation of the disk

The spindle shall position the disk as specified in 12.4. It shall rotate the disk at 40,00 Hz ± 0,08 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 a spindle window on Side A to allow the spindle of the drive to clamp the disk by its hub. Both Side A and Side B of the case have a head window, the one on Side A for the optical head of the drive, the other one on Side B for the slider with a magnetic head providing the necessary magnetic fields. 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, and write-inhibit and reflectance detection features.

10.2 Reference planes of the case

The dimensions of the case shall be referred to three orthogonal planes X, Y and Z (see annex K). The case shall be constrained such that four reference surfaces S1 to S4 on Side A of the case lie in plane Z when measuring those dimensions of the case in 10.3 which are referenced to this plane. The intersection of the three planes defines the centre of the location hole. The centre of the alignment hole shall lie at the intersection of planes X and Z (see annex K). 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 total length of the case shall be

L_1 = 97,0 mm ± 0,3 mm

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

L_2 = 78,0 mm ± 0,2 mm

The total width of the case shall be

L_3 = 92,0 mm ± 0,2 mm

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

L_4 = 5,0 mm ± 0,2 mm

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

R_1 = 6,0 mm ± 0,2 mm

and the two corners at the bottom with a radius

R_2 = 6,0 mm ± 0,5 mm

In the zones extending

L_5 = 9,6 mm min.

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

L_6 = 5,0 mm ± 0,2 mm

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

R_3 = 0,5 mm ± 0,2 mm

10.3.2 Location hole (see figure 3)

The centre of the location hole shall coincide with the interaction of the planes X, Y and Z. The diameter of the hole shall be

$D_1 = 3{,}60 \text{ mm} \begin{matrix} +\,0{,}00 \text{ mm} \\ -\,0{,}06 \text{ mm} \end{matrix}$

held to a depth

L_7 = 1,0 mm min.

The location hole shall extend below plane Z by

L_8 = 3,5 mm min.

with a diameter equal to, or greater than D_1.

The location hole shall not extend through Side B.

The lead-in edges shall be rounded with a radius

R_4 = 0,5 mm max.

10.3.3 Alignment hole (see figure 3)

The centre of the alignment hole shall lie in the X plane at a distance

L_9 = 82,0 mm ± 0,2 mm

from reference plane Y.

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

$L_{10} = 3{,}60 \text{ mm} \begin{matrix} +\,0{,}00 \text{ mm} \\ -\,0{,}06 \text{ mm} \end{matrix}$

$L_{11} = 4{,}4 \text{ mm} \begin{matrix} +\,0{,}2 \text{ mm} \\ -\,0{,}0 \text{ mm} \end{matrix}$

held to a depth

L_{12} = 1,0 mm min.

below which the alignment hole shall extend to

L_{13} = 3,5 mm min.

with dimensions equal to, or greater than, L_{10} and L_{11} , respectively.

The alignment hole shall not extend through Side B.

The lead-in edges shall be rounded with a radius R_4 .

10.3.4 Reference surfaces (see figure 4)

Side A of the case shall contain four reference surfaces S1, S2, S3 and S4.

Surface S1 and S2 shall be circular with a diameter

D_2 = 7,0 mm min.

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

Surface S3 and S4 shall be semi-circular with a diameter

D_3 = 7,0 mm min.

The location of the centre of S4 is specified by

L_{14} = 54,0 mm ± 0,2 mm

L_{15} = 82,0 mm ± 0,2 mm

The centre of S3 shall be in plane Y at a distaince L_{14} of plane X.

Surface finish and the height of S1, S2, S3 and S4 shall be the same as those of the surrounding area.

No portion of the case, including the warp, or of the shutter mechanism shall protrude more than

L_{16} = 0,2 mm max.

L_{17} = 5,4 mm max.

beyond plane Z.

10.3.5 Insertion slots and detent features (see figure 5)

The case shall have two sets of symmetrically placed insertion slots with detent features. The slots are intended to prevent mis-insertion of the cartridge into a drive. The detent features are intended for autoloading.

The slots are called inject notches, the detents mis-insert grooves.

Each detent shall extend from plane Z up to

L_{18} = 3,0 mm ± 0,2 mm

and shall not extend through Side B.

Inject notches are defined by semi-circular sections with a radius

R_5 = 2,1 mm ± 0,1 mm

which stretch out to the edge of the case along two straight lines extending from the semi-circle. The radii of the two inject notches originate from points located at

L_{19} = 65,5 mm ± 0,2 mm

from plane X, and at

L_{20} = 1,5 mm ± 0,2 mm

and

L_{21} = 83,5 mm ± 0,2 mm

from plane Y.

The outside edges of the inject notches shall be rounded off by a radius

R_6 = 0,5 mm ± 0,2 mm

Mis-insert grooves are defined by

L_{22} = 39,5 mm ± 0,2 mm

from plane X, and have a depth of

$L_{23} = 2,5 \text{ mm } {}^{+0,3 \text{ mm}}_{-0,0 \text{ mm}}$

from the edges of the case.

The detents of the mis-insert grooves shall be rounded off by radii

R_7 = 1,0 mm max.

R_8 = 0,5 mm ± 0,2 mm

The lead-in edges of mis-insert grooves shall be ramps to the top of the case with an angle

A_1 = 15° ± 2°

starting from the point defined by the intersection of L_{23} and

L_{24} = 8,0 mm ± 0,2 mm

10.3.6 Functional Areas (see figure 6)

The case shall have an opening in Side A corresponding to the surfaces of Functional Areas FA1 and FA2.

Functional Area FA1 shall be circular with a diameter

D_4 = 2,5 mm min.

with its centre located at a distance

L_{25} = 14,0 mm ± 0,2 mm

from plane X, and a distance

L_{26} = 15,0 mm ± 0,2 mm

from plane Y. Side B shall have an opening corresponding to the surface of Functional Area FA1.

Functional Area FA2 shall have the diameter D_4 and held to a depth

L_{27} = 3,5 mm min.

from plane Z with its centre located at a distance L_{25} from plane X, and a distance

L_{28} = 10,0 mm ± 0,2 mm

from plane Y.

There shall be no opening in Side B corresponding to Functional Area FA2.

The cartridge shall have a device capable of

- either closing FA1 or FA2,
- or closing both FA1 and FA2.

The two Functional Areas shall indicate the reflectance of the disk in the cartridge and 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 FA1 and FA2

FA1	FA2	Writing	Reflectance	Type of Cartridge
Open	Closed	Inhibited	Low	R/W, P-ROM
Closed	Open	Permitted	Low	R/W or P-ROM
Closed	Closed	Inhibited	High	O-ROM
Open	Open	Not permitted by this ECMA Standard		

The surface of the device shall be at a depth

L_{29} = 0,3 mm max.

from plane Z.

10.3.7 Spindle and head windows (see figure 7)

Side A of the case shall have two windows to enable the spindle and the optical head of the drive to access the disk.

The dimensions of the top window for the optical head are referenced to a centreline, located at a distance

L_{30} = 41,0 mm ± 0,2 mm

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

$L_{31} = 9{,}75 \text{ mm} \begin{matrix} +\,0{,}25 \text{ mm} \\ -\,0{,}00 \text{ mm} \end{matrix}$

The top of the window shall be defined by the radius

R_9 = 44,6 mm min.

originating from L_{30} and

L_{32} = 27,0 mm ± 0,2 mm

The window for the optical head shall extend from

L_{33} = 39,0 mm max.

to the arc of R_9 , originating from L_{30} and L_{32}.

The area bounded by R_9 and the top of the case shall be recessed from plane Z by

L_{34} = 1,6 mm min.

over the width of the window.

The window for the spindle shall be circular with a diameter

$D_5 = 19{,}5 \text{ mm} \begin{matrix} +0{,}5 \text{ mm} \\ -0{,}0 \text{ mm} \end{matrix}$

originating from L_{30} and L_{32}.

The two inside corners shall be rounded with radii

R_{10} = 2,0 mm max.

Side B of the case shall have a window to enable the magnetic head of the drive to access the disk.

The dimensions of the window are referenced to a centreline, located at a distance L_{30} from plane Y.

The width of the window shall be given by

$L_{35} = 8{,}00 \text{ mm} \begin{matrix} +0{,}25 \text{ mm} \\ -0{,}00 \text{ mm} \end{matrix}$

The window for the magnetic head shall extend from

L_{36} = 39,0 mm max.

to the arc of R_9, originating from L_{30} and L_{32}.

The area bounded by R_9 and the top of the case shall be, over the width of the window, at a distance

L_{37} = 3,5 mm max.

from plane Z.

The two inside corners shall be rounded with a radius

R_{11} = 2,0 mm max.

10.3.8 Shutter (see figure 8)

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 up to at least the minimum size allowed by the following dimensions, given in 10.3.7:

on Side A: from the circle defined by D_5 up to the top of the case, and from L_{33} up to the top of the case, and from L_{31};

on Side B: from L_{36} up to the top of the case, and from L_{35}.

on the top: from plane Z to L_{34}, from L_{31}, from L_{37} up to Side B, from L_{35}.

The shutter shall be free to slide in a recessed area of the case in such a way as to ensure that the overall thickness of the case and shutter does not exceed L_{14} by more than L_{16} and L_{17}.

The shutter shall have one edge against which the shutter opener of the drive can push to open the shutter. When the shutter is closed, this edge shall be

$L_{38} = 76{,}0 \text{ mm} \begin{matrix} +0{,}0 \text{ mm} \\ -0{,}4 \text{ mm} \end{matrix}$

from plane Y. A movement of the edge to

L_{39} = 54,6 mm min.

shall be sufficient to open the windows to the minimum size specified in 10.3.8. It shall be possible to move the edge to

L_{40} = 54,0 mm max.

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

10.3.9 Path for shutter opener and shutter sensor notch (see figures 9 and 10)

The profile on the top of the case provides a path over which the shutter opener of the drive can move.

The path shall run from

L_{41} = 78,0 mm ± 0,3 mm

to

$L_{42} = 57{,}0 \text{ mm} \begin{array}{l} +\ 0{,}4 \text{ mm} \\ -\ 0{,}0 \text{ mm} \end{array}$

at a distance

L_{43} = 75,5 mm ± 0,3 mm

from plane X.

The lead-in edge at L_{41} shall be a ramp to the top of the case at a distance

L_{44} = 79,5 mm ± 0,3 mm

from plane Y.

The path shall end in a notch with a width at the bottom extending from L_{42} to

L_{45} = 54,0 mm max.

and a depth

$L_{46} = 2{,}0 \text{ mm} \begin{array}{l} +\ 0{,}3 \text{ mm} \\ -\ 0{,}0 \text{ mm} \end{array}$

below L_{43}. The lead-in edge at the left-hand side of the notch shall be rounded with a radius

R_{12} = 0,5 mm max.

and the bottom of the same side of the notch shall be rounded with a radius

R_{13} = 0,5 mm ± 0,2 mm

When the shutter edge is moved to L_{39}, a length of at least (L_{42} - L_{39}) of the notch shall be exposed.

This enables a drive to confirm that the shutter is fully open.

The top of the slider shall be given by

L_{47} = 77,7 mm ± 0,3 mm

L_{48} = 0,7 mm min.

10.3.10 Label area (see figure 11)

The case shall have a label area on Side B with dimensions

L_{49} = 10,0 ± 0,2 mm

L_{50} = 72,0 ± 0,3 mm

L_{51} = 10,0 ± 0,2 mm

and

L_{52} = 42,0 ± 0,3 mm.

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

R_{14} = 2,0 mm max.

When there is no label, the area shall be recessed by

L_{53} = 0,12 mm min.

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 ECMA Standard.

10.4.2 Mass

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

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 assures 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 fully open the shutter does not exceed 1,0 N. It shall be sufficiently strong to fully close a free-sliding shutter, irrespective of the orientation of the case.

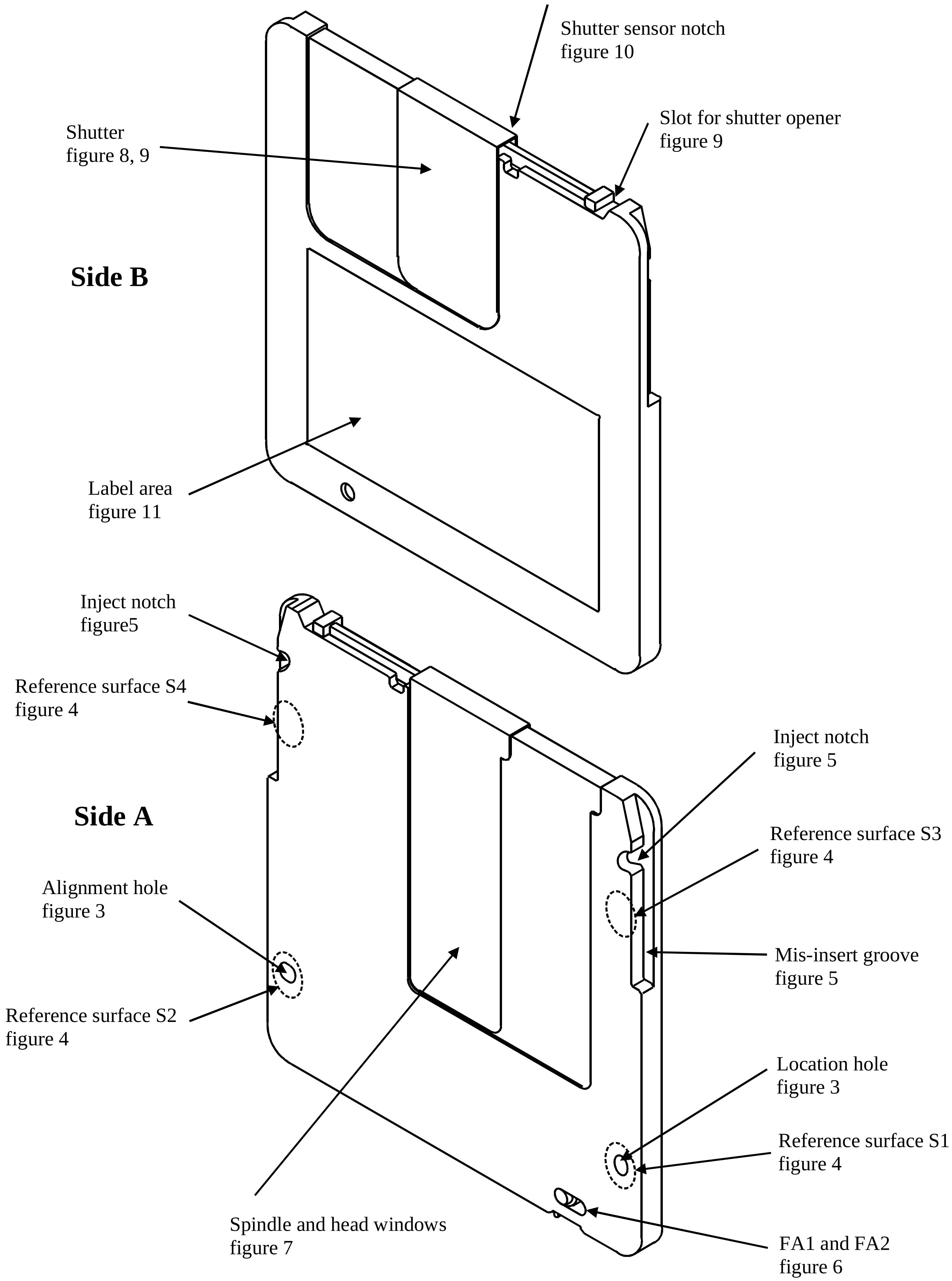


Figure 2 - General view of the case

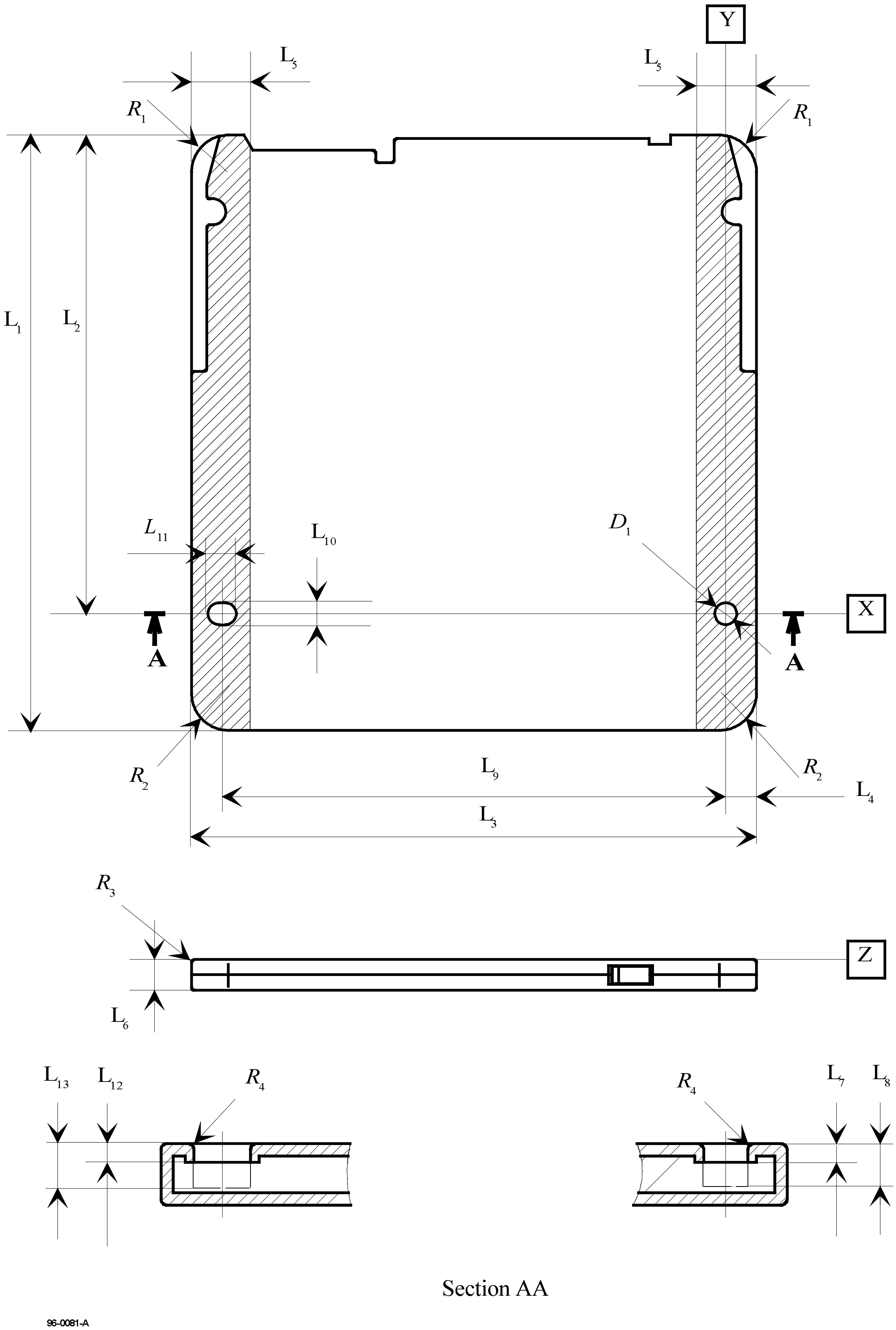


Figure 3 - Overall dimensions, viewed on Side A

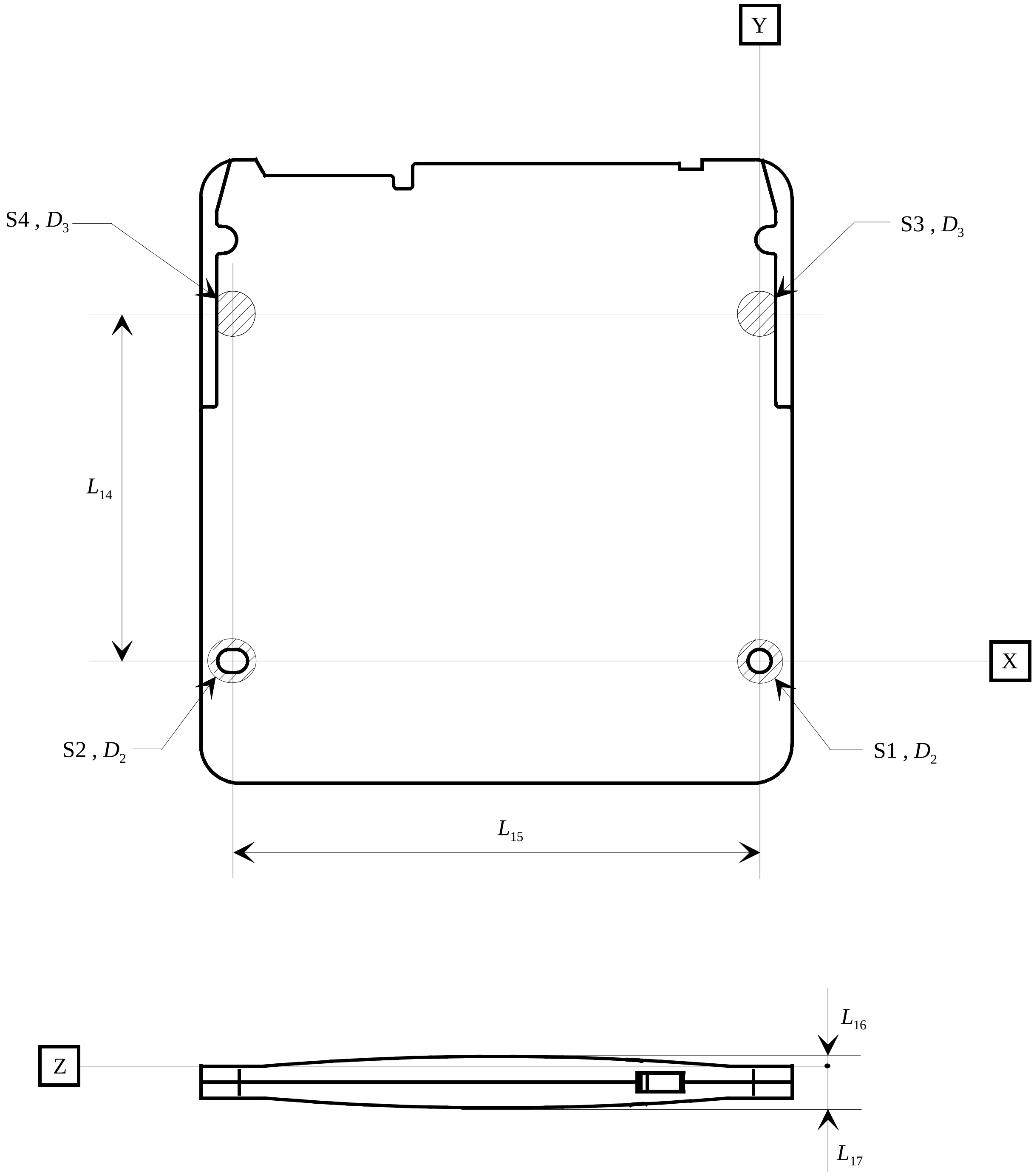


Figure 4 -Reference surfaces on Side A

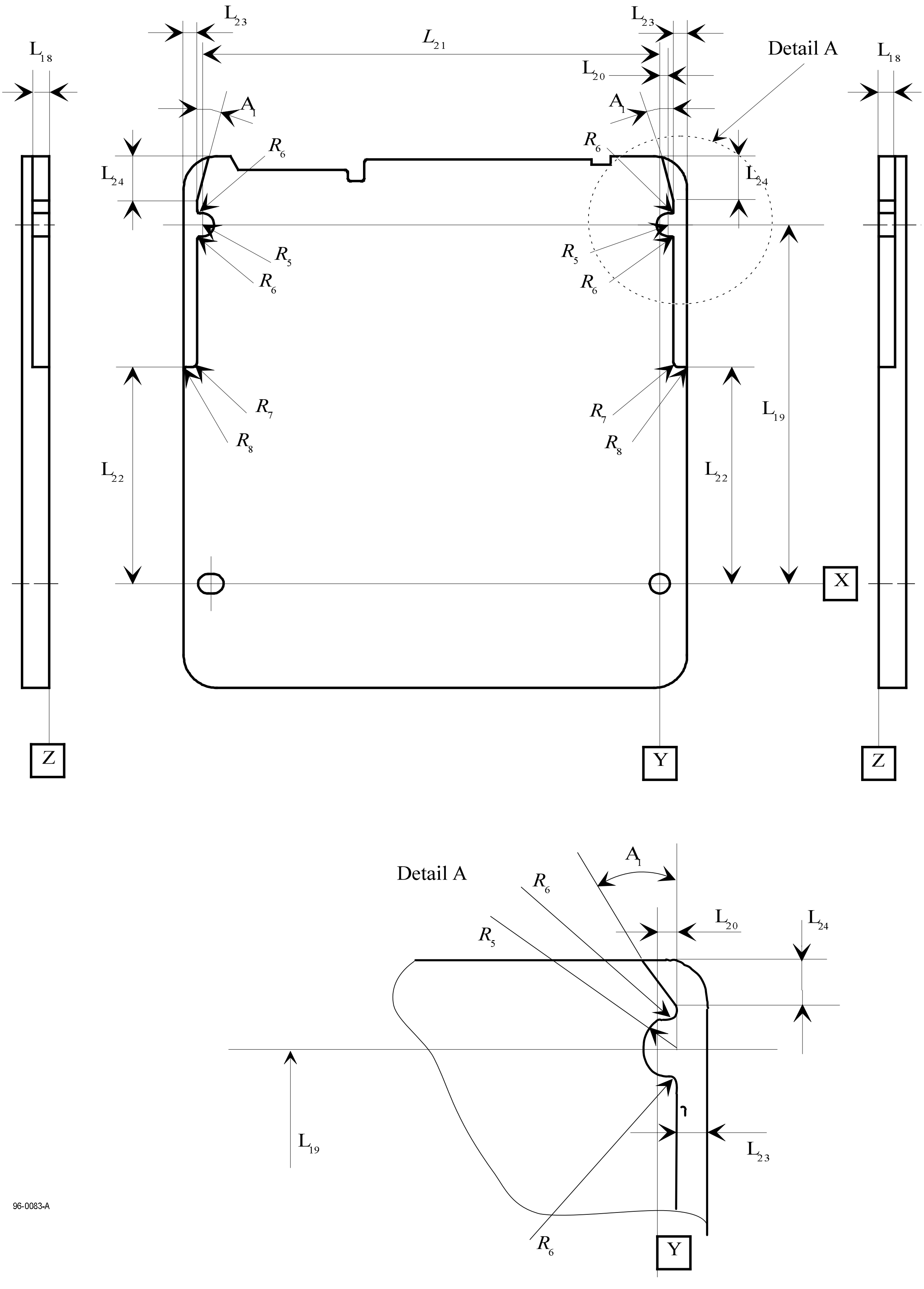


Figure 5 - Detent feature, seen on Side A

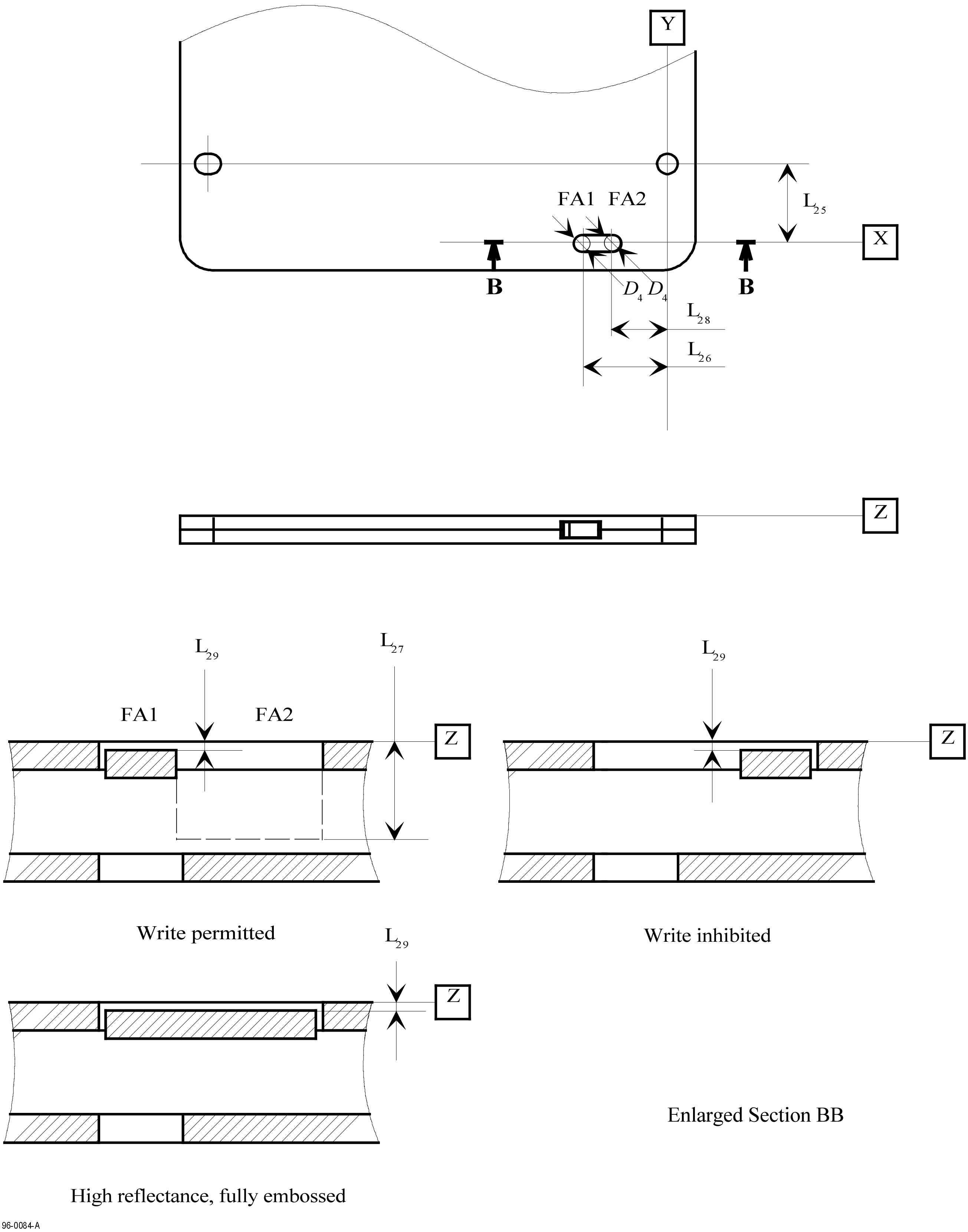


Figure 6 - Functional Areas FA1 and FA2, seen on Side A and in cross-section

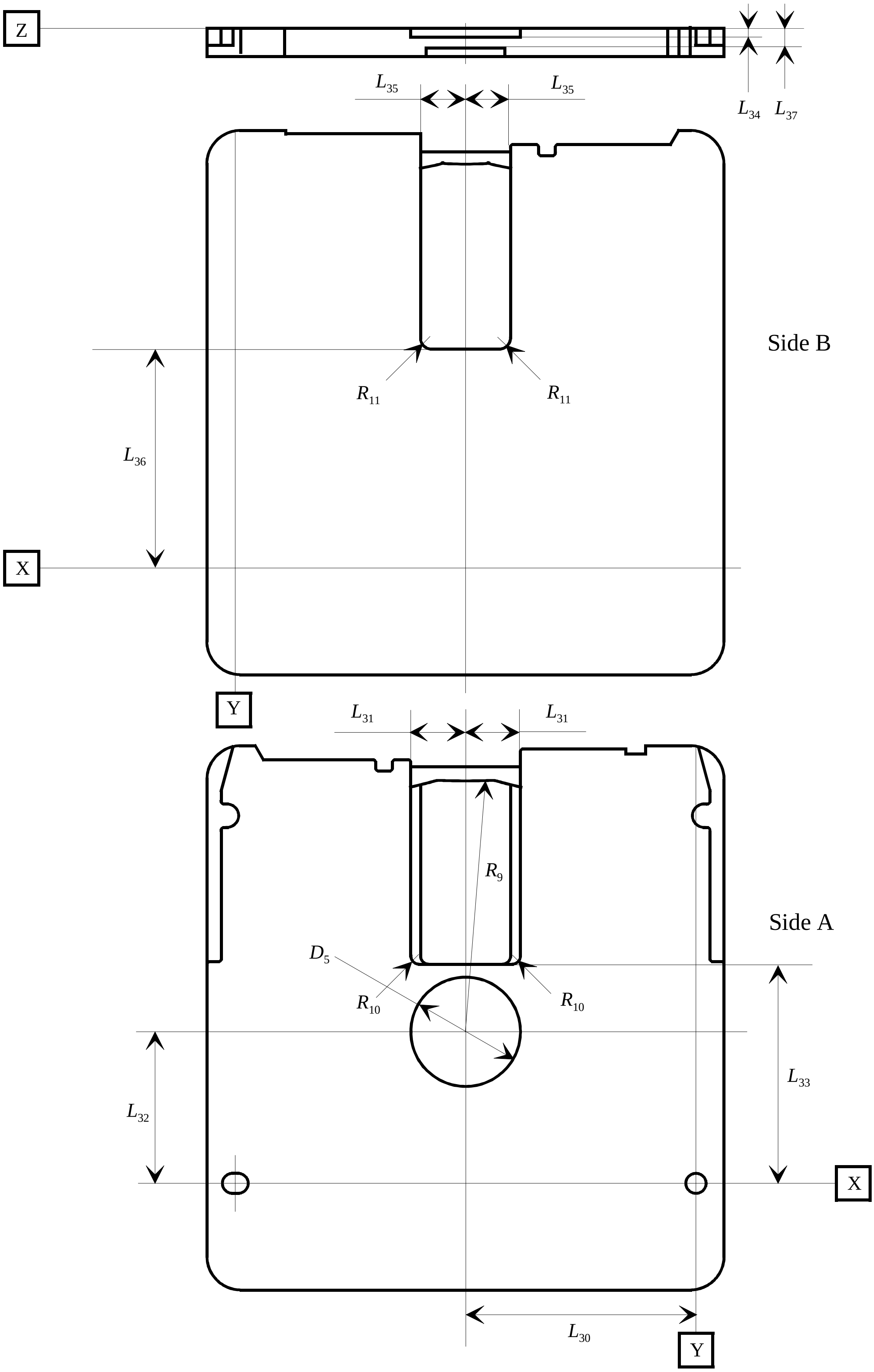


Figure 7 - Spindle and head windows on Side A and B of the case without shutter

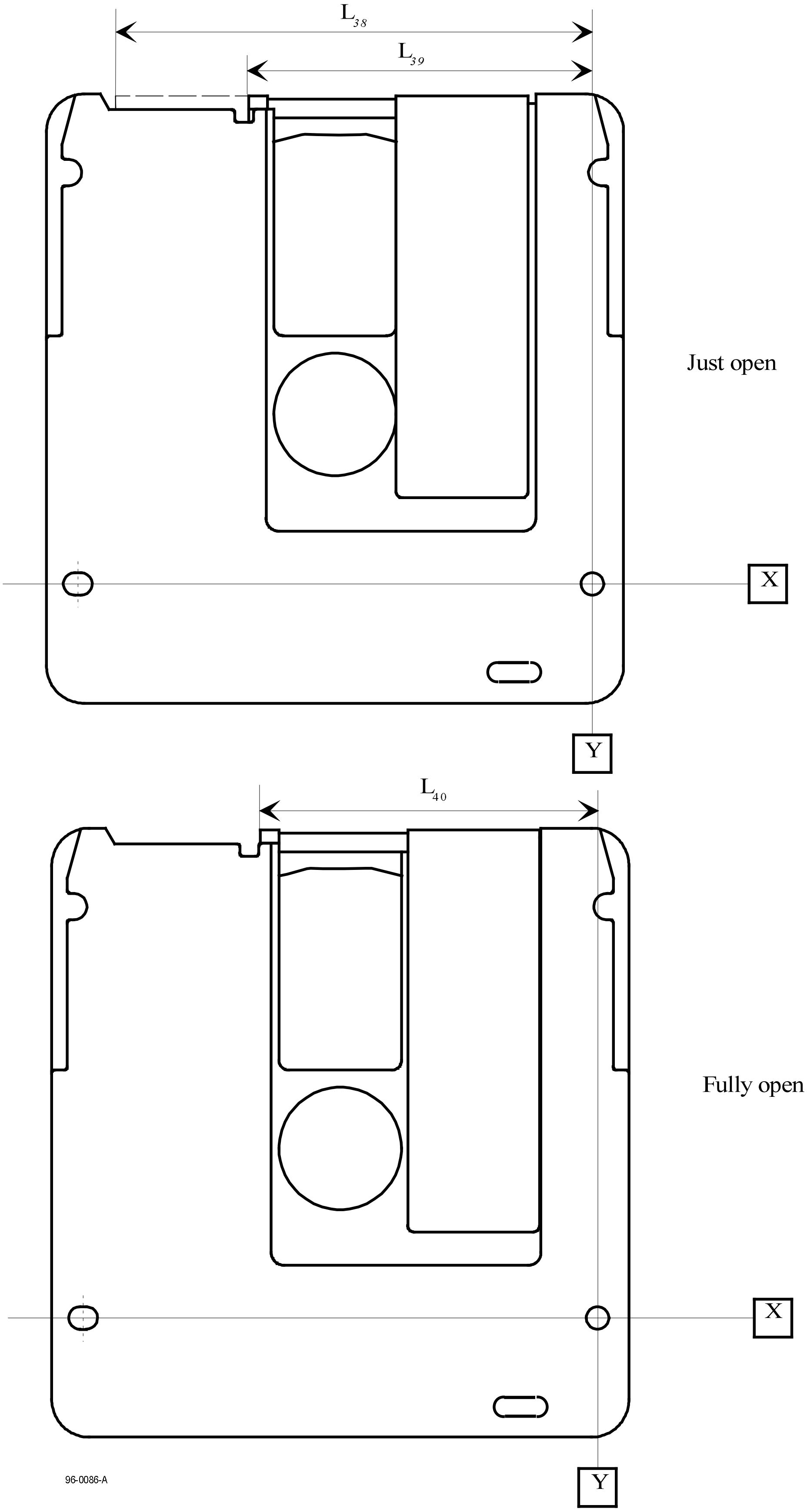


Figure 8 - Shutter in just open position and fully open position.
The dashed line indicates the position of the shutter edge when the shutter is closed.

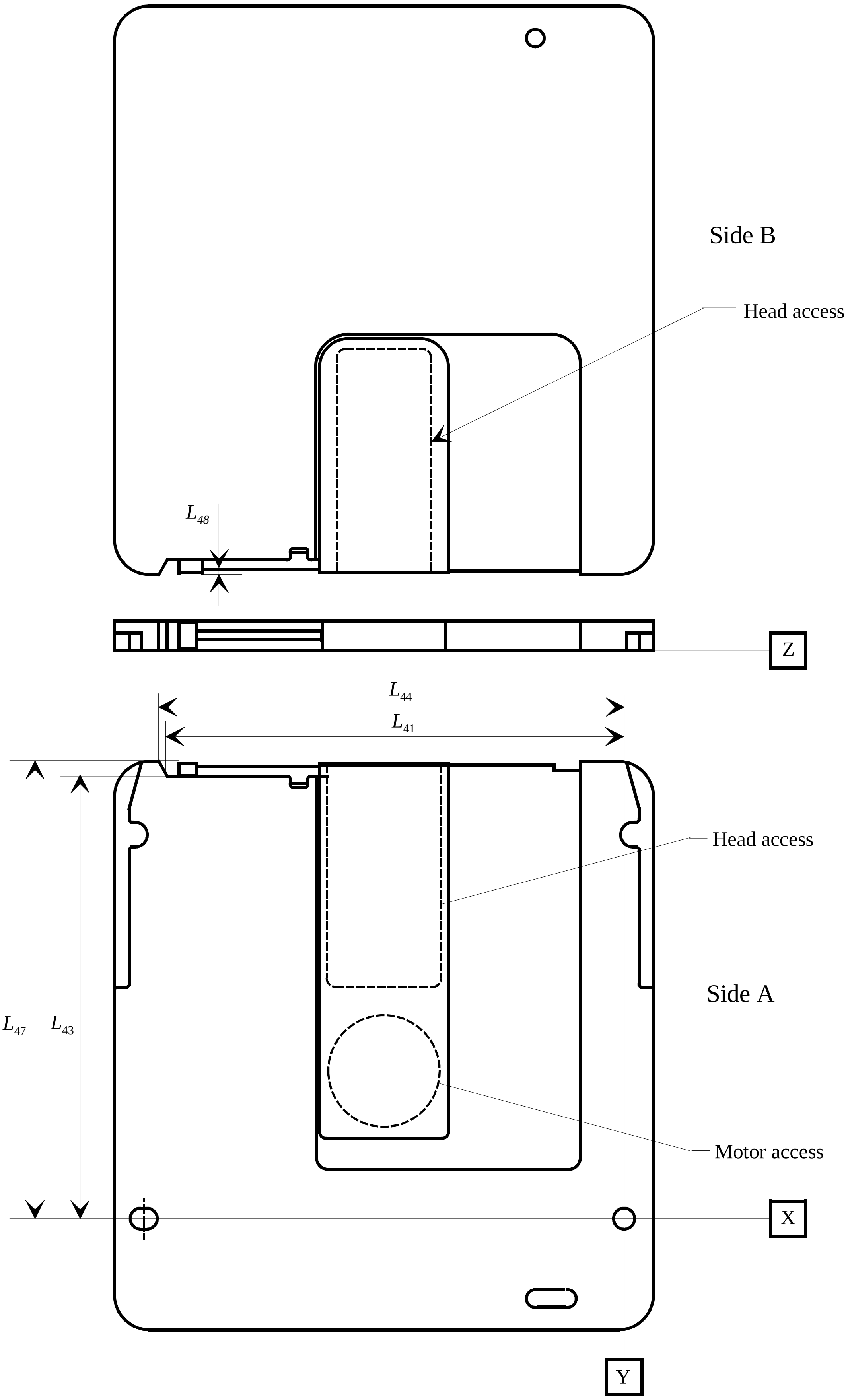


Figure 9 - Path for the shutter opener

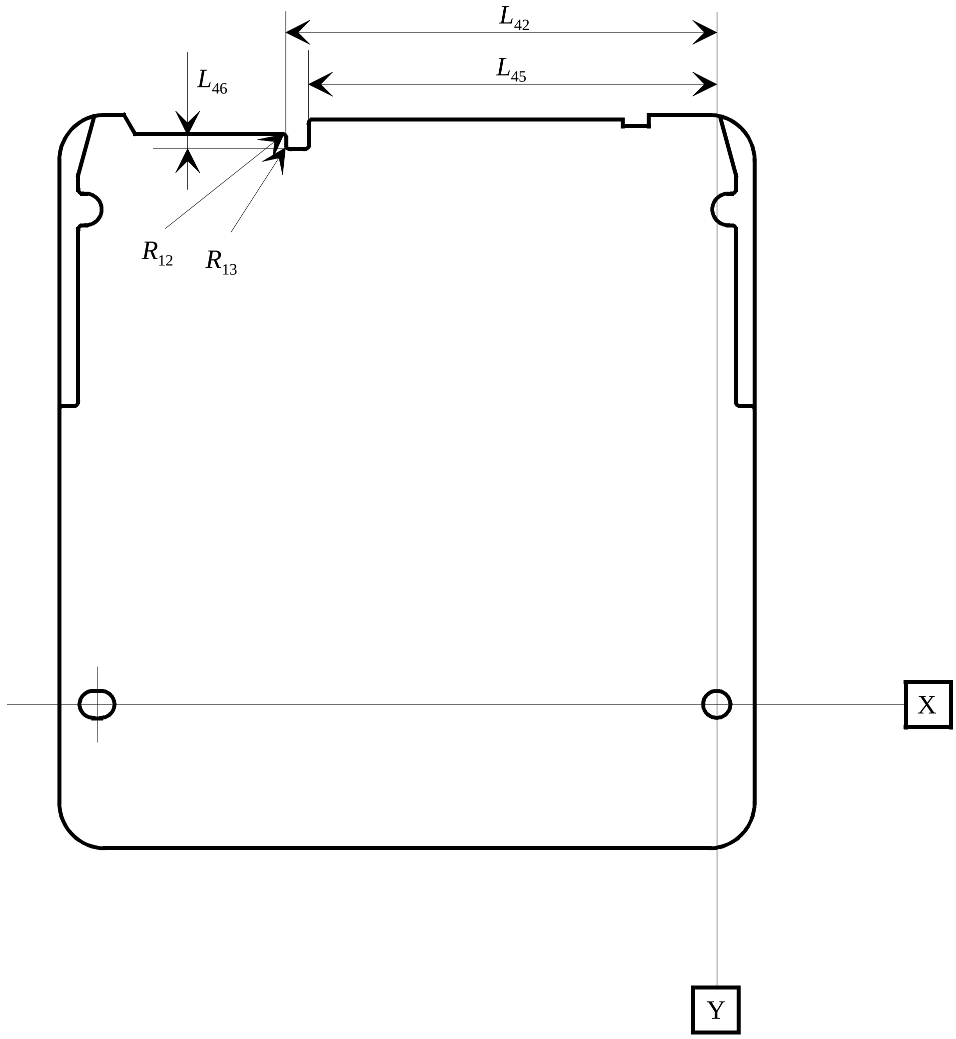


Figure 10 - Path for shutter opener and sensor notch, seen from Side A without shutter

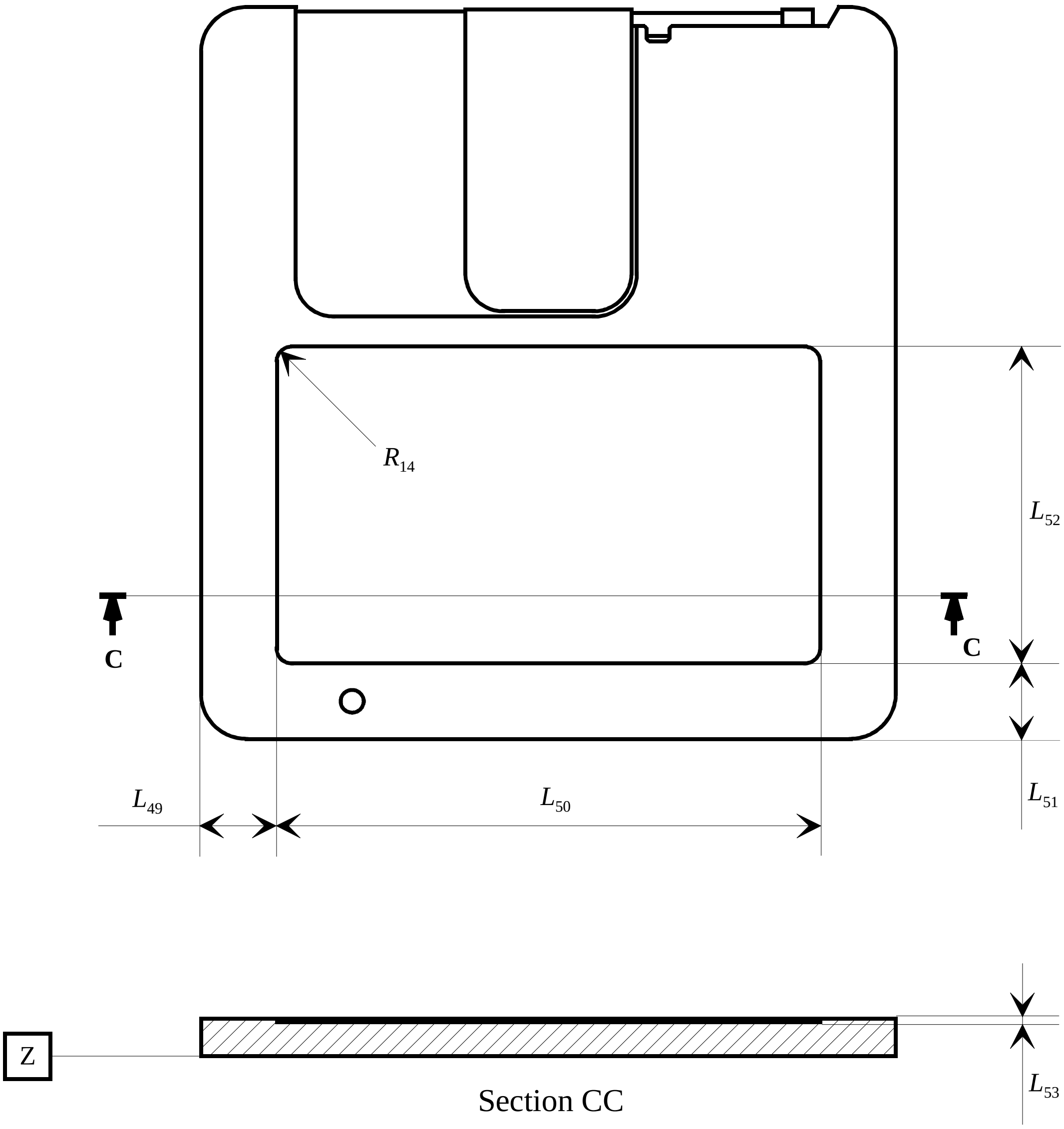


Figure 11 - Label area

11 Dimensional, mechanical and physical characteristics of the disk

11.1 General description of the disk

The disk shall consist of a circular substrate with a hub on one side and a recording layer coated on the other side. The recording layer shall be protected by a protective layer. The Information Zone of the substrate is transparent to allow an optical beam to focus on the recording layer through the substrate. The circular hub is in the centre of the disk on the side of the recording layer and provides the radial centring of the disk and the clamping force.

11.2 Reference axis and plane of the disk

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

11.3 Dimensions of the disk (see figure 12)

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 below.

The outer diameter of the disk shall be

$$D_6 = 88{,}0 \text{ mm} \begin{array}{l} + 0{,}4 \text{ mm} \\ - 0{,}0 \text{ mm} \end{array}$$

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

$$D_8 = 11{,}0 \text{ mm} \begin{array}{l} + 0{,}1 \text{ mm} \\ - 0{,}0 \text{ mm} \end{array}$$

Excluding axial deflection (see 11.4.5), the total thickness of the disk in the range of D_6 to D_7 shall not exceed 0,9 mm. D_7 shall not exceed 26,0 mm.

The total thickness of the disk in the range from D_7 to D_8 shall be 1,30 mm ± 0,05 mm. The disk thickness shall be the range between D_7 and D_6 is recessed below plane P..

11.3.1 Hub dimensions (see figure 12)

The diameter of the centre hole of the hub shall be

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

The outer diameter of the hub shall be

$$D_{10} = 11{,}0 \text{ mm} \begin{array}{l} + 0{,}0 \text{ mm} \\ - 0{,}2 \text{ mm} \end{array}$$

The position of the top of the magnetizable surface shall be

$$h_1 = 0{,}5 \text{ mm} \begin{array}{l} + 0{,}00 \text{ mm} \\ - 0{,}15 \text{ mm} \end{array}$$

The centring length at a diameter D_9 shall be

h_2 = 0,15 mm min.

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

R_{15} = 0,2 mm ± 0,1 mm

The outer edge of the centre hole shall either have a chamfer C_2 of 45° by 0,2 mm ± 0,1 mm or be rounded off by radius

R_{16} = 0,7 mm ± 0,2 mm

11.3.2 Clamping zone (see figure 12)

The outer diameter of the clamping zone D_{11} shall be

18,0 mm < D_{11} < D_7 .

The inner diameter of the clamping zone D_{12} shall be

D_8 < D_{12} < 15,0 mm.

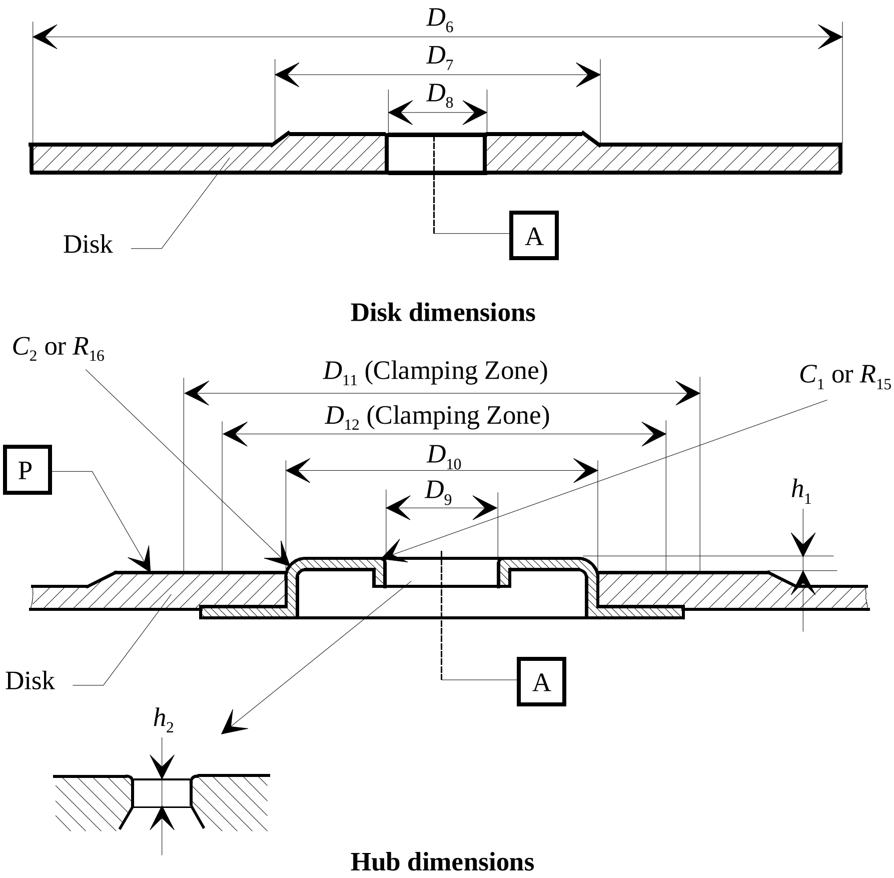


Figure 12 - Disk and hub dimensions

11.4 Mechanical characteristics

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

11.4.1 Material

The disk shall be made from any suitable materials such that it meets the requirements of this ECMA Standard. The only material properties specified by this ECMA 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 8 g.

11.4.3 Moment of inertia

The moment of inertia of the disk relatively to axis A shall not exceed 0,010 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 40 Hz.

11.4.6 Axial acceleration

The maximum allowed tracking error e_{max} (see annex R) shall not exceed 0,8 µm, measured using the Reference Servo for axial tracking of the recording layer. The rotational frequency of the disk shall be as specified in 9.5. The stationary part of the motor is assumed to be motionless (no external disturbances). The measurement shall be made using a servo with the transfer function

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

where

$\omega = 2\pi f$

$\omega_0 / 2\pi = 1\,145$ Hz

$i = \sqrt{-1}$

or any other servo with $|1+H|$ within 20% of $|1+H_S|$ in the bandwidth of 40 Hz to 100 kHz. Thus, the disk shall not require an axial acceleration of more than 13,8 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-uniformities in the index of refraction.

The runout, defined as the difference between the maximum and the minimum distance of the centre of any track from the axis of rotation, measured along a fixed radial line over the one revolution of the disk, shall not exceed 60 µm (Type R/W, Type P-ROM), 100 µm (Type O-ROM) as measured by the optical system under conditions of a hub mounted on a perfect sized test fixture shaft, at a rotation frequency of the disk as specified in 9.5.

11.4.8 Radial acceleration

The maximum allowed tracking error e_{max} (see annex R) shall not exceed 0,12 µm, measured using the Reference Servo for radial tracking of the tracks. The rotational frequency of the disk shall be as specified in 9.5. The stationary part of the motor is assumed to be motionless (no external disturbances). The measurement shall be made using a servo with the transfer function.

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

where

$\omega = 2\pi f$

$\omega_0 / 2\pi = 1\,725$ Hz

$i = \sqrt{-1}$

or any other servo with $|1+H|$ within 20% of $|1+H_S|$ in the bandwidth of 40 Hz to 100 kHz. Thus, the disk shall not require a radial acceleration of more than 4,7 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 1,46 to 1,60.

11.5.2 Thickness of the substrate

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

$$1{,}20 < n \times d < 1{,}33$$

where n is the index of refraction and d is the thickness of the substrate.

11.5.3 Reflectance

11.5.3.1 General

The reflectance R is the value of the reflectance on an unrecorded, ungrooved area of the Data Zone of the disk, 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 21 of the SFP Zone (see annex D).

11.5.3.2 Measured Value

The measured value R_m of the reflectance shall be measured under the conditions a) to f) of 9.2. Measurements shall be made in the Data Zone in any track without embossed data fields.

R_a is defined as the mean value between the maximum value of R_m and the minimum value of R_m in the same disk.

11.5.3.3 Requirements

The value of R at the standard wavelength specified in 9.2 shall lie within the range from 0,15 to 0,25 for partially embossed or fully rewritable disks and for low reflectance fully embossed disks. The value of R shall lie within the range from 0,70 to 0,90 for high reflectance fully embossed disks (see annex L).

At any point of the Data Zone, the value R_a shall be equal to $(1\pm 0{,}15)R$ and lie within the allowed range.

This requirement specifies the acceptable range for R_a for all disks with the same value of R. Additionally, the value R_m shall be equal to $(1\pm 0{,}12)R_a$ and lie within the allowed range.

11.6 Protective coating

11.6.1 General description of protective coating

A protective coating shall cover the side of a disk which contains the recording layer to protect it from environmental influences and to fly the slider with magnetic head.

The slider with magnetic head usually does not touch the protective coating under the operating condition. But under the test condition specified in annex Q, the slider touches the protective coating at low rotation speed to test the characteristics of protective coating.

The protective coating shall not disturb the recording magnetic field.

11.6.2 General description of the flyable zone

The flyable zone is a part of the protective coating area. It is the area over which the slider with a magnetic head can fly.

11.6.3 Characteristics of the protective coating in the flyable zone (figure 13)

The dimensions and physical characteristics of the protective coating in the flyable zone shall meet the requirements specified in 11.6.3.1 to 11.6.3.5.

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

11.6.3.1 Dimensions of the protective coating in the flyable zone

The inner diameter of the flyable zone shall be

D_{13} = 28,0 mm max.

The outer diameter of the flyable zone shall be

D_{14} = 86,0 mm min.

The thickness of the protective coating in the flyable zone shall be within the range from 5 µm to 20 µm (see figure 13).

11.6.3.2 Surface roughness

The surface roughness of the protective coating in the flyable zone is determined by the value of B_a. A scan length of 8,0 mm and a cut-off value 2,5 mm are used to measure B_a .

B_a shall not exceed 0,3 µm at any point of the flyable zone.

11.6.3.3 Surface waviness

The surface waviness of the protective coating in the flyable zone is determined by the value of W_a. A scan length of 8,0 mm and a cut-off value 2,5 mm are used to measure W_a .

W_a shall not exceed 1,5 µm at any point in the flyable zone.

11.6.3.4 Surface irregularity

Surface irregularity of the protective coating in the flyable zone is determined by the value of B_{max} . A scan length of 8,0 mm is used to measure B_{max} . B_{max} shall not exceed 10 µm at any point of the flyable zone.

11.6.3.5 Friction force and wear in thickness test

An example of a test method of friction force and wear in thickness is specified in annex Q. The maximum friction force shall not exceed 50 mN during 10 000 test cycles. The wear shall not exceed 1 µm after 10 000 test cycles.

11.6.4 Dimensions of the protective coating outside the flyable zone

The thickness of the protective coating in the zone outside the flyable zone shall not exceed 100 µm from the recording layer (see figure 13).

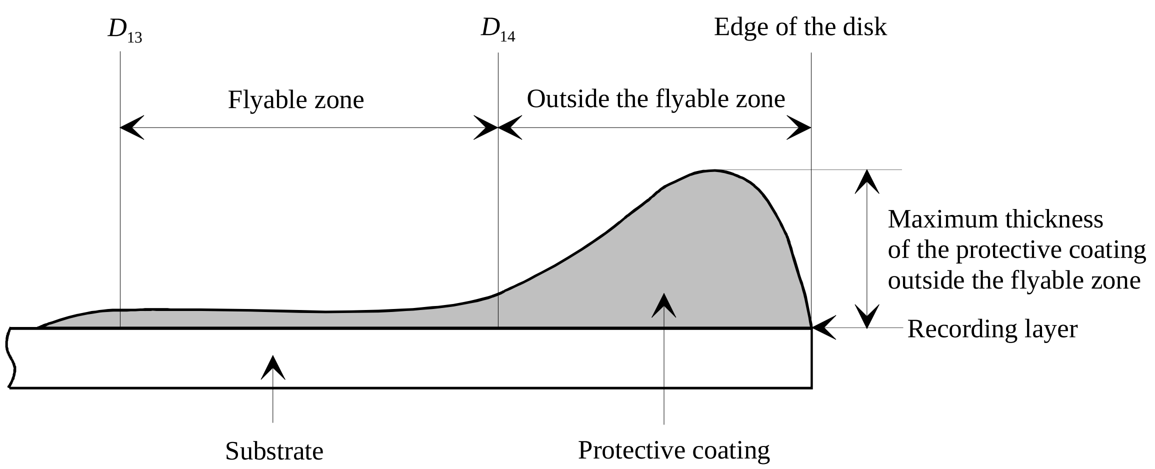


Figure 13 - Thickness of the protective coating

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 H) and the magnets in the spindle. The radial positioning of the disk is provided by the centring of the axis of the spindle in the centre hole of the hub. A cup-shaped turntable of the spindle shall support the disk in its clamping zone, determining the axial position of the disk in the case.

12.2 Clamping force

The clamping force exerted by the spindle on the hub shall be 2,8 N ± 0,4 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 12).

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_{54} = 0,1 mm min.

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

L_{55} = 2,3 mm max.

above plane Z. The radius of the cylinder shall be

R_{17} = 1,0 mm max.

and its centre shall be given by the nominal values of L_{30} and L_{32} in the drive.

12.4 Disk position in operating conditions (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_{56} = 1,7 ± 0,1 mm

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

R_{18} = 0,1 mm max.

and a centre given by the nominal values of L_{30} and L_{32} .

The torque to be exerted on the disk in the operating condition in order to maintain a rotational frequency of 40 Hz shall not exceed 0,01 N • m

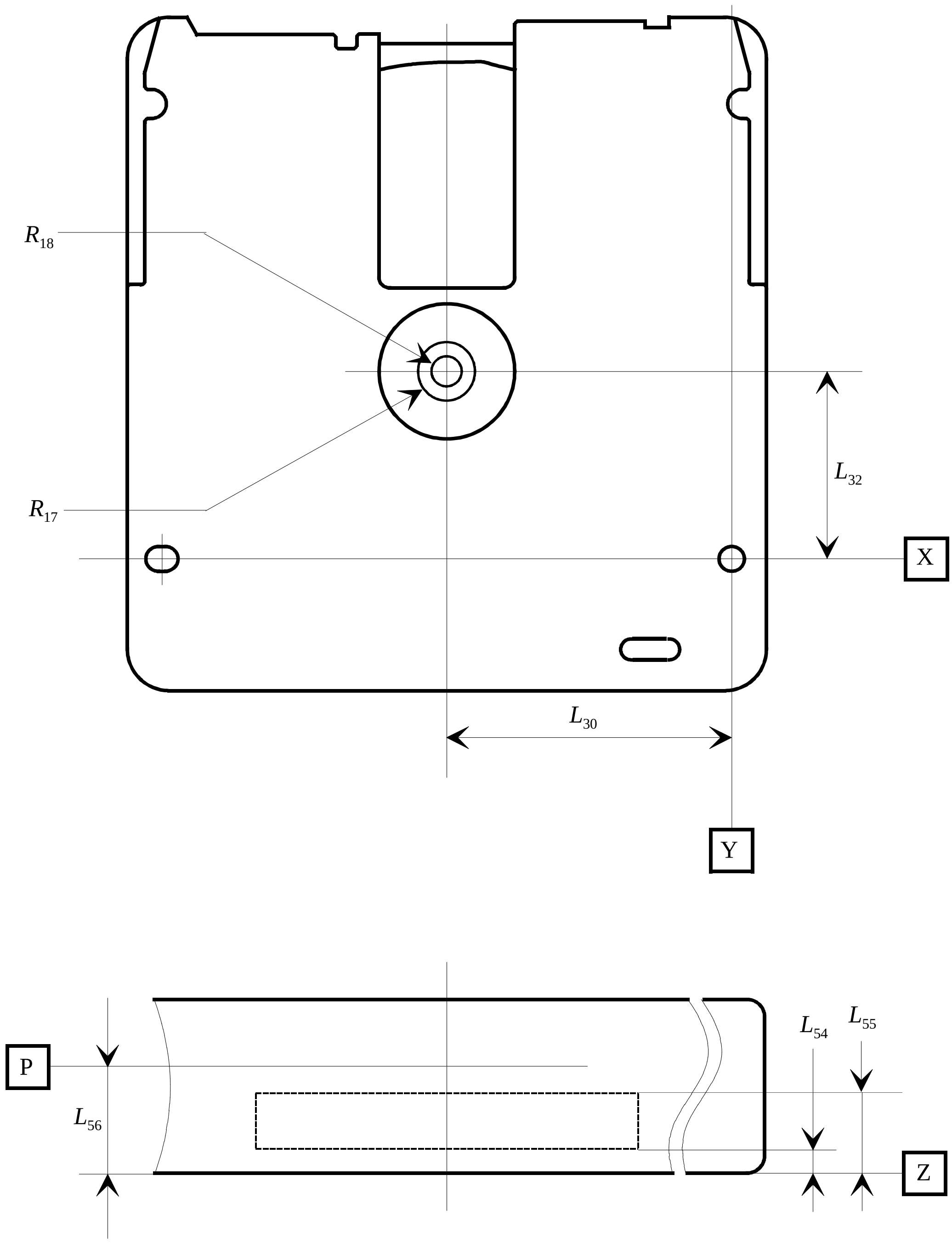


Figure 14 - Capture cylinder for the hub

Section 3 - Format of information

13 Track geometry

13.1 Track shape

In certain areas of the disks, a track shall consist of a groove-land-groove combination, where each groove is shared with a neighbouring track. A groove is a trench-like feature, the bottom of which is located nearer the entrance surface than the land. The centre of a track, i.e. where the recording is made, is the centre of the land. The shape of the groove is determined by the requirements in clause 24.

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

13.2 Direction of track spiral

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

13.3 Track pitch

The track pitch is the distance between adjacent track centrelines, measured in a radial direction. It shall be 1,20 µm ± 0,05 µm.

The width of a band of 10 000 tracks shall be 12,00 mm ± 0,50 mm.

14 Track format

14.1 Track number

Each 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 41,20 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 Address field of the Address Segments in TWO's complement. Thus track -1 is indicated by (FFFF).

14.2 Track layout

On each track there shall be 100 frames. Each frame shall comprise one address segment and 13 data segments. A segment shall have a length of 216 Servo Channel bits. Thus, on each track there shall be 1 300 data segments (see figure 15). The tracks in the Data Zone are grouped into 16 bands (see 18.5).

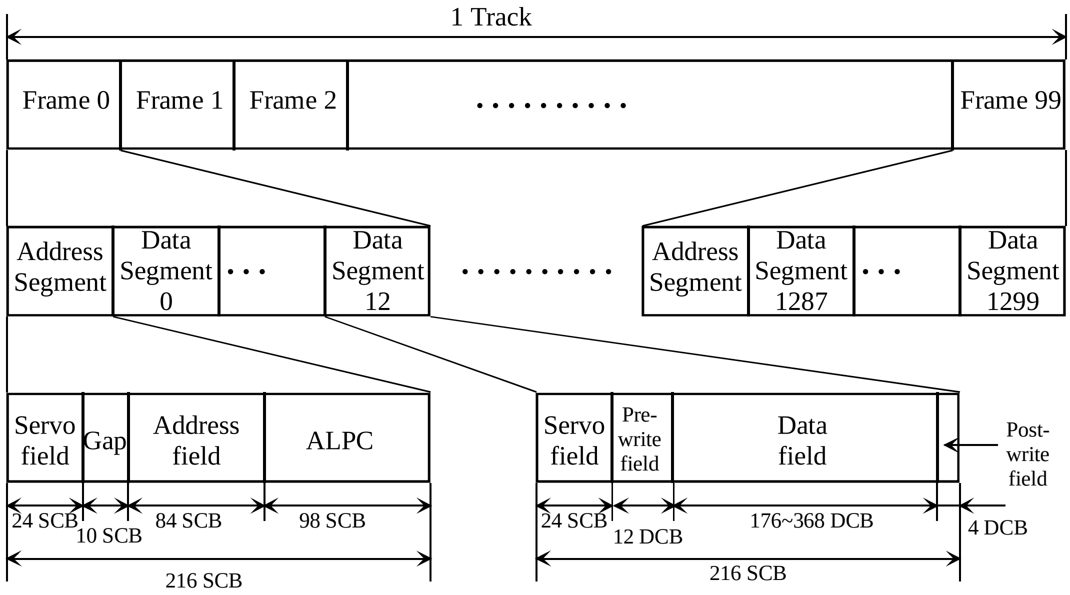


Figure 15 - Track layout

14.3 Clock frequencies

14.3.1 Servo clock

The Servo clock shall be derived from the embossed Wobble Marks in the Servo field of each segment. It is used for producing sampling pulses of focusing, tracking and detecting address codes.

The nominal Servo Clock frequency at the rotation speed of the disk as specified in 9.5 shall be 12,096 MHz.

The Servo clock frequency shall be constant within the whole Information Zone irrespective of the radial position.

The length of one period of the servo clock is called a Servo Channel bit.

14.3.2 Data clock

The Data clock shall be derived from the Servo clock. The nominal Data clock frequency shall be *Q*/24 times the Servo clock frequency, where the clock ratio *Q* is specified in table 2 for each Zone and each Band. This variation of the Data clock frequency will make the recording density along the track to be almost the same for all Zones and Bands.

The length of one period of the data clock is called a Data Channel bit.

14.4 Frame number

The frames of a track shall be numbered consecutively from 0 to 99.

Table 2 -Nominal Data clock frequencies when the disk rotates at 40 Hz

Zone	Clock ratio *Q*	Data clock frequency *f* (MHz)
Lead-in Zone		
- Outer Control Zone		
. GEP zone	--	--
. Transition Zone	48	24,192
. SFP zone	48	24,192
. Buffer Zone	48	24,192
- Outer Test Zone		
. for drives	48	24,192
. for manufacturers	48	24,192
Data Zone		
Band 0	48	24,192
Band 1	47	23,688
Band 2	46	23,184
Band 3	45	22,680
Band 4	43	21,672
Band 5	42	21,168
Band 6	40	20,160
Band 7	39	19,656
Band 8	37	18,648
Band 9	35	17,640
Band 10	34	17,136
Band 11	32	16,128
Band 12	30	15,120
Band 13	28	14,112
Band 14	25	12,600
Band 15	24	12,096
Lead-out Zone		
- Inner Test Zone		
. for manufacturers	24	12,096
. for drives	24	12,096
- Inner Control Zone		
. Buffer Zone	24	12,096
. SFP Zone	24	12,096
. Transition Zone	24	12,096
. GEP Zone	--	--

15 Segment format

There are two types of segments, Address Segments and Data Segments. One Address Segment and 13 Data Segments shall form a frame (see figure 15).

15.1 Layout of Address Segments

Each Address Segment shall comprise a Servo field, a Gap, and an Address field as well as an ALPC field for testing the write laser power level. The layout of the Address Segment shall be as specified in figure 16.

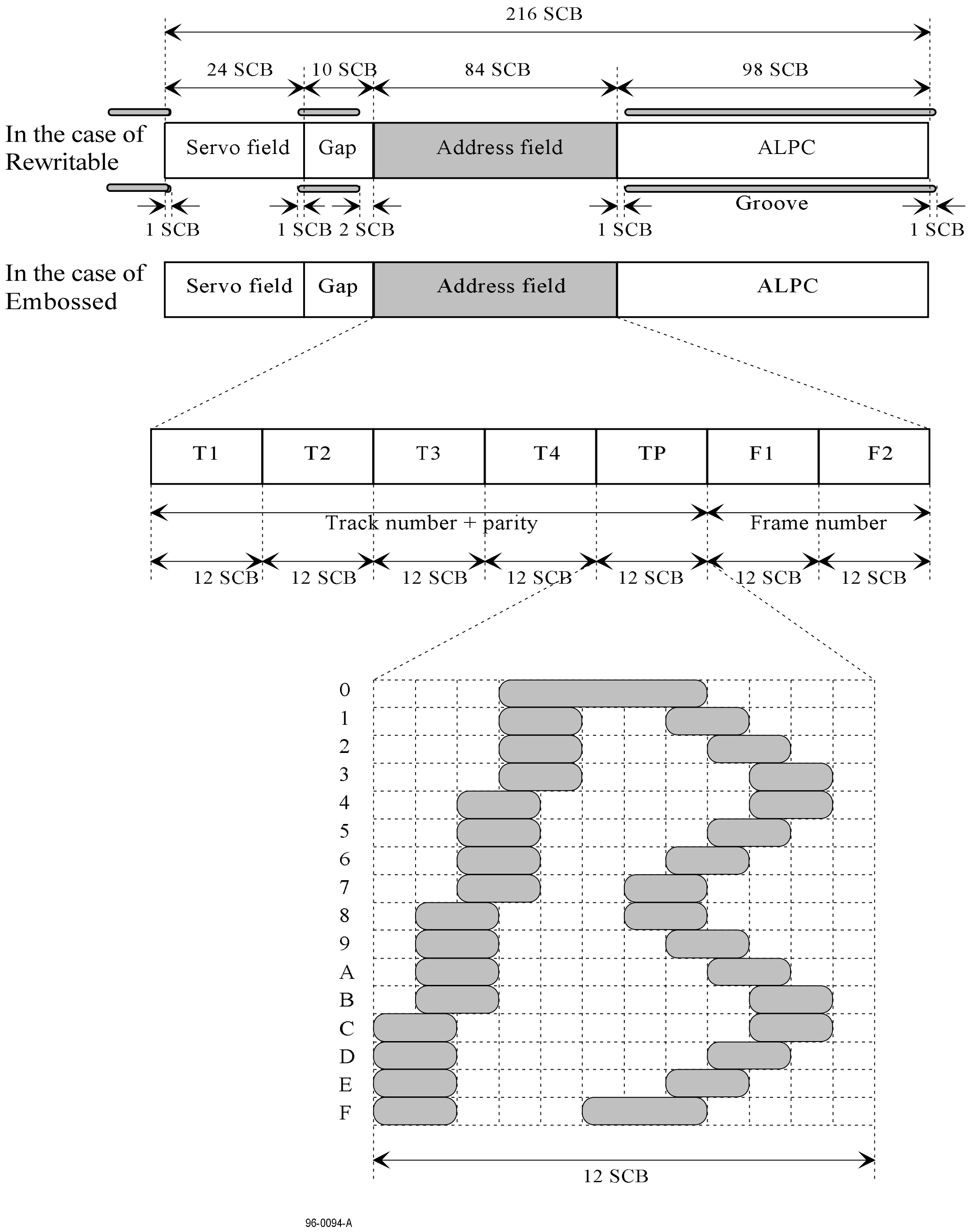


Figure 16 - Layout of the Address Segment

15.1.1 Servo field

The Servo field shall have a length of 24 Servo Channel bits, and contain a Segment Mark, two Wobble Marks, and a Focus sampling field. Pit patterns of these marks are shown in figure 18a.

In the case of the Rewritable Zone, grooves shall be placed in the first and the last Servo Channel bit position of the Servo field (see figure 16).

15.1.1.1 Segment Mark

The Segment Mark is an embossed mark which shall be located on the centre of the track and have a length of 2 Servo Channel bits. Its position along the track shall indicate the type of the segment, and in the case where it is a Data Segment, whether it is the first, the last or a middle segment of a sector. Annex W shows an example of the Segment Mark detection.

The meaning of the position of the Segment Mark expressed as Servo Channel bit positions of the centre of the mark and counted from the beginning of the Servo field shall be as follows.

Servo Channel bit position	Type of segment
3	Address segment
4	First Data segment of a sector
5	Last Data segment of a sector
6	Other Data segment

15.1.1.2 Wobble Marks

Wobble Marks are two marks which shall be positioned at 1/4 track pitch off the centre of the track. They are used for generating the servo clock and tracking error signal (see figures 18a and 18b).

The two Wobble Marks shall have a length of 2 Servo Channel bits each. Their centre shall be positioned at 11 Servo Channel bits and at 16 Servo Channel bits after the beginning of the Servo field, respectively.

The phase error signal of the servo clock shall be the difference between the phase of the Servo clock and the phase obtained from the centre of the optical beam when it passes over the centre of a Wobble Mark. Averaging the phase error from two Wobble Marks causes the gain of the error signal to be constant irrespective of the radial position of the optical beam.

The tracking error signal shall be the difference between the signal levels obtained from the centres of the two Wobble Marks.

15.1.1.3 Focus sampling field

The Focus sampling field shall extend from Servo Channel bit position 18 to Servo Channel bit position 23 and shall not be embossed.

This field is used for sampling the focus signal. Because the field is a mirror plane, the gain of focus error derived from the centre of the field is constant even during seek operations of a drive.

15.1.2 Gap

There shall be a Gap field with a length of 10 Servo Channel bits following the Servo field.

If the segment is in the Rewritable Zone, grooves shall be placed in the Gap field over a length of 8 Servo Channel bits from the beginning of the field. A length of 7 Servo Channel bits from the beginning of the field shall be written with the Channel bit pattern 0000000 to obtain a constant envelope of the Channel 2 signal with the level clamped (see annex E).

15.1.3 Address field

The Address field shall have a length of 84 Servo Channel bits. It shall contain the track number and the frame number (see figure 16).

All marks in the Address field shall be embossed using the servo clock. Therefore, the information is detected without converting servo clock signals into data clock signals, during seek operations of a drive.

The Address field shall be divided into seven units of 12 Servo Channel bits each. Each unit shall be converted into Gray code according to figure 16.

The first four units, T1 to T4, shall contain the track number, and the fifth unit, TP, parity information. If the least significant bit of a unit is set to ONE, then the next unit shall be expressed in ONE's complement notation and converted into a Gray code. Each bit of the TP shall be specified as an odd parity of the sum of corresponding bits of T1, T2, T3 and T4.

T1 : Track number bits 15 to 12

T2 : Track number bits 11 to 8

T3 : Track number bits 7 to 4

T4 : Track number bits 3 to 0

TP : Parity (n) = [{ T1(n) + T2(n) + T3(n) + T4(n) + 1 } mod 2] n = 0, 1, 2, 3

The last two units, F1 and F2, shall contain the frame number. If the least significant bit of F1 is set to ONE, F2 shall be expressed as ONE’s complement.

F1 : Frame number bits 7 to 4

F2 : Frame number bits 3 to 0

15.1.4 ALPC

The ALPC shall have a length of 98 Servo Channel bits, and be used for testing the write power level of the optical beam. The contents of this field is not defined by this ECMA Standard. In the case where the segment is in the Rewritable Zone, grooves shall be placed along the extent of the field, except for the first Servo Channel bit position. Otherwise there shall be no grooves.

15.2 Layout of Data Segments

Each Data Segment shall consist of a Servo field, a Pre-write field, a Data field and a Post-write field. The layout of the Data Segments shall be as specified in figure 17.

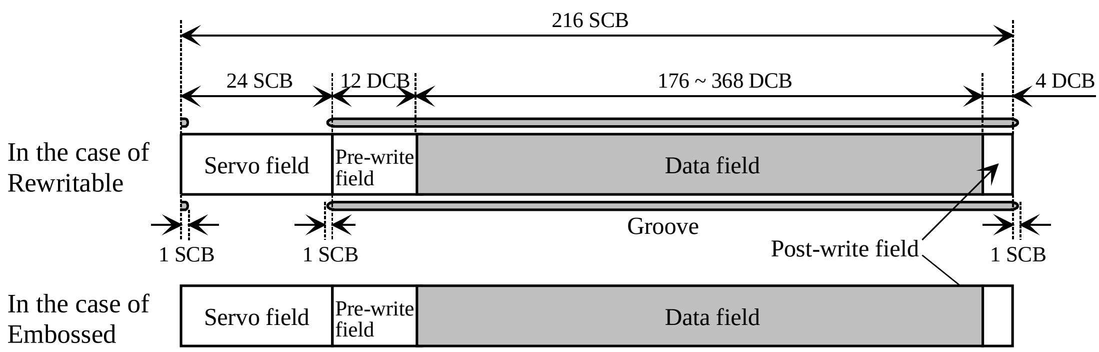


Figure 17 - Layout of the Data Segment

15.2.1 Servo field

The characteristics of the Servo field of a Data Segment shall be as specified for the Servo field of an Address Segment in 15.1.1. Pit patterns of these marks are shown in figure 18b.

In the case where the segment is in the Rewritable Zone, grooves shall be placed in the first and the last Servo Channel bit position of the Servo field.

15.2.2 Pre-write field

The Pre-write field shall comprise 12 Data Channel bits set to 0000 0000 0000. It is used to clamp the Channel 2 signal.

In the case where the segment is in the Rewritable Zone, grooves shall be placed along the extent of the field. If embossed, there shall be no grooves.

15.2.3 Data field

The Data field shall have a length of 176 to 368 Data Channel bits. It may contain user-written data and/or embossed data. Data shall be written in this field using the data clock frequency specified in table 2 for each Data Zone: the number of Data Channel bits is $\frac{f}{63} - 16$.

In the case where the segment is in the Rewritable Zone, grooves shall be placed along the extent of the field. If the segments are embossed, there shall be no grooves.

15.2.4 Post-write field

The Post-write field shall comprise the last 4 Data Channel bits of the Data field, before the beginning of the Servo field of the next segment. Its purpose is to isolate interference from the residual signals which could remain after overwriting. It shall be written with the Channel bit pattern 0000.

In the case where the segment is in the Rewritable Zone, grooves shall be placed along the extent of the field. If embossed, there are no grooves.

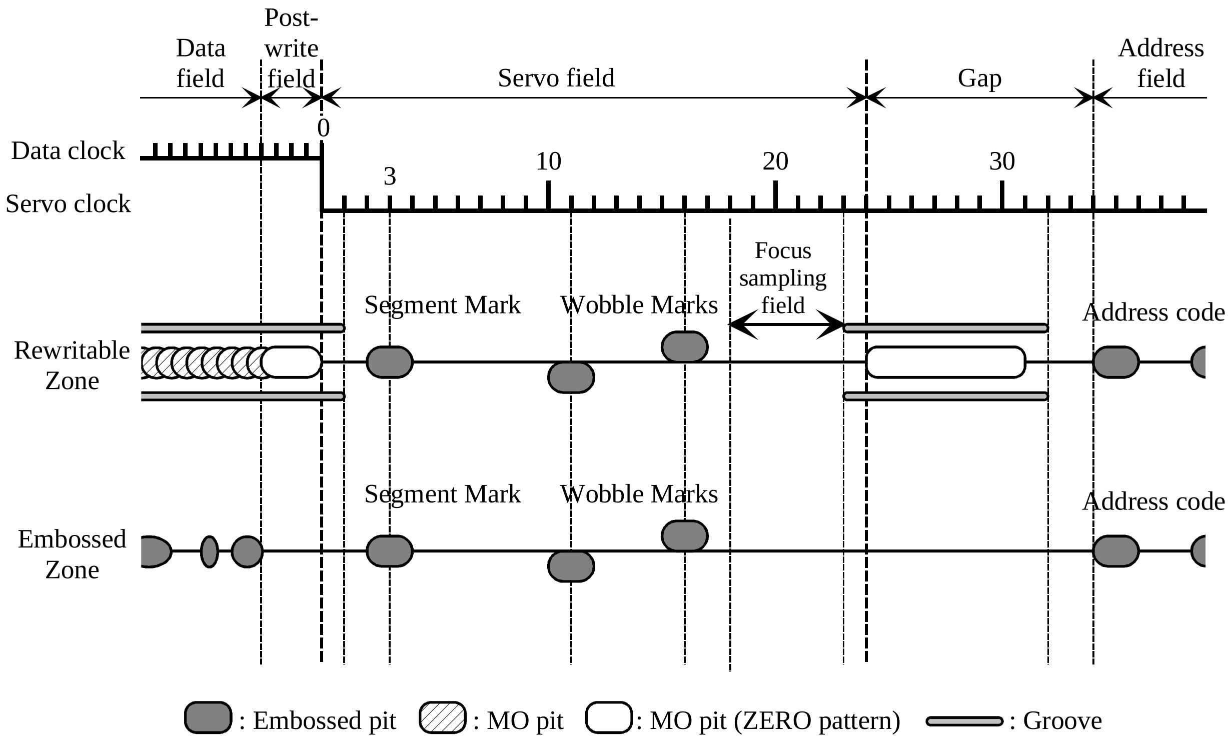


Figure 18a - Pit pattern of the marks in the Address Segments

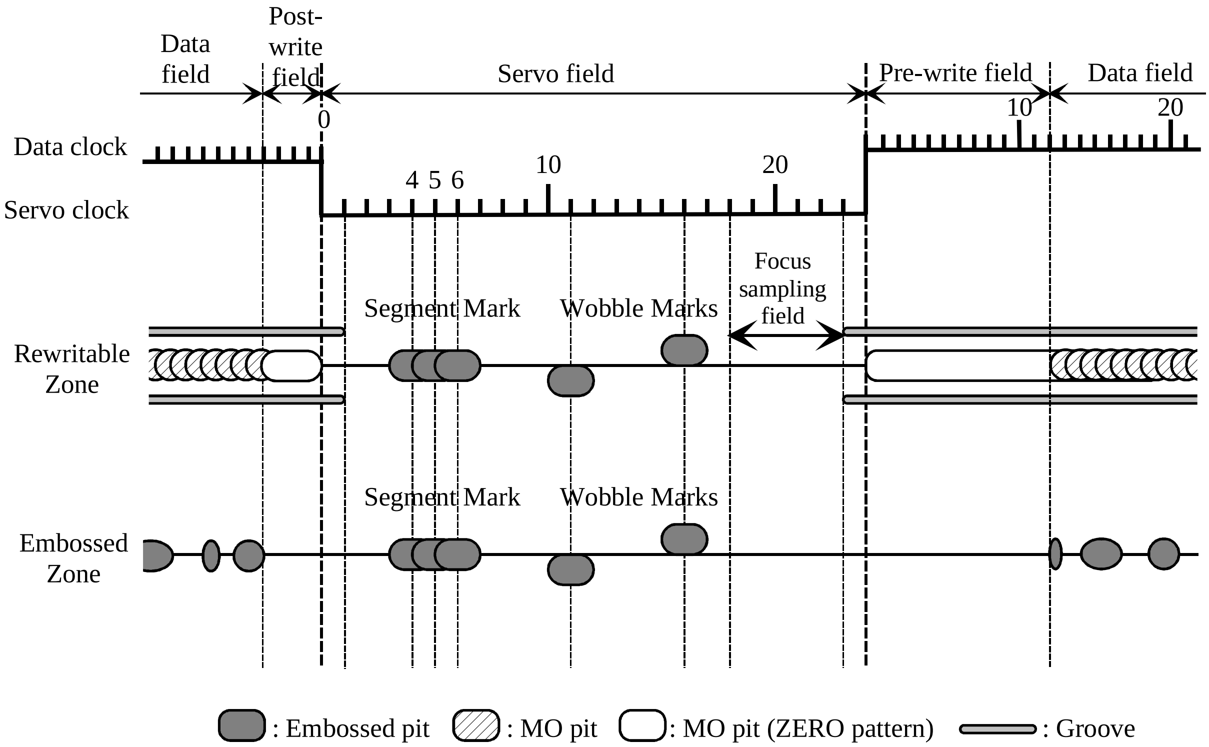


Figure 18b - Pit pattern of the marks in the Data Segments

15.3 Position accuracy of data pits

The maximum allowable displacement of recorded data marks or embossed data marks, relative to their intended position as determined in figures 18a and 18b shall be ± 0,3 Data Channel bits.

16 Sector format

16.1 Sector layout

A Sector shall comprise 53 to 110 data segments, excluding Address Segments, depending on which zone the sector belongs to (see annex D). The capacity of a segment expressed in bytes is also specified in annex D.

A sector shall start at the beginning of the data field in Data Segments. Each sector shall have a total length of 2 418 bytes and shall comprise several fields as shown in figure 19.

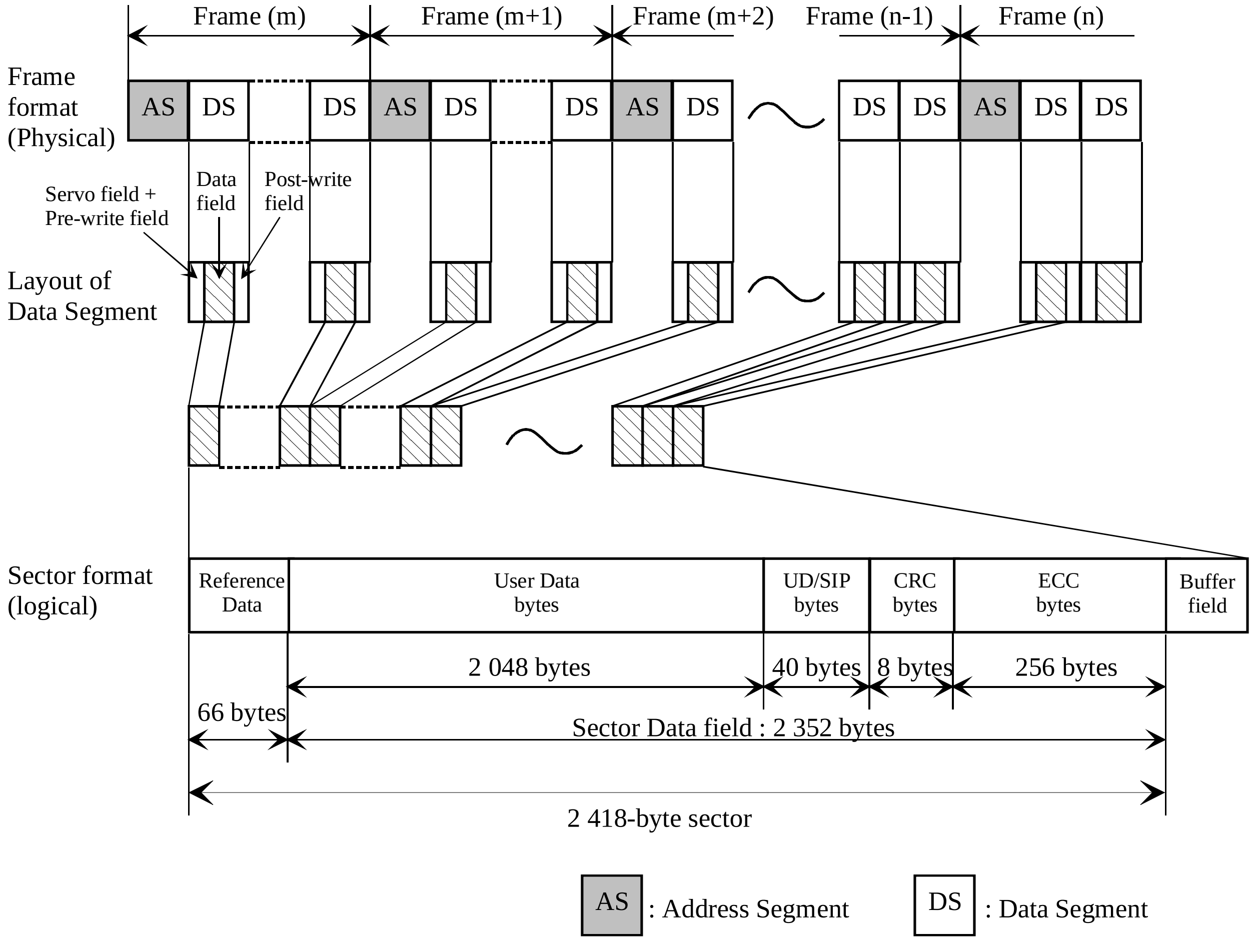


Figure 19 - Sector format

16.2 Reference data

The Reference data at the beginning of each sector shall comprise 4 blocks of 16 bytes followed by 2 bytes, both set to ZERO. Each block shall be divided into 12 bytes of written 2T repeated data (11001100...) used for phase compensation of the read data clock, and 4 bytes of 8T repeated data (1111111100000000...) used for detecting the threshold of data detection. See figure 20.

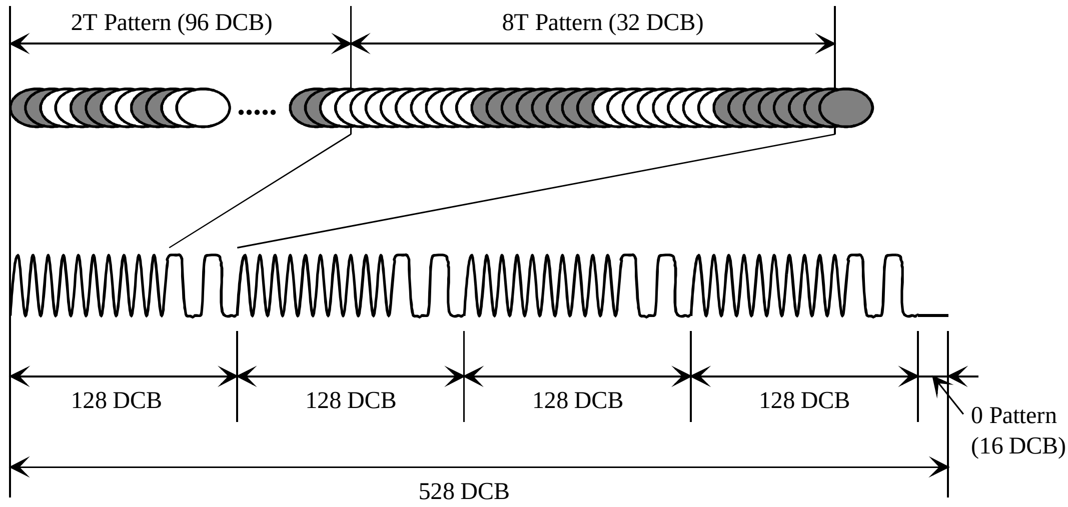


Figure 20 - Reference data

16.3 Sector Data field

The Sector Data field is intended for recording User data. It shall have a length of 2 352 bytes and shall comprise

- 2 048 bytes of user data
- 40 bytes of UD/SIP
- 8 bytes of CRC, and
- 256 bytes of ECC

The disposition of these bytes in the Sector Data field with their 16-way interleave and contents of the last three categories is specified in annex C.

16.3.1 User Data bytes

The user data bytes are for recording user data.

16.3.2 UD/SIP bytes

The 40 bytes defined as Sector Interleave Parity (SIP) are used for error detection and correction of erroneous data of Embossed Zones. The bytes shall be as specified annex C. In the Rewritable Zone these are called User Defined bytes. The contents of User-Defined bytes are not specified by this ECMA Standard and shall be ignored in interchange.

16.3.3 CRC and ECC bytes

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

16.4 Buffer field

The remaining field after the ECC bytes is called the Buffer field and shall be set to all ZEROs.

16.5 Sector number

Each sector shall be identified by a sector number. The sectors shall be numbered consecutively starting with 0.

Sector 0 shall be the first sector of track 0.

Sectors of optical disks according to this ECMA Standard do not have a sector ID field. Thus, the sector number shall be calculated from the track number and the segment number according to annex M.

17 Recording code

The bit sequence of 2 352 bytes data in the Sector Data field shall be scrambled, and then recorded in NRZI code. The scrambling circuit, shown in the annex N, is only for the Sector Data field and not for either the Reference data or the Address field. The data sequence is recorded in LSB first.

It is assumed that the initial value of the NRZI code is ZERO in every segment.

18 Format of the Information Zone

18.1 General description of the Information Zone

The Information Zone contains 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 Sector Data field of a sector, which, in general, is transferred to or from the host. This clause defines the layout of the information; the characteristics of the signals obtained from this information are specified in section 4.

18.2 Division of the Information Zone

The Information Zone is divided into three parts: a Lead-in Zone, a Data Zone and a Lead-out Zone. The Data Zone is intended for recording of user data. The Lead-in and Lead-out Zones contain control information for the drive and zones for performing tests by the manufacturer or drive.

The division of the Information Zone shall be as given in table 3. The dimensions given in table 3 are for reference only, and are nominal locations. The tolerance on the location of track 0 is specified in 14.1. The tolerances on the other radii is determined by the tolerance on the track pitch as specified 13.3.

Table 3 - Layout of the Information Zone

Zone or Band	Nominal Radius Start-End (mm)	Number of Tracks	Track Number Start-End
Lead-in Zone			
- Outer Control Zone			
. GEP Zone	42,00 to 41,22	652	-666 to -15
. Transition Zone	41,22 to 41,21	2	-14 to -13
. SFP Zone	41,21 to 41,21	5	-12 to -8
. Buffer Zone	41,21 to 41,21	2	-7 to -6
- Outer Test Zone			
. for drives	41,21 to 41,20	3	-5 to -3
. for manufacturers	41,20 to 41,20	2	-2 to -1
Data Zone			
Band 0	41,20 to 40,18	848	0 to 847
Band 1	40,18 to 39,15	864	848 to 1 711
Band 2	39,15 to 38,09	880	1 712 to 2 591
Band 3	38,09 to 37,00	912	2 592 to 3 503
Band 4	37,00 to 35,86	944	3 504 to 4 447
Band 5	35,86 to 34,69	976	4 448 to 5 423
Band 6	34,69 to 33,46	1 024	5 424 to 6 447
Band 7	33,46 to 32,20	1 056	6 448 to 7 503
Band 8	32,20 to 30,85	1 120	7 504 to 8 623
Band 9	30,85 to 29,43	1 184	8 624 to 9 807
Band 10	29,43 to 27,97	1 216	9 808 to 11 023
Band 11	27,97 to 26,42	1 296	11 024 to 12 319
Band 12	26,42 to 24,75	1 392	12 320 to 13 711
Band 13	24,75 to 22,96	1 488	13 712 to 15 199
Band 14	22,96 to 20,92	1 696	15 200 to 16 895
Band 15	20,92 to 20,00	770	16 896 to 17 665
Lead-out Zone			
- Inner Test Zone			
. for manufacturers	20,00 to 20,00	2	17 666 to 17 667
. for drives	20,00 to 19,99	3	17 668 to 17 670
- Inner Control Zone			
. Buffer Zone	19,99 to 19,99	2	17 671 to 17 672
. SFP Zone	19,99 to 19,99	5	17 673 to 17 677
. Transition Zone	19,99 to 19,98	2	17 678 to 17 679
. GEP Zone	19,98 to 19,00	820	17 680 to 18 499

NOTE

The radii of a zone given in the table refer to the nominal positions of the centres of the first and the last tracks of the zone.

18.3 Control Zones

There shall be an Outer Control Zone and an Inner Control Zone. They shall contain embossed control information for the drive.

Each Control Zone shall comprise a GEP Zone, a SFP Zone, a Buffer Zone and a Transition Zone. The control information shall be recorded in the GEP Zones and the SFP Zones. The methods of recording are different for these two zones.

18.3.1 GEP Zone

The information contained in the GEP Zone gives a general characterization of the disk. It specifies the type of disk, the ECC, the tracking method, etc.

The GEP Zone in the Outer Control Zone and the GEP Zone in the Inner Control Zone shall contain identical sets of information. All information shall be pre-recorded using Gray code modulation.

The marks in all tracks of this zone shall be radially aligned, so as to allow information recovery from this zone without radial tracking being established by the drive.

18.3.1.1 Track layout in the GEP Zone

In the GEP Zone, each frame consists of the Address Segment followed by 13 segments. The seventh segment following the Address Segment is called the GEP Segment and shall be recorded as defined in 18.3.1.2. The remaining segments shall contain all ZEROs 10 GEP segments recorded on consecutive frames shall contain a single set of control information. Thus, each track shall contain 10 GEP segments identified by a page number (PN) 0 to 9 with identical control information.

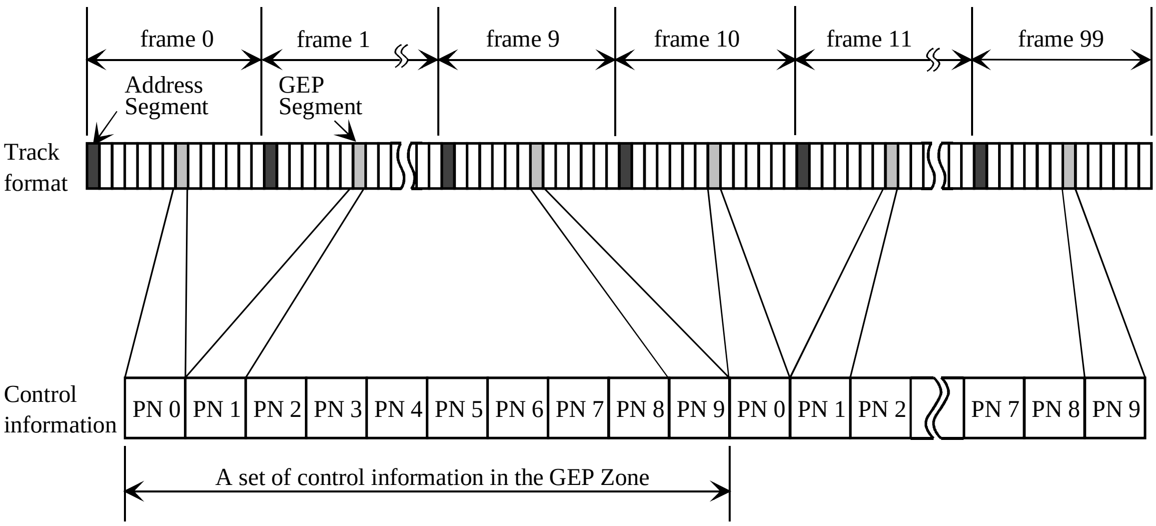


Figure 21 - Track layout in the GEP Zone

18.3.1.2 Layout of GEP Segments

Each GEP Segment shall comprise a Servo field, a Gap, a GEP field and an ALPC field. The layout of the GEP Segment shall be as specified in figure 22. The characteristics of the Servo field, the Gap and the ALPC field shall be the same as specified for an Address Segment in 15.1.

The GEP field shall be divided into seven units with 12 Servo Channel bits each. Each unit shall be recorded with the same modulation method used for an Address field as specified in 15.1.3 and figure 16. The first four units (G1, G2, G3 and G4) shall contain 16 bits of control information, and the fifth unit parity information (GP) of the first four units. The calculation method of GP shall be same as TP in an Address field specified in 15.1.3.

G1	: Control information	bits 15 to 12
G2	: Control information	bits 11 to 8
G3	: Control information	bits 7 to 4

G4 : Control information bits 3 to 0
GP : Parity(n) = [{ G1(n) + G2(n) + G3(n) + G4(n) + 1 } mod 2] n = 0, 1, 2, 3

The last two units shall contain the page number (P1 and P2).

P1 : Page number bits 7 to 4
P2 : Page number bits 3 to 0

The contents of the control information on each page and their meaning shall be as specified in annex D.

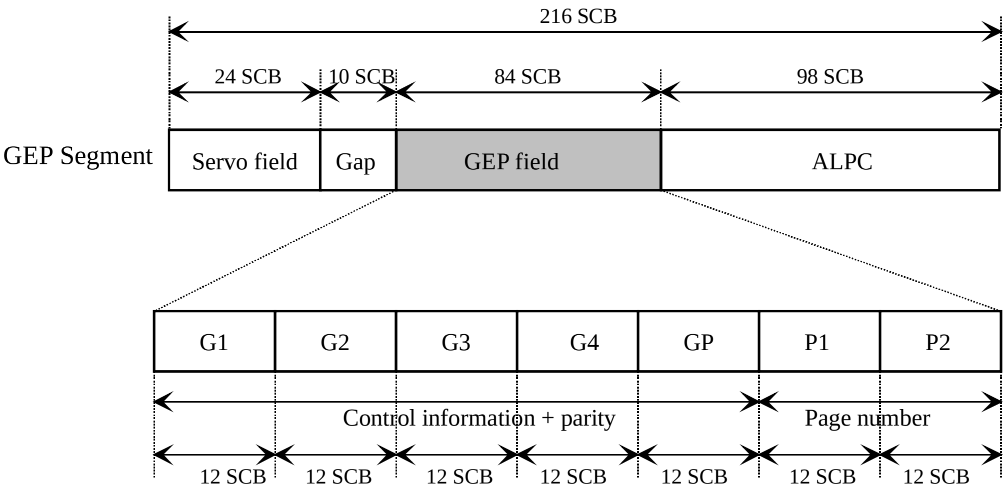


Figure 22 - Layout of the GEP Zone

18.3.2 SFP Zone

The SFP Zone of the Outer Control Zone shall consist of a band of tracks recorded with the same modulation method and format which is used in Zone 0 of the Data Zone, except for the number of segments per sector.

The SFP Zone of the Inner Control Zone shall consist of a band of tracks recorded with the same modulation method and format which is used in Zone 15 of the Data Zone, except for the number of segments per sector.

Each SFP Zone shall contain a duplicate of the information given in the GEP Zone, as well as additional disk and system information as specified in annex D.

18.3.3 Buffer Zone

Each Control Zone shall contain a Buffer Zone between the SFP Zone and the Test Zone.

It is used to protect and buffer the areas that contain information from accidental damage by tests performed in the Test Zone.

18.3.4 Transition Zone

Each Control Zone shall contain a Transition Zone between the GEP Zone and the SFP Zone.

It is an area in which the format changes between the GEP Zone and the SFP Zone.

18.4 Test Zone

There shall be an Outer Test Zone and an Inner Test Zone. Each Test Zone shall comprise 5 tracks.

The Test Zone for drives are intended for tests to check write and read operations, and shall not consist of embossed data in the case of fully rewritable or partially embossed disks.

The Test Zone for manufacturers is intended for quality test by the media manufacturer.

18.5 Data Zone

The Recording fields of the Data Zone may be user-written or contain embossed data in the format specified in clause 15. The layout of the Data Zone is specified in clause 19.

The Data Zone shall be divided into 16 bands numbered from 0 to 15. Each band shall consist of the number of tracks specified in table 3.

In addition, the Data Zone shall be partitioned into 1 or 16 groups as specified in 19.4.

The Data Zone shall start with track 0 and end with track 17 665.

19 Format of the Data Zone

In the case of fully rewritable disks, the Data Zone shall contain four Defect Management Areas (DMAs), two at the beginning of the zone and two at the end of the zone. The area between the two sets of the DMAs is called the User Area (see table 4).

In the case of partially embossed disks, there shall be one set of Buffer Sectors specified in 19.1 at the edge of the rewritable band adjoining the embossed band. The layout of a partially embossed disk shall be as one of the two layouts specified in table 5. In layout No. 1, an Embossed Zone shall be located first and a Rewritable Zone after it. The Buffer Sectors shall be located in the beginning of the first rewritable band, and are called the Pre-buffer Sectors. In layout No. 2, a Rewritable Zone shall be located first and an Embossed Zone after it. The Buffer Sectors shall be located at the end of the last rewritable band, and are called the Post-buffer Sectors. The Data Zone shall also contain four DMAs, two at the beginning of the first writable band excluding Buffer Sectors and two at the end of the last writable band excluding Buffer Sectors. The areas excluding Buffer Sectors and DMAs in the Data Zone are called User Areas.

In the case of fully embossed disks, the Data Zone shall not contain any DMAs. The Data Zone is also called the User Area (see table 4).

The layout of the Data Zone and adjacent zones is shown in tables 4 and 5, where the tracks marked R/W are rewritable.

Table 4 - Layouts of the Data Zone and Test Zones for Type R/W and O-ROM disks

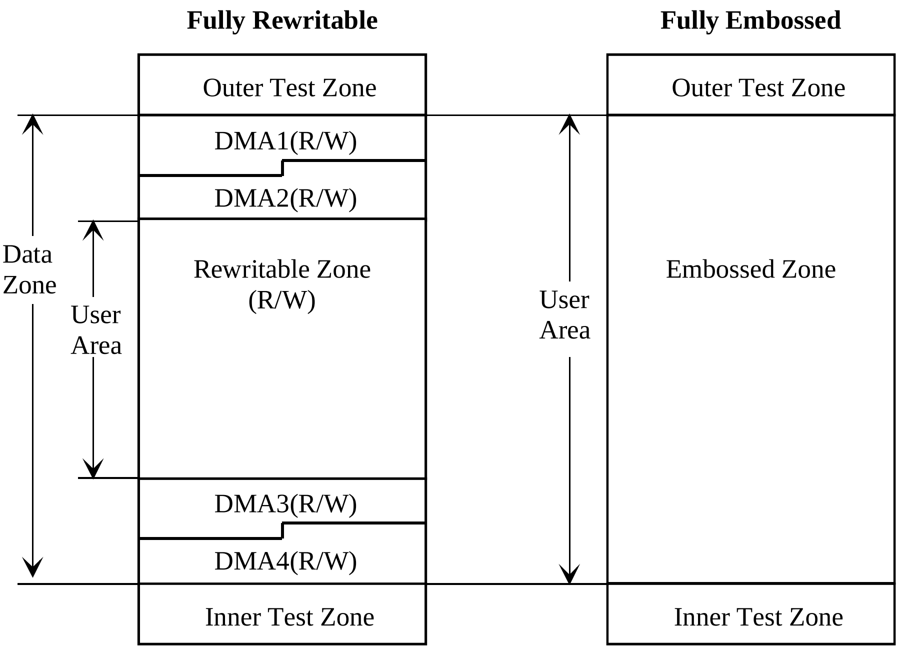
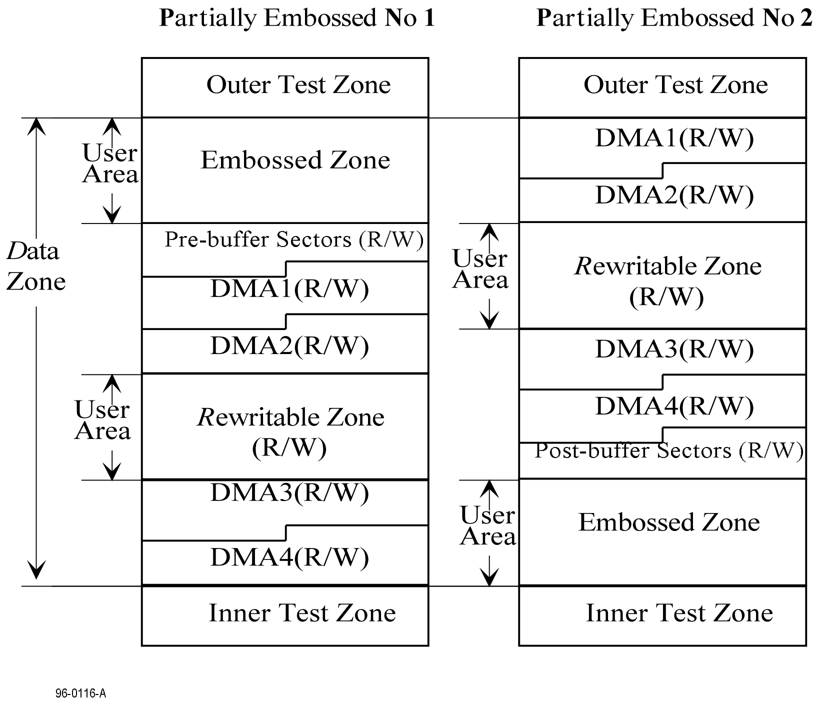


Table 5 - Layouts of the Data Zone and Test Zones for Type P-ROM disks



19.1 Buffer Sectors in the Data Zone of partially Embossed disks

The Buffer Sectors are areas in which the format changes between the rewritable tracks with grooves and the embossed tracks with no grooves. The Buffer Sectors are part of the rewritable band, however, grooves shall not be placed on the side which is adjacent to the embossed tracks in order to protect the signal from the embossed tracks against the effects from the grooves of the rewritable tracks. The Buffer Sectors shall not be used for the user data.

The numbers of the Buffer Sectors in each band are specified by the manufacturer and recorded in the SFP Zones (see annex D).

19.2 Defect Management Areas (DMAs)

The four Defect Management Areas contain information on the structure of the Data Zone and on defect management. The length of each DMA shall be 16 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 specified by the manufacturer and recorded in bytes 35 to 46 of the SFP Zones (see annex D). Table 6 indicates the boundaries of the DMAs in case of fully rewritable disks as one of the examples.

Table 6 - Locations of the DMAs (Fully Rewritable)

	Beginning Sector number	Ending Sector number	Number of sectors
DMA1	0	15	16
DMA2	16	31	16
DMA3	321 068	321 083	16
DMA4	321 084	321 099	16

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

The content of the DMA sectors following the SDL is not specified for fully rewritable and partially embossed disks and shall be ignored in interchange.

The contents of the DDS are specified in 19.3; those of the PDL and SDL are specified in 20.1.5 and 20.1.6.

19.3 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 rewritable, Partially Embossed Zones into groups, the kind of the 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..

For partially embossed disks, values for some of the DDS parameters are specified by the manufacturer and recorded in bytes 35 to 46 of the SFP Zones (see annex D).

The information given in table 7 on the disk structure shall be recorded in each of the four DDSs. There is no DDS area on fully embossed disks.

Table 7 - Byte assignment of the Disk Definition Structure (DDS)

Byte No.	Description	Fully Rewritable	Partially Embossed
0	DDS Identifier	(0A)	(0A)
1	DDS Identifier	(0A)	(0A)
2	Reserved	(00)	(00)
3	Disk has been certified	(01)	(01)
	Disk has not been certified	(02)	(02)
4	Number of groups MSB	(00)	(00)
5	Number of groups LSB (1 or 16)	(01|10)	(10)
6	Band 0 Type	(01)	(01/02)
7	Band 1 Type	(01)	(01/02)
8	Band 2 Type	(01)	(01/02)
9	Band 3 Type	(01)	(01/02)
10	Band 4 Type	(01)	(01/02)
11	Band 5 Type	(01)	(01/02)
12	Band 6 Type	(01)	(01/02)
13	Band 7 Type	(01)	(01/02)
14	Band 8 Type	(01)	(01/02)
15	Band 9 Type)	(01)	(01/02)
16	Band 10 Type	(01)	(01/02)
17	Band 11 Type	(01)	(01/02)
18	Band 12 Type	(01)	(01/02)
19	Band 13 Type	(01)	(01/02)
20	Band 14 Type	(01)	(01/02)
21	Band 15 Type	(01)	(01/02)
22	Start sector number of PDL, MSB	-	-
23	Start sector number of PDL	-	-
24	Start sector number of PDL	-	-
25	Start sector number of PDL, LSB	-	-
26	Start sector number of SDL, MSB	-	-
27	Start sector number of SDL	-	-
28	Start sector number of SDL	-	-
29	Start sector number of SDL, LSB	-	-
30 to 2 047		(00)	(00)

In the above table

– the symbol “**-**” means that the appropriate value is to be entered in the DSS;

– for bytes 6 to 21, the setting (01) means rewritable and (02) embossed;

– 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 16 groups are employed;

– an entry in the form "(**aa**/**bb**)" indicates:

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

19.3.1 Fully Rewritable Disks

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

The Rewritable Zone shall extend from sector 32 to sector 321 067. Every band of fully rewritable disks shall be recorded in bytes 6 to 21 of the DDS as being rewritable.

19.3.2 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 Sector Data field of all sectors in this zone shall be as specified in annex C.

The Embossed Zone shall extend from sector 0 to sector 321 099. Every band of fully embossed disks shall be recorded in bytes 76 to 91 of the SFP Zone as being embossed (see annex D).

19.3.3 Partially Embossed Disks

The user area of partially embossed disks shall have a Rewritable Zone and an Embossed Zone. The Rewritable Zone and the Embossed Zone shall extend from sector 0 to sector 321 099. Each band of partially embossed disks shall be recorded in byte 6 to 21 of the DDS as being either rewritable or embossed.

19.4 Partitioning

19.4.1 Fully Rewritable Disks

During initialization of the disk, the Rewritable Zone shall be partitioned into 1 or 16 consecutive groups. If one group is used, it shall span the entire User Area; if 16 groups are used, each group shall span one complete band. Each group shall comprise a number of data sectors followed by spare sectors. The number of spare sectors per group is shown in tables 8 and 9.

19.4.2 Partially Embossed Disks

During preparation of the embossed data for manufacturing of the disk, the disk shall be partitioned into 16 groups. Partially embossed disks shall have one to fifteen rewritable band(s). The remaining band(s) shall be embossed. Each group in the Rewritable Zone shall comprise a number of data sectors followed by spare sectors and span one complete band. Each group in the Embossed Zone shall comprise data sectors. The number of spare sectors for each band is given in table 11 as one of the examples.

19.4.3 Fully Embossed Disks

During preparation of the embossed data for manufacturing of the disk, the disk shall be partitioned into 1 group. Fully embossed disks shall span the entire User Area. The group shall comprise a number of data sectors. The number of data sectors is shown in table 10.

Table 8 - Usage of Tracks 1 (Type R/W grouping = 1)

Band No.	Start Track	Pre-buffer Sectors	DMA1&2 Sectors	Data Sectors	Number of Data Sectors	Spare Sectors	Number of Spare Sectors	DMA3&4 Sectors	Post-buffer Sectors	End Track
0	0	-	0 to 31	32 to 20 799	20 768	-	0	-	-	847
1	8	-4	-8	20 800 to 41 599	20 800	-	0	-	-	1 711
2	1 712	-	-	41 600 to 62 399	20 800	-	0	-	-	2 591
3	2 592	-	-	62 400 to 83 199	20 800	-	0	-	-	3 503
4	3 504	-	-	83 200 to 103 999	20 800	-	0	-	-	4 447
5	4 448	-	-	104 000 to 124 799	20 800	-	0	-	-	5 423
6	5 424	-	-	124 800 to 145 599	20 800	-	0	-	-	6 447
7	6 448	-	-	145 600 to 166 399	20 800	-	0	-	-	7 503
8	7 504	-	-	166 400 to 187 199	20 800	-	0	-	-	8 623
9	8 624	-	-	187 200 to 207 999	20 800	-	0	-	-	9 807
10	9 808	-	-	208 000 to 228 799	20 800	-	0	-	-	11 023
11	11 024	-	-	228 800 to 249 599	20 800	-	0	-	-	12 319
12	12 320	-	-	249 600 to 270 399	20 800	-	0	-	-	13 711
13	13 712	-	-	270 400 to 291 199	20 800	-	0	-	-	15 199
14	15 200	-	-	291 200 to 311 999	20 800	-	0	-	-	16 895
15	16 896	-	-	312 000 to 319 019	7 020	319 020 to 321 067	2 048	321 068 to 321 099	-	17 665
Total					318 988		2 048			

Table 9 - Usage of Tracks 2 (Type R/W grouping = 16)

Band No.	Start Track	Pre buffer Sectors	DMA1&2 Sectors	Data Sectors	Number of Data Sectors	Spare Sectors	Number of Spare Sectors	DMA3&4 Sectors	Post-buffer Sectors	End Track
0	0	-	0 to 31	32 to 20 671	20 640	20 672 to 207 99	128	-	-	847
1	848	-	-	20 800 to 41 471	20 672	41 472 to 415 99	128	-	-	1 711
2	1 712	-	-	41 600 to 62 271	20 672	62 272 to 62 399	128	-	-	2 591
3	2 592	-	-	62 400 to 83 071	20 672	83 072 to 83 199	128	-	-	3 503
4	3 504	-	-	83 200 to 103 871	20 672	103 872 to 103 999	128	-	-	4 447
5	4 448	-	-	104 000 to 124 671	20 672	124 672 to 124 799	128	-	-	5 423
6	5 424	-	-	124 800 to 145 471	20 672	145 472 to 145 599	128	-	-	6 447
7	6 448	-	-	145 600 to 166 271	20 672	166 272 to 166 399	128	-	-	7 503
8	7 504	-	-	166 400 to 187 071	20 672	187 072 to 187 199	128	-	-	8 623
9	8 624	-	-	187 200 to 207 871	20 672	207 872 to 207 999	128	-	-	9 807
10	9 808	-	-	208 000 to 228 671	20 672	228 672 to 228 799	128	-	-	11 023
11	11 024	-	-	228 800 to 249 471	20 672	249 472 to 249 599	128	-	-	12 319
12	12 320	-	-	249 600 to 270 271	20 672	270 272 to 270 399	128	-	-	13 711
13	13 712	-	-	270 400 to 291 071	20 672	291 072 to 291 199	128	-	-	15 199
14	15 200	-	-	291 200 to 311 871	20 672	311 872 to 311 999	128	-	-	16 895
15	16 896	-	-	312 000 to 320 939	8 940	320 940 to 321 067	128	321 068 to 321 099	-	17 665
Total					318 988		2 048			

Table 10 - Usage of Tracks 3 (Type O-ROM grouping = 1)

Band No.	Start Track	Pre buffer Sectors	DMA1&2 Sectors	Data Sectors	Number of Data Sectors	Spare Sectors	Number of Spare Sectors	DMA3&4 Sectors	Post-buffer Sectors	End Track
0	0	-	-	0 to 20 799	20 800	-	-	-	-	847
1	848	-	-	20 800 to 41 599	20 800	-	-	-	-	1 711
2	1 712	-	-	41 600 to 62 399	20 800	-	-	-	-	2 591
3	2 592	-	-	62 400 to 83 199	20 800	-	-	-	-	3 503
4	3 504	-	-	83 200 to 103 999	20 800	-	-	-	-	4 447
5	4 448	-	-	104 000 to 124 799	20 800	-	-	-	-	5 423
6	5 424	-	-	124 800 to 145 599	20 800	-	-	-	-	6 447
7	6 448	-	-	145 600 to 166 399	20 800	-	-	-	-	7 503
8	7 504	-	-	166 400 to 187 199	20 800	-	-	-	-	8 623
9	8 624	-	-	187 200 to 207 999	20 800	-	-	-	-	9 807
10	9 808	-	-	208 000 to 228 799	20 800	-	-	-	-	11 023
11	11 024	-	-	228 800 to 249 599	20 800	-	-	-	-	12 319
12	12 320	-	-	249 600 to 270 399	20 800	-	-	-	-	13 711
13	13 712	-	-	270 400 to 291 199	20 800	-	-	-	-	15 199
14	15 200	-	-	291 200 to 311 999	20 800	-	-	-	-	16 895
15	16 896	-	-	312 000 to 321 099	9 100	-	-	-	-	17 665
Total					321 100					

Table 11 - Usage of Tracks 4 (Type P-ROM grouping = 16)

(In case of Band 0 ~ 4 : Rewritable / Band 5 ~ 15 : embossed)

Band No.	Start Track	Pre buffer Sectors	DMA1&2 Sectors	Data Sectors	Number of Data Sectors	Spare Sectors	Number of Spare Sectors	DMA3&4 Sectors	Post-buffer Sectors	End Track
0	0	-	0 to 31	32 to 20 671	20 640	20 672 to 20 799	128	-	-	847
1	848	-	-	20 800 to 41 471	20 672	41 472 to 41 599	128	-	-	1 711
2	1 712	-	-	41 600 to 62 271	20 672	62 272 to 62 399	128	-	-	2 591
3	2 592	-	-	62 400 to 83 071	20 672	83 072 to 83 199	128	-	-	3 503
4	3 504	-	-	83 200 to 103 775	20 576	103 776 to 103 903	128	103 904 to 103 935	64	4 447
5	4 448	-	-	104 000 to 124 799	20 800	-	-	-	-	5 423
6	5 424	-	-	124 800 to 145 599	20 800	-	-	-	-	6 447
7	6 448	-	-	145 600 to 166 399	20 800	-	-	-	-	7 503
8	7 504	-	-	166 400 to 187 199	20 800	-	-	-	-	8 623
9	8 624	-	-	187 200 to 207 999	20 800	-	-	-	-	9 807
10	9 808	-	-	208 000 to 228 799	20 800	-	-	-	-	11 023
11	11 024	-	-	228 800 to 249 599	20 800	-	-	-	-	12 319
12	12 320	-	-	249 600 to 270 399	20 800	-	-	-	-	13 711
13	13 712	-	-	270 400 to 291 199	20 800	-	-	-	-	15 199
14	15 200	-	-	291 200 to 311 999	20 800	-	-	-	-	16 895
15	16 896	-	-	312 000 to 321 099	9 100	-	-	-	-	17 665
Total					320 332		640		64	

20 Defect Management

20.1 Rewritable groups: Spare sectors

Defective sectors in the Rewritable Zone shall be replaced by good sectors according to the defect management method described below. The disk shall be initialized before use. This ECMA Standard allows initialization with or without certification. Defective sectors are handled by a Linear Replacement Algorithm and a Sector Slipping Algorithm. The Total number of defective sectors replaced by both algorithms shall not be greater than 2 049. If 16 groups are used, the 128 spare sectors are distributed to each rewritable group as shown in tables 9 and 11. The spare sectors are not distributed to embossed groups as shown in tables 10 and 11.

20.1.1 Initialization of the Disk

During initialization of the disk, the four DMAs are recorded prior to the first use of the disk. The Rewritable Zone shall be partitioned into 1 or 16 groups if the disk is fully rewritable. If the disk is partially embossed, the number of groups shall be 16. Each rewritable group shall contain a number of data sectors followed by spare sectors. The spare sectors can be used as replacements for defective data sectors. Initialization can include a certification of the rewritable 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 12 and 13.

20.1.2 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 ECMA Standard. It may involve writing, and reading the sectors in the groups. Defective sectors found during certification shall be handled by the Slipping Algorithm or, where applicable, by the Linear Replacement Algorithm. Defective sectors shall not be used for reading or writing. Guidelines for replacing defective sectors are given in annex P.

20.1.2.1 Slipping Algorithm

The Slipping Algorithm shall be applied individually to each and every group in Rewritable Zone in the case that 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 defective sector shall be handled by the Linear Replacement Algorithm. This process involves assigning a replacement sector from the spare sector area of another group and cannot be accomplished until the other group has been certified. This is due to the fact that the next available spare sector is not known until its group is certified, i.e. the Slipping Algorithm has been skipped.

20.1.2.2 Linear Replacement Algorithm

The Linear Replacement Algorithm is used to handle defective sectors found after certification. It is also used during certification in the event of the spare area of a group becoming exhausted.

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, the defective sector shall be replaced by the first good spare sector of another group. The addresses of the defective sector and of the replacement sector shall be recorded in the SDL.

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, it shall be dealt with by making a new entry in the SDL indicating a replacement sector for that defective sector.

20.1.3 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, the defective sector shall be replaced by the first good spare sector of another group. The addresses of the defective sector and of the replacement sector shall be recorded in the SDL.

If there exists a list of the defective sectors in the PDL, these sectors shall be skipped for use even if the disk are not certified.   This is the same as the process specified in 20.1.2.1 for the certified disks.

20.1.4 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.

20.1.5 Primary Defect List (PDL)

A PDL is established upon certification of the media. A PDL shall be recorded when the disk is certified. A PDL shall not be recorded when the disk is not certified.

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 12 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 2047 shall be set to (FF).

Table 12 - 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 (00), Byte 3 is the end of the PDL)
4	Address of the First Defective Sector (Sector number, MSB)
5	Address of the First Defective Sector (Sector number)
6	Address of the First Defective Sector (Sector number)
7	Address of the First Defective Sector (Sector number, LSB)
.	.
.	.
.	.
x-3	Address of the Last Defective Sector (Sector number, MSB)
x-2	Address of the Last Defective Sector (Sector number)
x-1	Address of the Last Defective Sector (Sector number)
x	Address of the Last Defective Sector (Sector number, LSB)

20.1.6 Secondary Defect List (SDL)

The Secondary Defect List (SDL) is created during initialization and used during and after certification. All Disks with a Rewritable 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 in the SDL.

If a replacement sector listed in the SDL is later found to be defective, an new entry shall be made in the SDL indicating a replacement sector for that defective sector.

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 3 in table 13 shall be present only in the first sector.

Table 13 - Content of the SDL

Byte	SDL Content
0	(00), SDL Identifier
1	(02), SDL Identifier
2	Number of Entries in the SDL, MSB
3	Number of Entries in the SDL, LSB (if bytes 2 and 3 are (00), Byte 3 is the end of the SDL) (each entry is 8 bytes long)
4	Address of the First Defective Sector (Sector number, MSB)
5	Address of the First Defective Sector (Sector number)
6	Address of the First Defective Sector (Sector number)
7	Address of the First Defective Sector (Sector number, LSB)
8	Address of the First Replacement Sector (Sector number, MSB)
9	Address of the First Replacement Sector (Sector number)
10	Address of the First Replacement Sector (Sector number)
11	Address of the First Replacement Sector (Sector number, LSB)
.	.
.	.
.	.
y-7	Address of the Last Defective Sector (Sector number, MSB)
y-6	Address of the Last Defective Sector (Sector number)
y-5	Address of the Last Defective Sector (Sector number)
y-4	Address of the Last Defective Sector (Sector number, LSB)
y-3	Address of the Last Replacement Sector (Sector number, MSB)
y-2	Address of the Last Replacement Sector (Sector number)
y-1	Address of the Last Replacement Sector (Sector number)
y	Address of the Last Replacement Sector (Sector number, LSB)

20.2 Embossed groups: Sector Interleave Parity

The Sector Interleave Parities included in the UD/SIP bytes of the embossed sectors provide an error correction system for the embossed data of the previous sector. The Sector Interleave Parity of the next sector allows the drive to correct the sector that cannot be corrected by ECC, thus it is possible to recover more than two defective sectors if the next sector of the last defective sector can be read.

The sector interleave parity for each sector shall be stored in the UD/SIP bytes (40 bytes) of the next sector. The sector interleave parity of the last sector in the last embossed band is stored in the UD/SIP bytes of the first sector in the first embossed band. These bytes shall be as specified in annex C.

Section 4 - Characteristics of embossed information

21 Method of testing

The format of the embossed information on the disk is defined in clauses 13 to 19. Clauses 22 to 25 specify the requirements for the signals from Wobble Marks, Segment Marks, Address fields and grooves, as obtained when using the Reference Drive defined in clause 9.

Clauses 22 to 25 specify only the average quality of the embossed information. Local deviations from the specified values, called defects, can cause tracking errors, erroneous Addresses or errors in the Data fields. These errors are covered by section 6.

21.1 Environment

All signals in clauses 22 to 25 shall be within their specified ranges with the cartridge in any environment in the range of allowed operating environments defined in 8.1.2.

21.2 Reference Drive

21.2.1 Optics and mechanics

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

21.2.2 Read power

For the testings specified in this section, the optical power incident on the entrance surface of the disk (used for reading the information) shall be in the range from 1,0 mW to P_{max} .

P_{max} shall be in the range

$$1{,}00 \text{ mW} < P_{max} < 1{,}60 \text{ mW}$$

P_{max} shall be specified in byte 8 of SFP Zone.

21.2.3 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 shall have the implementation as given by Channel 1 in 9.1.

21.2.4 Tracking

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

$$e_{max} \text{ (axial)} = 0{,}8 \text{ µm}$$

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

$$e_{max} \text{ (radial)} = 0{,}12 \text{ µm}$$

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

21.3 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 in Channel 1 are referenced to signal I_0 , which is the signal in Channel 1 from an unembossed, ungrooved area in the Information Zone, such as the focus sampling field defined in 15.1.1.3.

The signals from the two halves of the split photodiode detector in the track centre-detection signal are indicated by I_1 and I_2.

Figures 23 to 27 show the signals specified in clauses 22 to 25, respectively.

22 Signals from Wobble Marks (see figures 23 and 24)

The signals obtained from the embossed Wobble Marks shall be measured in Channel 1 of the Reference Drive. The signals specified as I_{WL} and I_{WH} shall be measured with the radial tracking servo off. The signals specified as I_W shall be measured with the regular radial tracking servo on. The signals specified as I_{WR} shall be measured with the reversed radial tracking servo on the centre between adjacent tracks in order to obtain reverse parameters.

22.1 On-track modulation

$$0,35 < \frac{I_{W1}}{I_0} < 0,95$$

$$0,35 < \frac{I_{W2}}{I_0} < 0,95$$

In each track, this ratio shall not vary by more than 30%.

$$0,92 < \frac{I_{WR1}}{I_{W1}} < 1,08$$

$$0,92 < \frac{I_{WR2}}{I_{W2}} < 1,08$$

Over the whole disk, this ratio shall not vary by more than 30%.

22.2 Off-track modulation

$$0,30 < \frac{I_{WL1}}{I_0} < 0,70$$

$$0,30 < \frac{I_{WL2}}{I_0} < 0,70$$

In each track, this ratio shall not vary by more than 20%.

22.3 Wobble Mark Imbalance

$$0,9 < \frac{I_{WH1}}{I_{WH2}} < 1,1$$

Over the whole disk, this ratio shall not vary by more than 30%.

22.4 Tracking error modulation

$$0,25 < \frac{I_{WH1} - I_{WL1}}{I_0} < 0,65$$

$$0,25 < \frac{I_{WH2} - I_{WL2}}{I_0} < 0,65$$

In each track, this ratio shall not vary by more than 30%.

22.5 FWHM

The Full Width Half Maximum (FWHM) T_{W1} and T_{W2} of the signals from wobbled mark shall meet the requirement

$$\frac{T_{W1}}{2T_S} < 1,35$$

$$\frac{T_{W2}}{2T_S} < 1,35$$

where T_s is the period of one servo clock defined in 14.3.1. In each track, this ratio shall not vary by more than 20%.

22.6 Jitter of Wobble Marks

Jitter shall be defined as the standard deviation of the time intervals between Wobble Mark peak position and servo clock generated by Reference PLL Circuit.

The maximum allowed jitter of a Wobble Mark shall be

$$\frac{\sigma_1 + \sigma_2}{2} < \quad 0{,}8 \text{ ns for Band 0}$$

1,2 ns for Band 9

1,6 ns for Band 15

where the values of σ_1, σ_2 are the standard deviation of T_1, T_2 in figure 24.

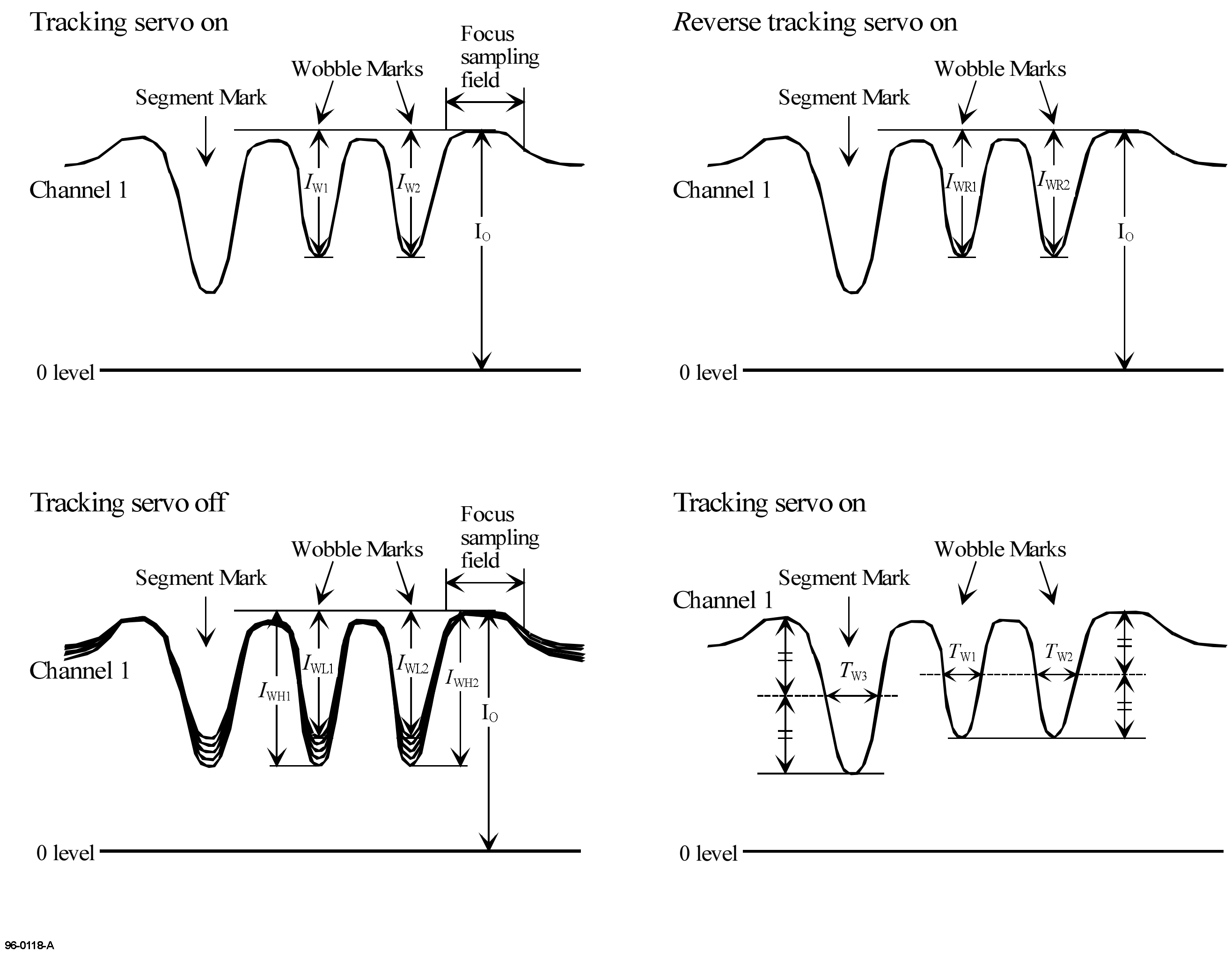


Figure 23 - Signals from Wobble Marks

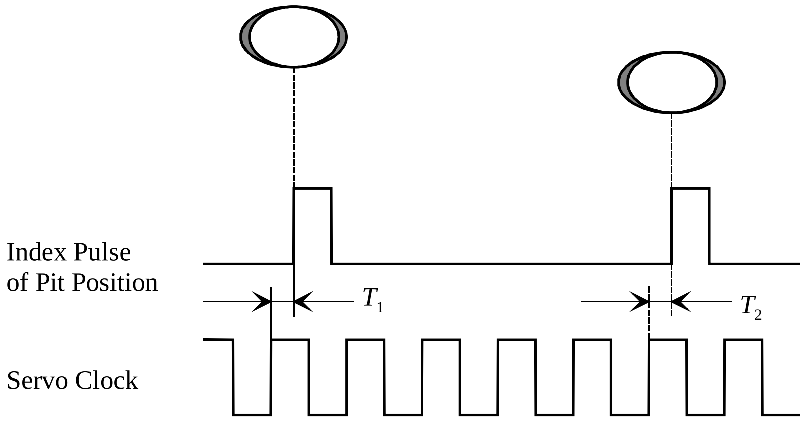


Figure 24 Timing jitter measurement of Wobble Marks

23 Signals from Segment Marks and Address fields (see figure 25)

The signals obtained from the Segment Marks and Address fields shall be measured in Channel 1 of the Reference Drive.

All signals specified in this clause shall be measured with the radial tracking on.

23.1 Segment Marks

$$0{,}60 < \frac{I_{SM(n)}}{I_0} < 0{,}95$$

Where n is the number from 3 to 6 defined in 15.1.1.1. In each track, this ratio shall not vary by more than 20%.

23.2 Address fields

$$0{,}60 < \frac{I_{2T}}{I_0} < 0{,}95$$

Where I_{2T} is the signal amplitude of an isolated 2T mark in Address fields. This amplitude is a level between I_0 level and a peak level of 2T mark.

In each track, this ratio shall vary by more than 20%.

23.3 FWHM

The Full Width Half Maximum (FWHM) T_{W3} of the signal from Segment Marks shall meet the requirement

$$\frac{I_{W3}}{2T_S} < 1{,}35$$

where T_s is a period of the servo clock defined in 14.3.1.

In each track, this ratio shall vary by more than 20%.

23.4 Segment Mark position

Segment Mark positions $T_{W4(n)}$ are the times between peak position of a segment mark and the first Wobble Mark. Four kind of $T_{W4(n)}$ exist according to the function of Segment Marks.

$T_{W4(n)}$ shall satisfy the following requirement.

$$| \{ T_{W4(n)} - T_s \text{ x } (11 - n)\} | < 0{,}2$$

where T_s is a period of the servo clock defined in 14.3.1, (*n*) is the number from 3 to 6 defined in 15.1.1.1.

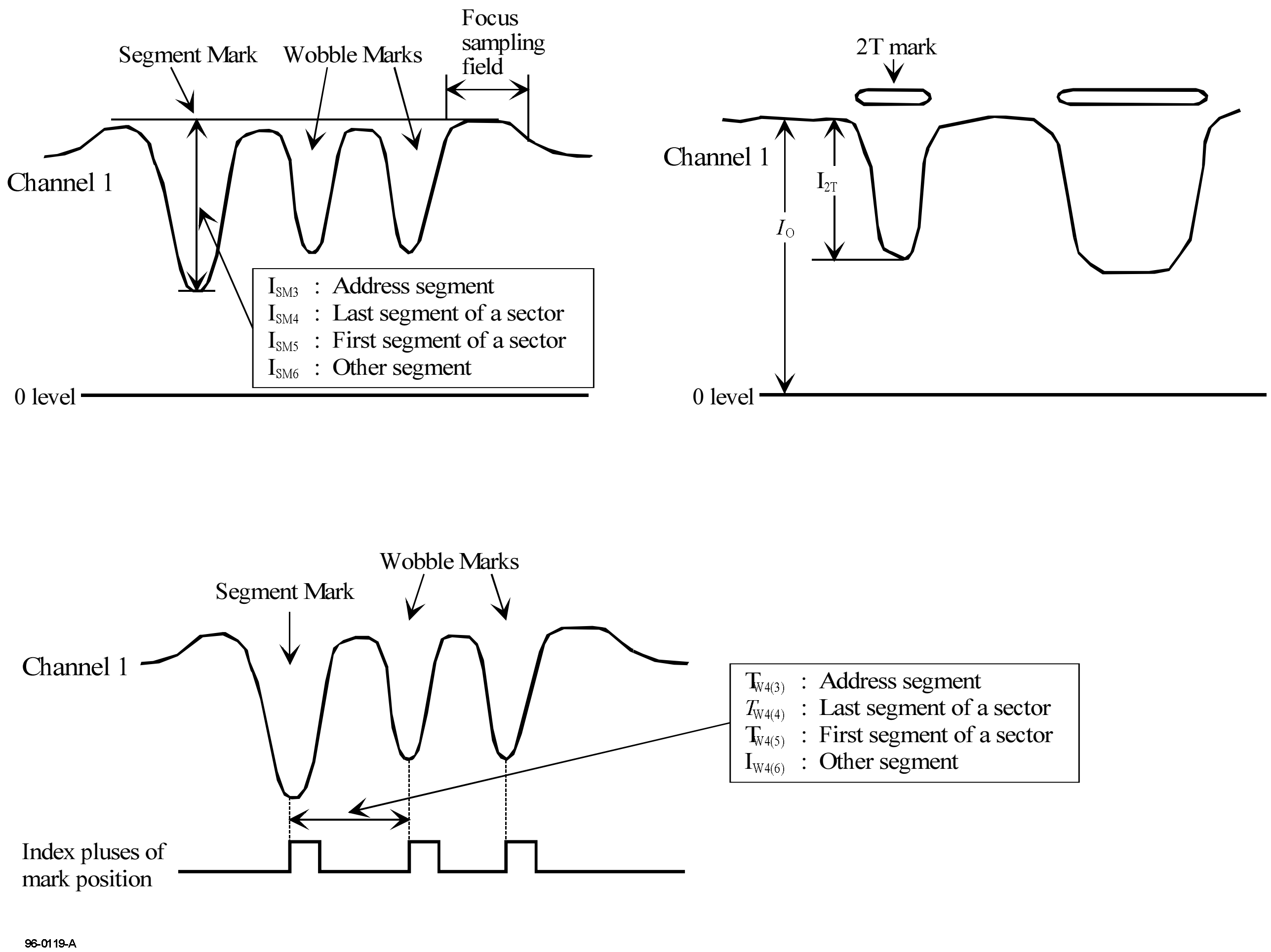


Figure 25 - Signals from Segment Marks and Address field

24 Signal from grooves (see figure 26)

24.1 Groove offset

The track centre detection signal M is the sinusoidal difference of the signal (I_1 - I_2) in the Push-pull Channel. Groove offset ΔI_T is the difference between the following two levels: the Track centre detection signal measured with the radial tracking on, and the centre of the Track centre detection signal measured with the radial tracking off. ΔI_T shall meet the requirement.

$$\frac{\Delta I_T}{(I_1 - I_2)_{P-P}} < 0,40$$

24.2 On-track signal

The on-track signal I_{OL} is the signal measured in Channel 1 when tracking in a grooved area without embossed data. The on-track signal I_{OL} shall meet the following requirement.

$$\frac{I_{OL}}{I_0} > 0,65$$

Over the whole disk, this ratio shall not vary by more than 30%.

24.3 Phase depth

The phase depth of the grooves equals

$$\frac{n \times d}{\lambda} \times 360°$$

where:

n is the index of refraction of the substrate

d is the groove depth

λ is the wavelength

The phase depth shall be less than 180°.

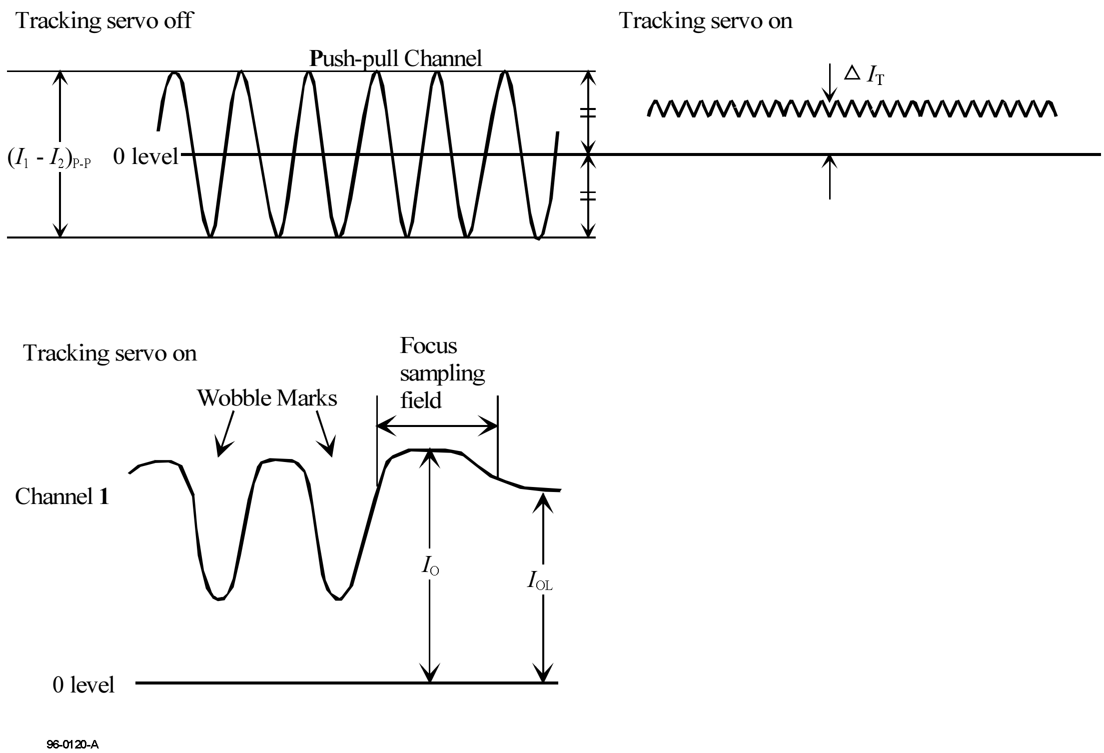


Figure 26 - Signals from grooves

25 Signals from embossed Recording fields (see figure 27)

25.1 Signal amplitude

Signal amplitude is measured in the Reference data defined in 16.2

Signal amplitude of a 2T signal shall meet the requirement

$$0{,}60 < \frac{I_{2T}}{I_0} < 0{,}95$$

25.2 Signal asymmetry

Signal asymmetry is measured in the Reference data defined in 16.2.

ΔI_s is the difference between the centre level of a 2T signal and that of a 8T signal in the reference data. ΔI_s shall meet the following requirement.

$$\frac{\Delta I_S}{I_{P-P}} < 0{,}10$$

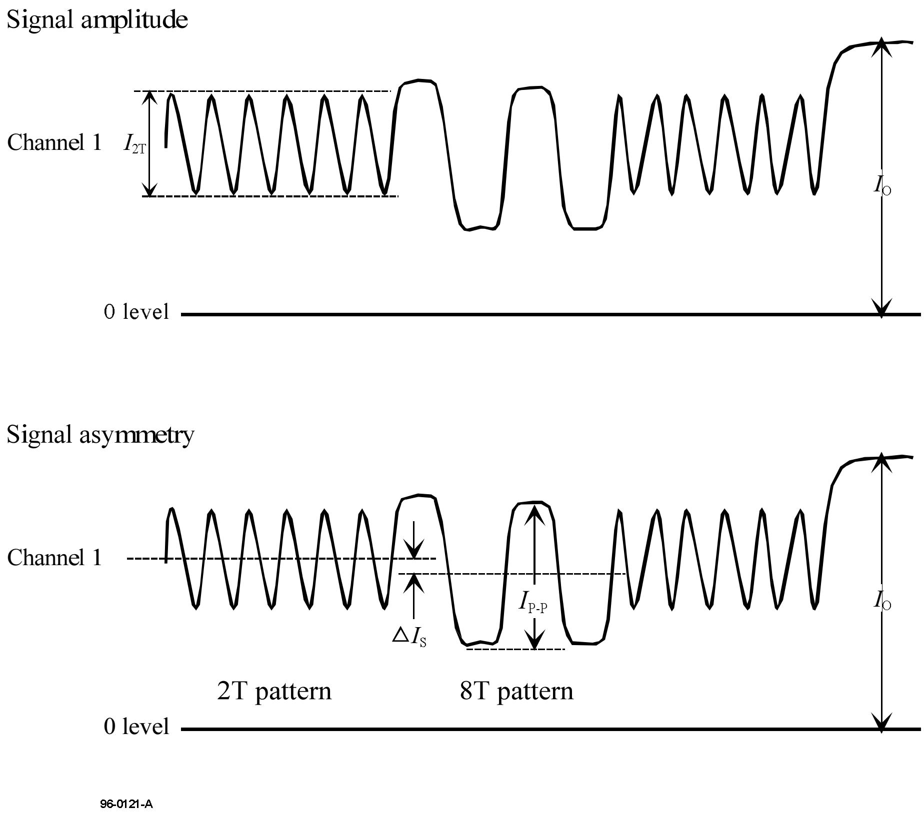


Figure 27 - Channel 1 signals from embossed Recording field

Section 5 - Characteristics of the recording layer

26 Method of testing

Clauses 27 and 28 describe a series of tests to assess the magneto-optical properties of the recording layer, as used for writing data. The tests shall be performed only in the Recording field of the segments in the Rewritable Zone. If there is no Rewritable Zone for user recording, clauses 27 and 28 shall not apply. The write and read operations necessary for the tests shall be made on the same Reference Drive (see also annex G).

Clauses 27 and 28 specify only the average quality of the recording layer. Local deviations from the specified values, called defects, can cause write problems. These defects are covered by section 6.

26.1 Environments

All signals in clauses 27 and 28 shall be within their specified ranges with the cartridge in the operating environments defined in 8.1.2.

26.2 Reference Drive

The write test described in clauses 27 and 28 shall be measured in Channel 2 of the Reference Drive. The drive shall have the following characteristics for the purpose of these tests.

26.2.1 Optics and mechanics

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

26.2.2 Read power

The optical power incident to the entrance surface of the disk and used for reading the information shall be in the range from 1,0 mW to P_{max}.

26.2.3 Read channel

The Reference Drive shall have a read channel which can detect magneto-optical marks in the recording layer. This channel shall have an implementation equivalent to that given by Channel 2 in 9.3.

26.2.4 Tracking

During the measurement of the signals, the focus of the optical beam shall follow the tracks as specified in 21.2.4.

26.3 Overwrite conditions

Marks are written on the disk by magnetic field modulation under successive pulses of optical beam.

26.3.1 Write pulse

Series of write pulses which are synchronized with the data clock are irradiated on the test area in the write process.

The shape of write pulse shall be as given in figure 28. A peak write power P_W, a bias power P_b, a pulse width T_W, a rise time T_r and a fall time T_f are defined in figure 28. The values of P_W and T_W appropriate to the band are specified in annex G. For bands other than specified the values shall be linearly interpolated. The actual power and pulse width used shall be within 5 % of those selected. The value of P_b shall be less than 0,2 mW. T_r and T_f shall be less than 3 ns.

26.3.2 Write magnetic field

The requirements of all tests shall be met for the recording magnetic field H_{ext} (figure 28) of applied magnetic field intensities at the recording layer during writing in the range from 10 kA/m to 24 kA/m.

The magnetic field shall be normal to the recording surface. The shape of the magnetic field on the recording layer is described in figure 28.

T_h is the time for which the absolute value of the magnetic field is more than

H_0 (= 0,9 x H_{ext}).

This shall be more than 20 ns in all write patterns.

The phase difference T_{M-P} is defined the time span between the moment the recording magnetic field rises at H_0 and the moment the laser power falls at a half of P_W, as shown in figure 28.

T_{M-P} shall be between 0 ns and 5 ns.

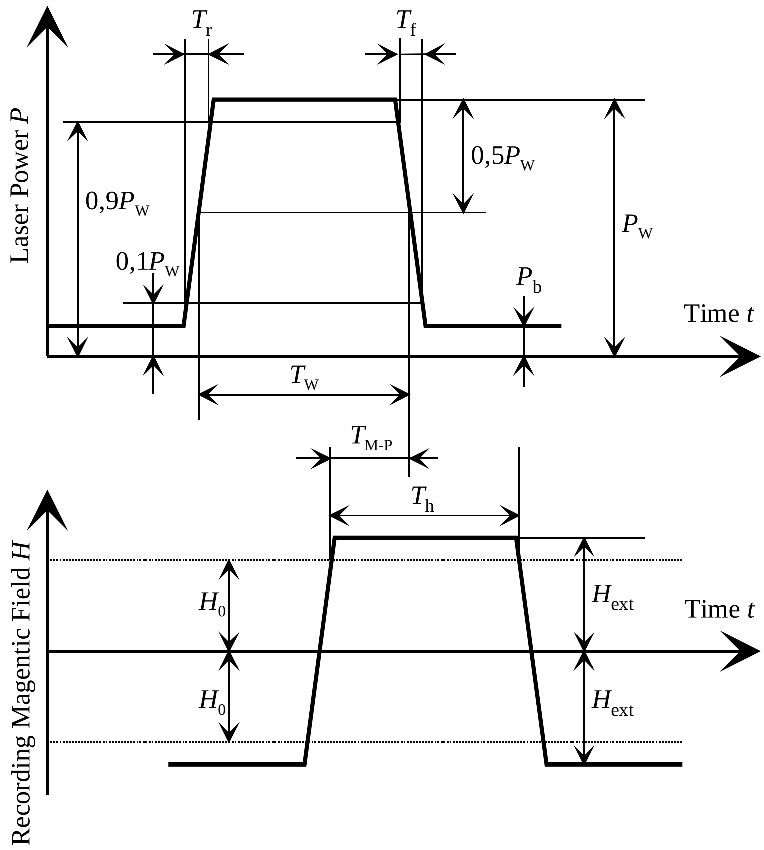


Figure 28 - Recording magnetic field shape and write pulse

26.3.3 N-mark and S-mark

The N-mark (N-domain) shall be a domain where the direction made by the magnetic field shall be from the entrance surface to the recording layer. The N-mark shall correspond to the written data bit ONE.

The S-mark (S-domain) shall be a domain where the direction made by the magnetic field shall be from the recording layer to the entrance surface. The S-mark shall correspond to the written data bit ZERO.

26.4 Definition of signals

The signals in Channel 2 are linearly related to the difference between the currents through the photo-diode detectors K_1 and K_2 and are therefore linearly related to the optical power falling on the detectors (see 9.1).

27 Magneto-optical characteristics

27.1 Figure of merit

The figure of merit F of the recording layer is a measure of the magnitude of the signal obtained from magneto-optical marks. It is defined as $R \sin\theta \ \cos 2\beta$, where R is the reflectance in the data field, excluding the Pre-write, Post-write and embossed area and expressed as a decimal fraction. θ is the Kerr rotation of the optical polarization between marks with different kinds of magnetization. β is the ellipticity of reflected beam, averaged over the aperture.

The polarity of the figure of merit shall be negative for a magneto-optical N-mark written in an Fe-rich Fe Tb alloy recording layer. In this case the direction of Kerr rotation is counter-clockwise as seen from the incident beam.

The figure of merit shall comply with

$0{,}0025 < |F| < 0{,}0050$

27.2 Imbalance of the magneto-optical signal

The imbalance of the magneto-optical signal is the ratio of the amplitude of the 8T signal of the channel 2 divided by the root-mean-square voltage of the channel 2 signal which is passed through the Reference Clamp Circuit defined in annex E. The measurement is made in the Data field of each Data Segment around a track, which is written with the data 0000.... The phase retarder in the optical system shall be in the neutral position (see 9.1). Imbalance may be caused by birefringence of the disk.

The imbalance shall be

- less than 0,012 at Band 0
- less than 0,012 at Band 9
- less than 0,024 at Band 15

28 Overwrite characteristics

28.1 Definition of 2T and Isolated patterns of 1S and 1SR

2T and isolated patterns are used in the measurements specified in 28.2 to 28.4, where T is the nominal clock period for the band corresponding to the test track. A 2T pattern is composed of a series of 2T N-marks followed by 2T S-marks specified in 26.3.3. An Isolated pattern is either a 1S pattern (00000001) or a 1SR pattern (11111110) repeated several times (see figure 29).

28.2 Resolution

I_{1S} and I_{1SR} are the signal levels obtained in Channel 2 (see figure 29) from 1S and 1SR eye pattern (see 28.1) written under any of the conditions given in 26.3, and read under the conditions specified in 26.2.

The levels of Isolated patterns comply with

$0{,}8 < (I_{1S} + I_{1SR}) / I_0 < 1{,}3$

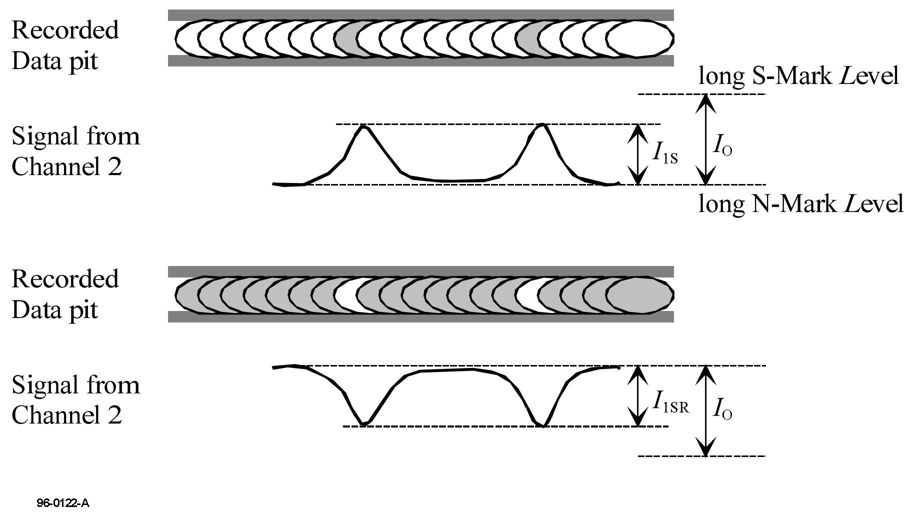


Figure 29 - Resolution

28.3 SNR

The signal-to-noise ratio is the ratio of the signal level of a 2T pattern to the noise level of a series of S-mark and N-mark patterns. It shall be determined as follows.

Write S-marks and N-marks (see 26.3.3) in the Recording fields of the segments under the condition specified in 26.3. Write a 2T pattern (specified in 28.1).

Read the Recording fields in Channel 2 with the Read Channel under the conditions specified in 26.2.

Measure the amplitudes of signal and noise as indicated in figure 30. The effect of the embossed pits in the servo area and the address area shall be excluded in order to obtain the value for the Recording field only.

$S_{2t(i)}$ of signal amplitude is the average signal amplitude of the 2T pattern in a frame with segment(i) to segment(i + 12), (i = 0, 13, 26, 39, ..., 1 264, 1 287).

$\sigma_{n(i)}$ and $\sigma_{s(i)}$ of noise are the sigmas of the level distributions of the N-marks and the S-marks resp. in segment(i) to segment(i +12).

Read the Recording fields in Channel 2 with the Read Channel under the conditions specified in 26.2 using a level analyzer.

The signal-to-noise ratio is calculated, using the following three variables

$S_{2t(i)}$	: Peak to peak level of 2T patterns in the segment(i)
$\sigma_{n(i)}$	: Standard Deviation of N-marks in the segment(i)
$\sigma_{s(i)}$	: Standard Deviation of S-marks in the segment(i)

as follows

$$\mathrm{SNR}(i : i = 0, 13, 26, ..., 1\,287) = \frac{\dfrac{\sum_{i}^{i+12} S_{2t(i)}}{13 \times 2\sqrt{2}}}{\dfrac{1}{2}\left(\dfrac{\sum_{i}^{i+12} \sigma_{n(i)}}{13} + \dfrac{\sum_{i}^{i+12} \sigma_{s(i)}}{13}\right)}$$

Each SNR (i) shall be better than 18 dB for all tracks in the Rewritable Zone for all allowed values of the write magnetic field.

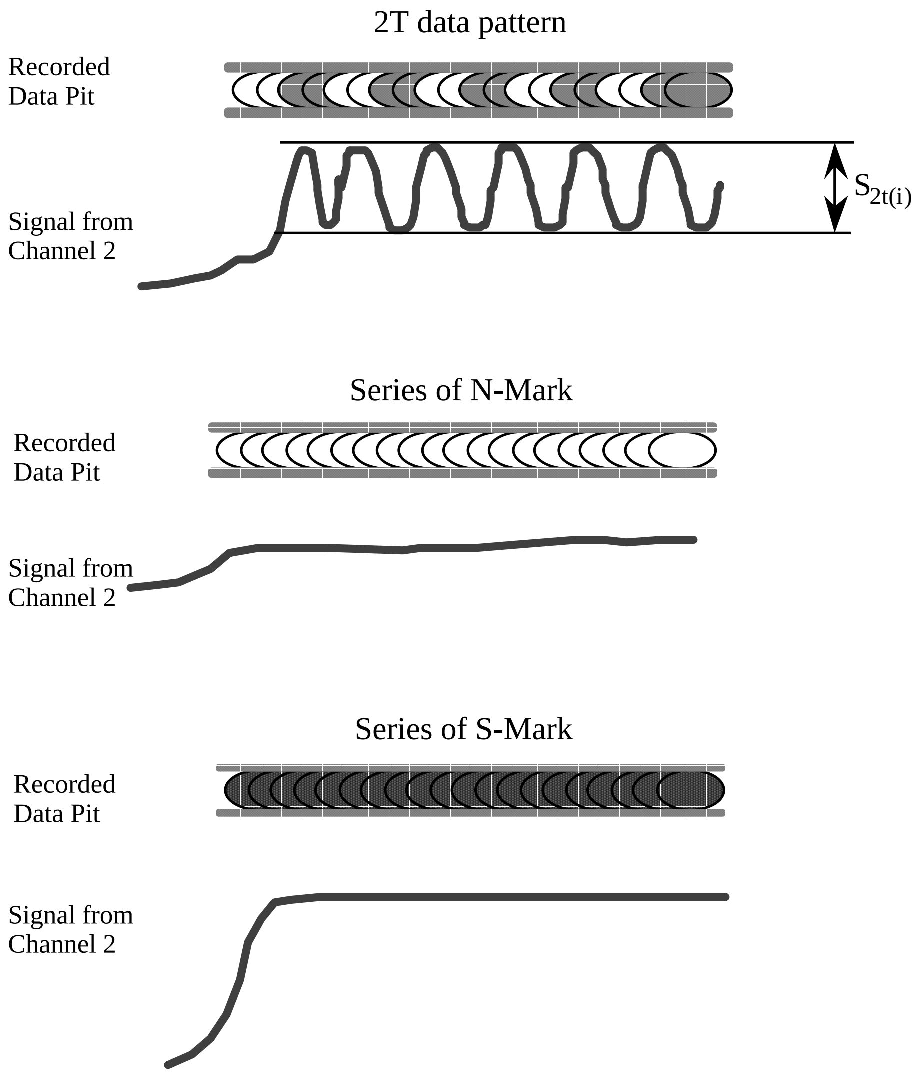


Figure 30 - SNR

28.4 Write power window

This window is defined by the upper limit power P_{wmax} and by the lower limit power P_{wmin} to obtain a required signal-to-noise ratio better than 15 dB after overwriting on the test track and the adjacent tracks. These values are defined using P_{nom} which is defined by the linear interpolation of write peak power values defined in annex G.

This window of the disk shall cover the range between 0,75 x P_{nom} and 1,15 x P_{nom}.

Section 6 - Characteristics of user data

29 Method of testing

Clauses 30 and 31 describe a series of measurements to test conformance of the user data on the disk with this ECMA Standard. The legibility of both embossed and user-written data is checked. 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 21 to 28 disregard defects, clauses 30 and 31 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 30 and 31 define a minimum quality of the data, necessary for data interchange.

29.1 Environment

All signals in clauses 30 to 31 shall be within their specified ranges with the cartridge 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.

29.2 Reference Drive

All signals specified in clauses 30 to 31 shall be measured in the indicated channels of the Reference Drive. The drive shall have the following characteristics for the purpose of these tests:

29.2.1 Optics and mechanics

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

29.2.2 Read power

The optical power incident on the entrance surface of the disk (used for reading the information) shall be in the range from 1,0 mW to P_{max}.

29.2.3 Read amplifiers

The read amplifiers after the photo-detectors in Channels 1 and 2 shall be as specified in 9.3.

29.2.4 Analog-to-binary converters

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

The converter for Channel 1 shall operate correctly for analog signals from embossed marks with amplitudes as determined by clauses 22 to 25.

The converter for Channel 2 shall operate correctly for analog signals from user-written marks with amplitudes as determined by clauses 27 and 28.

29.2.5 Error correction

Correction of error in the data bytes shall be carried out by an error detection and correction system based on the definition in C.3 of annex C. There shall be an additional correction system for the embossed data, based on the Sector Interleave Parity as defined in C.4 of annex C.

29.2.6 Tracking

During measurement of the signals, the focus of the optical beam shall follow the tracks as specified in 21.2.4.

30 Minimum quality of a sector

This clause specifies the minimum quality of the Address field and the 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 29.2.

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.

30.1 Segment Marks and Address fields

30.1.1 Segment Marks

There shall be either the last Segment Mark of the previous sector or the first Segment Mark of the target sector which has the timing specified in 15.1.1.1 and whose signal has the amplitude specified in 23.1.

30.1.2 Address fields

At least, one of three consecutive Address fields shall not have any errors, as checked by the parity in the field.

30.2 User-written data

The user-written data in a sector as read in Channel 2 shall not contain any byte errors that cannot be corrected by error correction defined in 29.2.5.

30.3 Embossed data

Embossed data in a sector as read in Channel 1 shall not contain any byte errors that cannot be corrected by error correction defined in 29.2.5.

31 Data interchange requirements

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

31.1 Tracking

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

31.2 User-written data

Any sector written in the Rewritable Zone that does not comply with 30.1 and 30.2 shall have been replaced according to the rules of the defect management as defined in clause 20.

31.3 Embossed data

Any sector in the Embossed Zone that does not comply with 30.1 and 30.3 shall be correctable by error correction based on the Sector Interleave Parity as defined in C.4 of annex C.

31.4 Quality of disk

The quality of the disk is reflected in the number of replaced sectors in the Rewritable Zone. This ECMA Standard allows a maximum of 2 048 replaced sectors. The maximum number acceptable to a user remains a matter of agreement between purchaser and supplier.

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 = 99,0 mm min.

L_b = 93,0 mm ± 0,1 mm

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

L_d = 5,3 mm ± 0,01 mm

L_e = 0,2 mm min.

L_f = 5,4 mm min.

A.4 When the cartridge is inserted vertically into the gauge, a vertical downward force F_i 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.

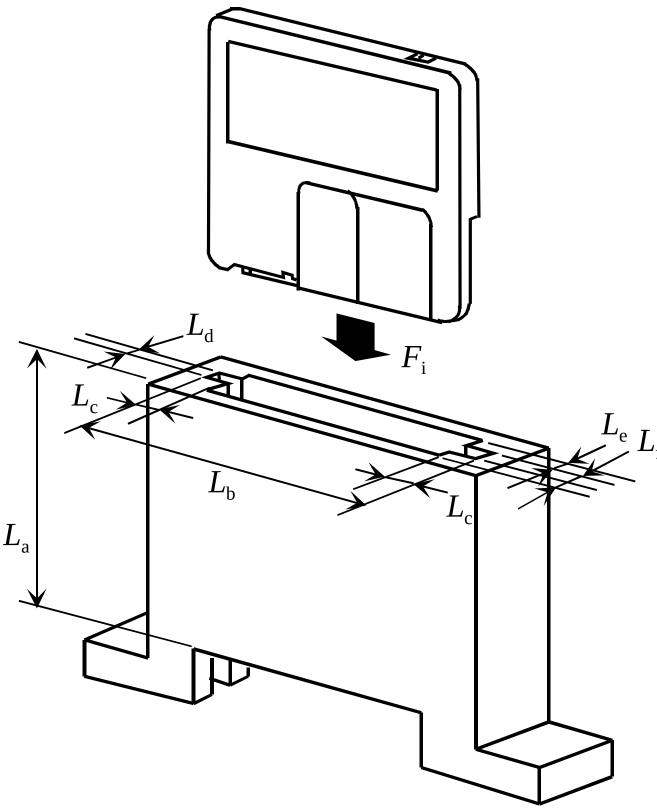


Figure A.1 - Distortion Gauge

Annex B

(normative)

Compliance test

B.1 The compliance test checks the flatness and flexibility of the case by forcing the four 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 location of the four reference surfaces S1, S2, S3 and S4 is defined in 10.3.4 and figure 4**.**

B.3 The test gauge consists of a base plate on which four plots P1, P2, P3 and P4 are fixed so as to correspond to the four surfaces S1, S2, S3 and S4 respectively (see figure B.1). The dimensions are as follows (see figure B.2):

Posts P1 and P2

D_a = 7,00 mm ± 0,01 mm

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

H_a = 1,0 mm ± 0,1 mm

H_b = 2,0 mm max

Posts P3 and P4

D_c = 7,00 mm ± 0,01 mm

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

After assembly, the upper annular surfaces of the four 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_c of 0,5 N shall be exerted on the cartridge opposite each of the four posts.

B.5 **Requirements**

Under the conditions of B.4, three of 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.

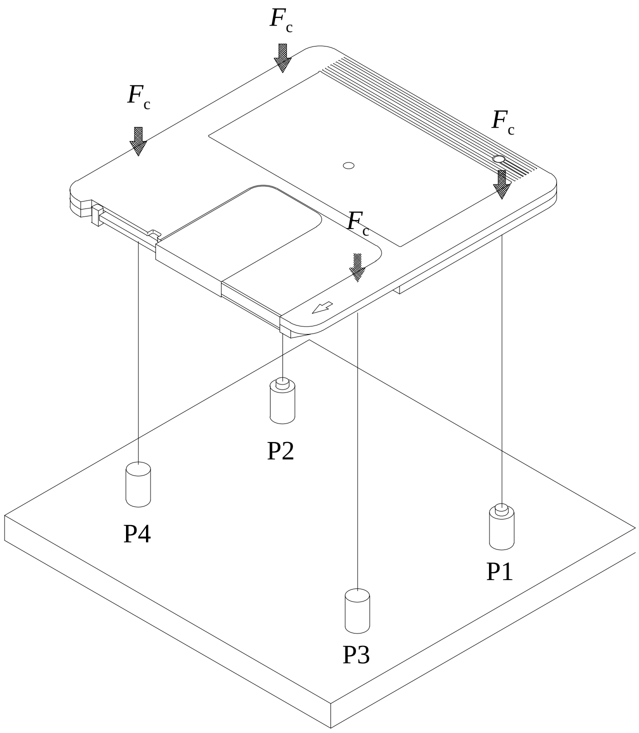


Figure B.1 - Compliance gauge

Figure B.2 - Detail of posts

Annex C

(normative)

Format of the Sector Data field

C.1 Contents of Sector Data field

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

$1 \leq n \leq 2\,048$: $A_n = D_n$	User data bytes
$2\,049 \leq n \leq 2\,088$: $A_n = F_m$	Vendor Unique / SIP bytes
$2\,089 \leq n \leq 2\,098$: $A_n = C_k$	CRC check bytes
$2\,099 \leq n \leq 2\,352$: $A_n = E_{st}$	ECC check bytes,

where

$m = n - 2\,048$

$k = n - 2\,088$

$s = \{ (n - 2\,099) \bmod 16 \} + 1$

$t = \mathrm{int}\, \{ (n - 2\,099) / 16 \} + 1$

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.

C.2 Interleaving

Before the ECC and CRC bytes are calculated, the bytes in the Data field are sixteen-way interleaved. For that purpose, the first three sub-groups of A_n are mapped onto a two-dimensional matrix B_{ij} with 131 rows and 16 columns (see table C.1). Thus

for $1 \leq n \leq 2\,088$: $B_{ij} = A_n$,

where

$i = 130 - \mathrm{int}\, \{ (n - 1) / 16 \}$

$j = (n - 1) \bmod 16$

C.3 CRC and ECC

C.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 $\alpha^i = \left(\beta^i\right)^{88}$, 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 $0 \leq n \leq 7$, when β is expressed on a polynomial basis.

C.3.2 CRC

The generator polynomial for the CRC bytes shall be

$$G_c = \prod_{i=136}^{i=143} (x + \alpha^i)$$

The eight check bytes of the CRC shall be computed over the user data and the 40 F_m bytes. The information polynomial shall be

$$I_c = [\sum_{i=1}^{i=130}(\sum_{j=0}^{j=15} B_{i,j}x^i)] + \sum_{j=0}^{7} B_{0,j}x^0$$

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

$$R_c(x) = I_c(x)x^8 \bmod G_c(x)$$

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

$$R_c(x) = \sum_{k=1}^{k=8} C_k x^{8-k}$$

C.3.3 ECC

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

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

The 256 check bytes of the ECC shall be computed over the user data, the 40 F_m bytes and the eight CRC bytes. The corresponding nine information polynomials shall be

$$I_{ej} = \sum_{i=0}^{i=130} B_{ij}x^i$$

where $0 \le j \le 8$

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

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

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 C.1.

C.4 Sector Interleave Parity (SIP)

The Sector Interleave Parity consists of 40 bytes data. The primitive polynomial and the elements shall be as specified in C.3.1. The generator polynomial for the check bytes of the SIP shall be

$$G_s(x) = \prod_{i=118}^{119}(x+\alpha^i)$$

The SIP shall be computed over the user data, the 40 SIP bytes, the eight CRC bytes and th 256 ECC bytes of the previous sector ((n - 1)th sector) as shown in figure C.1.

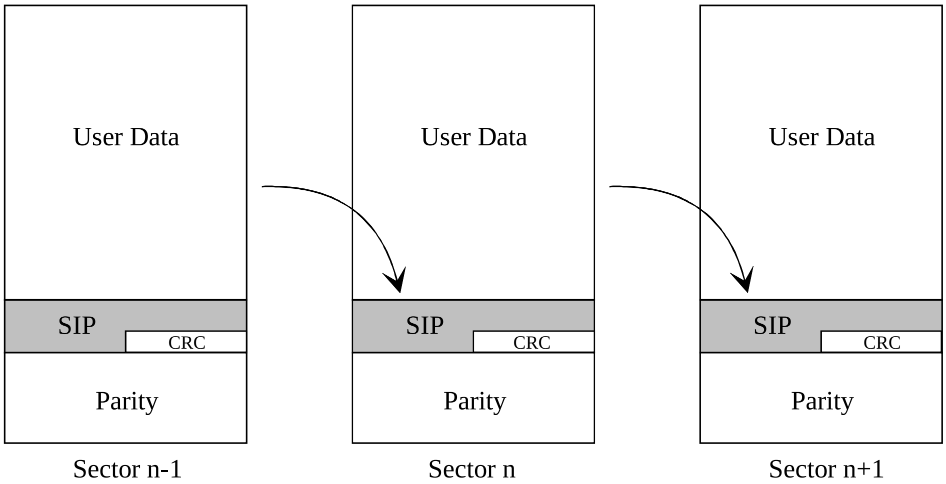


Figure C.1 - The arrangement of SIP

The contents of the 40 check bytes F_1 to F_{40} consist of 20 pairs of parity bytes defined by the second residual polynomials

$$F_1 \cdot x + F_2 = [\sum_{i=124}^{i=130} (\sum_{j=0}^{j=15} (B_{ij}) x^{(15-j+(i-124)\times 16)}) x^2] \bmod G_s(x)$$

$$F_3 \cdot x + F_4 = [\sum_{i=116}^{i=123} (\sum_{j=0}^{j=15} (B_{ij}) x^{(15-j+(i-116)\times 16)}) x^2] \bmod G_s(x)$$

$$F_5 \cdot x + F_6 = [\sum_{i=109}^{i=115} (\sum_{j=0}^{j=15} (B_{ij}) x^{(15-j+(i-109)\times 16)}) x^2] \bmod G_s(x)$$

$$F_7 \cdot x + F_8 = [\sum_{i=102}^{i=108} (\sum_{j=0}^{j=15} (B_{ij}) x^{(15-j+(i-102)\times 16)}) x^2] \bmod G_s(x)$$

$$F_9 \cdot x + F_{10} = [\sum_{i=94}^{i=101} (\sum_{j=0}^{j=15} (B_{ij}) x^{(15-j+(i-94)\times 16)}) x^2] \bmod G_s(x)$$

$$F_{11} \cdot x + F_{12} = [\sum_{i=87}^{i=93} (\sum_{j=0}^{j=15} (B_{ij}) x^{(15-j+(i-87)\times 16)}) x^2] \bmod G_s(x)$$

$$F_{13} \cdot x + F_{14} = [\sum_{i=80}^{i=86} (\sum_{j=0}^{j=15} (B_{ij}) x^{(15-j+(i-124)\times 16)}) x^2] \bmod G_s(x)$$

$$F_{15} \cdot x + F_{16} = [\sum_{i=72}^{i=79} (\sum_{j=0}^{j=15} (B_{ij}) x^{(15-j+(i-72)\times 16)}) x^2] \bmod G_s(x)$$

$$F_{17} \cdot x + F_{18} = [\sum_{i=65}^{i=71} (\sum_{j=0}^{j=15} (B_{ij}) x^{(15-j+(i-65)\times 16)}) x^2] \bmod G_s(x)$$

$$F_{19} \cdot x + F_{20} = [\sum_{i=58}^{i=64} (\sum_{j=0}^{j=15} (B_{ij}) x^{(15-j+(i-58)\times 16)}) x^2] \bmod G_s(x)$$

$$F_{21} \cdot x + F_{22} = [\sum_{i=50}^{i=57} (\sum_{j=0}^{j=15} (B_{ij}) x^{(15-j+(i-50)\times 16)}) x^2] \bmod G_s(x)$$

$$F_{23} \cdot x + F_{24} = [\sum_{i=43}^{i=49} (\sum_{j=0}^{j=15} (B_{ij}) x^{(15-j+(i-48)\times 16)}) x^2] \bmod G_s(x)$$

$$F_{25} \cdot x + F_{26} = [\sum_{i=36}^{i=42} (\sum_{j=0}^{j=15} (B_{ij}) x^{(15-j+(i-38)\times 16)}) x^2] \bmod G_s(x)$$

$$F_{27} \cdot x + F_{28} = [\sum_{i=28}^{i=35} (\sum_{j=0}^{j=15} (B_{ij}) x^{(15-j+(i-28)\times 16)}) x^2] \bmod G_s(x)$$

$$F_{29} \cdot x + F_{30} = [\sum_{i=21}^{i=27} (\sum_{j=0}^{j=15} (B_{ij}) x^{(15-j+(i-21)\times 16)}) x^2] \bmod G_s(x)$$

$$F_{31} \cdot x + F_{32} = [\sum_{i=14}^{i=20} (\sum_{j=0}^{j=15} (B_{ij}) x^{(15-j+(i-14)\times 16)}) x^2] \bmod G_s(x)$$

$$F_{33} \cdot x + F_{34} = [\sum_{i=6}^{i=13} (\sum_{j=0}^{j=15} (B_{ij}) x^{(15-j+(i-6)\times 16)}) x^2] \bmod G_s(x)$$

$$F_{35} \cdot x + F_{36} = [\sum_{i=-1}^{i=5} (\sum_{j=0}^{j=15} (B_{ij}) x^{(15-j+(i+1)\times 16)}) x^2] \bmod G_s(x)$$

$$F_{37} \cdot x + F_{38} = [\sum_{i=-8}^{i=-2} (\sum_{j=0}^{j=15} (B_{ij}) x^{(15-j+(i+8)\times 16)}) x^2] \bmod G_s(x)$$

$$F_{39} \cdot x + F_{40} = [\sum_{i=-16}^{i=-9} (\sum_{j=0}^{j=15} (B_{ij}) x^{(15-j+(i+16)\times 16)}) x^2] \bmod G_s(x)$$

The SIP (F_1 to F_{40}) is computed over 2 352 bytes of the previous sector. In the case of a Fully Embossed disk the SIP of the last sector is stored in the SIP area of the first sector of the Inner Test Zone. The SIP of the last sector in the last embossed band is stored in the UD/SIP bytes of the first sector in the first embossed band.

C.5 Recording Sequence

The bytes of the Sector Data field shall be recorded on the disk immediately after the Reference data. Their order shall be according to sequence A_n .

Table C.1 - Data field configuration. The indices *i* and *j* of bytes B_{ij} are given along the sides of the matrix

Column No. *j* →	0	1	…	7	8	9	10	11	12	13	14	15	Row No. *i* ↓
	D_1	D_2		D_8	D_9	D_{10}	D_{11}	D_{12}	D_{13}	D_{14}	D_{15}	D_{16}	130
	D_{17}	D_{18}		D_{24}	D_{25}	D_{26}	D_{27}	D_{28}	D_{29}	D_{30}	D_{31}	D_{32}	129
	D_{33}	D_{34}		D_{40}	D_{41}	D_{42}	D_{43}	D_{44}	D_{45}	D_{46}	D_{47}	D_{48}	128
	D_{49}	D_{50}		D_{56}	D_{57}	D_{58}	D_{59}	D_{60}	D_{61}	D_{62}	D_{63}	D_{64}	127
131 rows													
	$D_{2\,017}$	$D_{2\,018}$		$D_{2\,024}$	$D_{2\,025}$	$D_{2\,026}$	$D_{2\,027}$	$D_{2\,028}$	$D_{2\,029}$	$D_{2\,030}$	$D_{2\,031}$	$D_{2\,032}$	4
	$D_{2\,033}$	$D_{2\,034}$		$D_{2\,040}$	$D_{2\,041}$	$D_{2\,042}$	$D_{2\,043}$	$D_{2\,044}$	$D_{2\,045}$	$D_{2\,046}$	$D_{2\,047}$	$D_{2\,048}$	3
	F_1	F_2		F_8	F_9	F_{10}	F_{11}	F_{12}	F_{13}	F_{14}	F_{15}	F_{16}	2
	F_{17}	F_{18}		F_{24}	F_{25}	F_{26}	F_{27}	F_{28}	F_{29}	F_{30}	F_{31}	F_{32}	1
	F_{33}	F_{34}		F_{40}	C_1	C_2	C_3	C_4	C_5	C_6	C_7	C_8	0
	$E_{1,1}$	$E_{2,1}$		$E_{8,1}$	$E_{9,1}$	$E_{10,1}$	$E_{11,1}$	$E_{12,1}$	$E_{13,1}$	$E_{14,1}$	$E_{15,1}$	$E_{16,1}$	-1
	$E_{1,2}$	$E_{2,2}$		$E_{8,2}$	$E_{9,2}$	$E_{10,2}$	$E_{11,2}$	$E_{12,2}$	$E_{13,2}$	$E_{14,2}$	$E_{15,2}$	$E_{16,2}$	-2
	$E_{1,3}$	$E_{2,3}$		$E_{8,3}$	$E_{9,3}$	$E_{10,3}$	$E_{11,3}$	$E_{12,3}$	$E_{13,3}$	$E_{14,3}$	$E_{15,3}$	$E_{16,3}$	-3
16 rows													
	$E_{1,13}$	$E_{2,13}$		$E_{8,13}$	$E_{9,13}$	$E_{10,13}$	$E_{11,13}$	$E_{12,13}$	$E_{13,13}$	$E_{14,13}$	$E_{15,13}$	$E_{16,13}$	-13
	$E_{1,14}$	$E_{2,14}$		$E_{8,14}$	$E_{9,14}$	$E_{10,14}$	$E_{11,14}$	$E_{12,14}$	$E_{13,14}$	$E_{14,14}$	$E_{15,14}$	$E_{16,14}$	-14
	$E_{1,15}$	$E_{2,15}$		$E_{8,15}$	$E_{9,15}$	$E_{10,15}$	$E_{11,15}$	$E_{12,15}$	$E_{13,15}$	$E_{14,15}$	$E_{15,15}$	$E_{16,15}$	-15
	$E_{1,16}$	$E_{2,16}$		$E_{8,16}$	$E_{9,16}$	$E_{10,16}$	$E_{11,16}$	$E_{12,16}$	$E_{13,16}$	$E_{14,16}$	$E_{15,16}$	$E_{16,16}$	-16

Annex D

(normative)

Contents of the Control Zones

D.1 Contents of the GEP Zones

The GEP Zone consists of Media characterization data. Page Numbers 0 to 4 include media parameters and Page Numbers 5 to 9 include segment information.

Page Number 0: Format type (MSB) / Media type (LSB)

Bit 15	shall be set to ONE indicating a media with grooves.
Bit 14	shall be set to ONE indicating a media where the Servo Channel bit position of the Segment Mark indicates the type of the Data segment.
Bits 13 to 8	These bits shall be set to ZERO.
Bits 7 to 4	0000: indicates a fully embossed disk. 0010: indicates a fully rewritable disk. 1010: indicates a partially embossed disk.
Bits 3 to 0	0000: indicates a capacity of 650 Mbytes per cartridge.

Page Number 1: Format Descriptor 1(MSB) /Format Descriptor 2 (LSB)

Bit 15	shall be set to ONE indicating the sample servo tracking method.
Bits 14 to 12	shall be set to 010 indicating a ZCAV.
Bit 11	shall be set to ZERO.
Bits 10 to 8	shall be set to 110 indicating NRZI coding.
Bit 7	shall be set to ZERO.
Bits 6 to 4	specify the error correction code : 010 indicates R-S LDC degree 16 with a 16-way interleave.
Bit 3	shall be set to ZERO.
Bits 2 to 0	represent in binary notation a number n such that 256 x 2^n equals the number of user bytes per sector. These bits shall be set to 011 to indicate the 2 048-byte sectors specified by this ECMA Standard.

Page Number 2: Track number of the first track of SFP Zone in Outer Control Zone (MSB/LSB)

These two bytes shall specify the track number of the first track of the SFP Zone in the Outer Control Zone. It shall be set to (FFF4) representing track number - 12.

Page Number 3: Track number of the first track of SFP Zone in Inner Control Zone (MSB/LSB)

These two bytes shall specify the track number of the first track of the SFP Zone in the Inner Control Zone. It shall be set to (4509) representing track number 17 673.

Page Number 4: Maximum read power (MSB) / Reserved (LSB)

The MSB shall specify the maximum read power P_R, in milliwatts, permitted for reading the Control Zones. It is specified as a number n such that

$$n = 20P_R.$$

The MSB shall be set to n = (20), representing a maximum read power of 1,6 mW. The LSB shall be set to (FF).

Page Number 5: Clock ratio of Outer Control Zone (MSB) / Number of segments per sector in Outer Control Zone (LSB)

The MSB shall specify the clock ratio Q of the data clock to the servo clock in the Outer Control Zone. A frequency of the data clock f_d is specified such that

$$f_d = \frac{Q}{24} \times f_s$$

where f_s is the frequency of the servo clock.

The MSB shall be set to Q = (30). The LSB byte shall specify the number of segments per sector of the Outer Control Zone. It shall be set to (41).

Page Number 6: Clock ratio of Inner Control Zone (MSB) / Number of segments per sector of Inner Control Zone (LSB)

The MSB shall specify the clock ratio Q of the data clock to the servo clock in the Inner Control Zone. A frequency of the data clock f_d is specified such that

$$f_d = \frac{Q}{24} \times f_s$$

where f_s is the frequency of the servo clock.

The MSB byte shall be set to Q = (18). The LSB byte shall specify the number of segments per sector of Inner Control Zone. It shall be set to (82).

Page Number 7: Number of Servo Channel bits per segment (MSB) / Number of servo clocks per Servo field (LSB)

The MSB shall specify the number of Servo Channel bits per segment. It shall be set to (D8). The LSB shall specify the number of Servo Channel bits in the Servo field of each segment. It shall be set to (18).

Page Number 8: Number of segments per track (MSB/LSB)

Theses two bytes shall specify the number of segments per track, and shall be set to (0578) representing 1 400 segments per track.

Page Number 9: Number of Address Segments per track (MSB) /Reserved (LSB)

The MSB shall specify the number of Address Segments per track. It shall be set to (64). The LSB shall be set to (FF).

Table D.1 - Summary of the contents of the GEP Zone

Page Number	Fully Rewritable	Partially Embossed	Fully Embossed
0	(C020)	(C0A0)	(4000)
1	(A623)	(A623)	(A623)
2	(FFF4)	(FFF4)	(FFF4)
3	(4509)	(4509)	(4509)
4	(20FF)	(20FF)	(20FF)
5	(3041)	(3041)	(3041)
6	(1882)	(1882)	(1882)
7	(D818)	(D818)	(D818)
8	(0578)	(0578)	(0578)
9	(64FF)	(64FF)	(64FF)

D.2 Contents of the SFP Zones

Each sector of the SFP Zones shall include 2 048 bytes of information numbered 0 to 2 047 and grouped in five sections;

Bytes 0 to 19	Media characterization data
Bytes 20 to 29	Recording control data
Bytes 30 to 99	System data
Bytes 100 to 419	Band data
Bytes 420 to 2 047	Unspecified data

D.2.1 Media characterization data

Bytes 0 to 19 shall be identical with the 20 bytes of the contents of the GEP Zone, specified in D.1.

Byte 0: Format Type

This byte is identical with the MSB of Page Number 0 in the GEP Zone.

Byte 1: Media Type

This byte is identical with the LSB of Page Number 0 in the GEP Zone.

Byte 2: Format Descriptor 1

This byte is identical with the MSB of Page Number 1 in the GEP Zone.

Byte 3: Format Descriptor 2

This byte is identical with the LSB of Page Number 1 in the GEP Zone.

Byte 4: Track number of the first track of SFP Zone in Outer Control Zone (MSB)

This byte is identical with the MSB of Page Number 2 in the GEP Zone.

Byte 5: Track number of the first track of SFP Zone in Outer Control Zone (LSB)

This byte is identical with the LSB of Page Number 2 in the GEP Zone.

Byte 6: Track number of the first track of SFP Zone in Inner Control Zone (MSB)

This byte is identical with the MSB of Page Number 3 in the GEP Zone.

Byte 7: Track number of the first track of SFP Zone in Inner Control Zone (LSB)

This byte is identical with the LSB of Page Number 3 in the GEP Zone.

Byte 8: Maximum read power

This byte is identical with the MSB of Page Number 4 in the GEP Zone.

Byte 9: Reserved

This byte is identical with the LSB of Page Number 4 in the GEP Zone.

Byte 10: Clock ratio of Outer Control Zone

This byte is identical with the MSB of Page Number 5 in the GEP Zone.

Byte 11: Number of segments per sector of Outer Control Zone

This byte is identical with the LSB of Page Number 5 in the GEP Zone.

Byte 12: Clock ratio of Inner Control Zone

This byte is identical with the MSB of Page Number 6 in the GEP Zone.

Byte 13: Number of segments per sector of Inner Control Zone

This byte is identical with the LSB of Page Number 6 in the GEP Zone.

Byte 14: Number of Servo Channel bits per segment

This byte is identical with the MSB of Page Number 7 in the GEP Zone.

Byte 15: Number of servo clocks per Servo field

This byte is identical with the LSB of Page Number 7 in the GEP Zone.

Byte 16: Number of segments per track (MSB)

This byte is identical with the MSB of Page Number 8 in the GEP Zone.

Byte 17: Number of segments per track (LSB)

This byte is identical with the LSB of Page Number 8 in the GEP Zone.

Byte 18: Number of Address Segments per track

This byte is identical with the MSB of Page Number 9 in the GEP Zone.

Byte 19: Reserved

This byte is identical with the LSB of Page Number 9 in the GEP Zone.

D.2.2 Recording Control data

Bytes 20 to 29 specify the laser wavelength and the baseline reflectance, and track pitch.

Byte 20: Wavelength

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

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

This byte shall be set to $n =$ (89).

Byte 21: Reflectance

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

$$n = 100 \times R_1$$

The content of this byte is specified by media manufacturers.

Byte 22: Track Pitch

This byte shall specify the track pitch in micrometres times 100. It shall be set to (78) representing a track pitch of 1,20 µm.

Bytes 23 to 29: Reserved

These bytes shall be set to (FF).

D.2.3 System data

Byte 30: Highest track number of the Data Zone (MSB)

This byte shall specify the most significant byte of a track number of the highest track in the Data Zone. It shall be set to (45) representing the MSB of track number 17 665.

Byte 31: Highest track number of the Data Zone (LSB)

This byte shall specify the least significant byte of a track number of the highest track in the Data Zone. It shall be set to (01) representing the LSB of track number 17 665.

Byte 32: Highest sector number of the Data Zone (MSB)

This byte shall specify the most significant byte of a sector number of the highest sector in the Data Zone. It shall be set to (04) representing the MSB of track number 321 099.

Byte 33: Highest sector number of the Data Zone

This byte shall specify the middle byte of a sector number of the highest sector in the Data Zone. It shall be set to (E6) representing the middle byte of track number 321 099.

Byte 34: Highest sector number of the Data Zone (LSB)

This byte shall specify the least significant byte of a sector number of the highest sector in the Data Zone. It shall be set to (4B) representing the LSB of track number 321 099.

Byte 35: Sector number of the first sector of DDS1 (MSB)

This byte shall specify the most significant byte of a sector number of the first sector of the Disk Definition Structure in DMA1. This value depends on the Media Type. In case of Type R/W disks it shall be set to (00) representing the MSB of sector number 0.

Byte 36: Sector number of the first sector of DDS1

This byte shall specify the middle byte of a sector number of the first sector of the Disk Definition Structure in DMA1. This value depends on the Media Type. In case of Type R/W disks it shall be set to (00) representing the middle byte of sector number 0.

Byte 37: Sector number of the first sector of DDS1 (LSB)

This byte shall specify the least significant byte of a sector number of the first sector of the Disk Definition Structure in DMA1. This value depends on the Media Type. In case of Type R/W disks it shall be set to (00) representing the LSB of sector number 0.

Byte 38: Sector number of the first sector of DDS2 (MSB)

This byte shall specify the most significant byte of a sector number of the first sector of the Disk Definition Structure in DMA2. This value depends on the Media Type. In case of Type R/W disks it shall be set to (00) representing the MSB of sector number 16.

Byte 39: Sector number of the first sector of DDS2

This byte shall specify the middle byte of a sector number of the first sector of the Disk Definition Structure in DMA2. This value depends on the Media Type. In case of Type R/W disks it shall be set to (00) representing the middle byte of sector number 16.

Byte 40: Sector number of the first sector of DDS2 (LSB)

This byte shall specify the least significant byte of a sector number of the first sector of the Disk Definition Structure in DMA2. This value depends on the Media Type. In case of Type R/W disks it shall be set to (10) representing the LSB of sector number 16.

Byte 41: Sector number of the first sector of DDS3 (MSB)

This byte shall specify the most significant byte of a sector number of the first sector of the Disk Definition Structure in DMA3. This value depends on the Media Type. In case of Type R/W disks it shall be set to (04) representing the MSB of sector number 321 068.

Byte 42: Sector number of the first sector of DDS3

This byte shall specify the middle byte of a sector number of the first sector of the Disk Definition Structure in DMA3. This value depends on the Media Type. In case of Type R/W disks it shall be set to (E6) representing the middle byte of sector number 321 068.

Byte 43: Sector number of the first sector of DDS3 (LSB)

This byte shall specify the least significant byte of a sector number of the first sector of the Disk Definition Structure in DMA3. This value depends on the Media Type. In case of Type R/W disks it shall be set to (2C) representing the LSB of sector number 321 068.

Byte 44: Sector number of the first sector of DDS4 (MSB)

This byte shall specify the most significant byte of a sector number of the first sector of the Disk Definition Structure in DMA4. This value depends on the Media Type. In case of Type R/W disks it shall be set to (04) representing the MSB of sector number 321 084.

Byte 45: Sector number of the first sector of DDS4

This byte shall specify the middle byte of a sector number of the first sector of the Disk Definition Structure in DMA4. This value depends on the Media Type. In case of Type R/W disks it shall be set to (E6) representing the middle byte of sector number 321 084.

Byte 46: Sector number of the first sector of DDS4 (LSB)

This byte shall specify the least significant byte of a sector number of the first sector of the Disk Definition Structure in DMA4. This value depends on the Media Type. In case of Type R/W disks it shall be set to (3C) representing the LSB of sector number 321 084.

Byte 47: Number of tracks in the Test Zone

This byte shall specify the number of tracks in the Test Zone. It shall be set to (05).

Byte 48: Number of Sectors in the set of DMAs

This byte shall specify the number of sectors in the set of DMAs: DMA 1 and 2 or DMA 3 and 4. It shall be set to (20).

Byte 49: Total number of the Spare Sectors (MSB)

This byte shall specify the most significant byte of the total number of the Spare Sectors. It shall be set to (08) representing the MSB of sector number 2 048.

Byte 50: Total number of the Spare Sectors (LSB)

This byte shall specify the least significant byte of the total number of the Spare Sectors. It shall be set to (00) representing the LSB of sector number 2 048.

Byte 51: Number of bytes in the Sector Data field of a sector (MSB)

This byte shall specify the most significant byte of the number of the bytes in the Sector Data Field of a sector. It shall be set to (09) representing the MSB of byte number 2 352.

Byte 52: Number of bytes in the Sector Data Field of a sector (LSB)

This byte shall specify the least significant byte of the number of the bytes in the Sector Data Field of a sector. It shall be set to (30) representing the LSB of byte number 2 352.

Byte 53: Number of Data Channel bits in Reference data of a sector

This byte shall specify the number of the Data Channel bits in Reference data. It shall be set to (42).

Byte 54: Number of Data Channel bits in Post-write field of a Data Segment

This byte shall specify the number of the Data Channel bits in Post-write field. It shall be set to (04).

Byte 55: Number of Data Channel bits in Pre-write field of a Data Segment

This byte shall specify the number of the Data Channel bits in Pre-write field. It shall be set to (0C).

Byte 56: Number of bands in the Data Zone

This byte shall specify the number of bands in the Data Zone. It shall be set to (10).

Bytes 57 to 69: Reserved

These bytes shall be set to (FF).

Bytes 70 to 91: Control bytes

These bytes shall contain the values for bytes 0 to 21 of the DDS as shown in table D.2. These control bytes shall be defined by the manufacturer at the time the disk is manufactured. The control bytes can be used by the user as a input to the format process and to recover the contents of the DDS if lost through machine error or if inadvertently overwritten.

Table D.2 - Content of the Control bytes

Byte No.	Description	Fully Rewritable	Partially Embossed	Fully Embossed
70	DDS Identifier	(0A)	(0A)	(0A)
71	DDS Identifier	(0A)	(0A)	(0A)
72	Reserved	(00)	(00)	(00)
73		(00)	(00)	(00)
74	Number of groups MSB	(00)	(00)	(00)
75	Number of groups LSB (1 or 16)	(00)	(10)	(01)
76	Band 0 Type	(01)	(01/02)	(02)
77	Band 1 Type	(01)	(01/02)	(02)
78	Band 2 Type	(01)	(01/02)	(02)
79	Band 3 Type	(01)	(01/02)	(02)
80	Band 4 Type	(01)	(01/02)	(02)
81	Band 5 Type	(01)	(01/02)	(02)
82	Band 6 Type	(01)	(01/02)	(02)
83	Band 7 Type	(01)	(01/02)	(02)
84	Band 8 Type	(01)	(01/02)	(02)
85	Band 9 Type	(01)	(01/02)	(02)
86	Band 10 Type	(01)	(01/02)	(02)
87	Band 11 Type	(01)	(01/02)	(02)
88	Band 12 Type	(01)	(01/02)	(02)
89	Band 13 Type	(01)	(01/02)	(02)
90	Band 14 Type	(01)	(01/02)	(02)
91	Band 15 Type	(01)	(01/02)	(02)

Bytes 92 to 99: Reserved

These bytes shall be set to (FF).

D.2.4 Band data

Bytes 100 to 419 shall specify information for band 0 to 16. Each 20 bytes shall contain a single set of band data for each band. The byte assignments of band data are shown in table D.3. The values of the band data depend on the Media type.

Byte (100 + *n* x 20) to (119 + *n* x 20): Band data for Band *n* (*n* : 0 to 15)

Byte (100 + *n* x 20): Track number of the first track of Band *n* (MSB)

This byte shall specify the most significant byte of a track number of the first track of the Band *n*.

Byte (101 + *n* x 20): Track number of the first track of Band *n* (LSB)

This byte shall specify the least significant byte of a track number of the first track of the Band *n*.

Byte (102 + *n* x 20): Number of tracks in Band *n* (MSB)

This byte shall specify the most significant byte of a number of tracks in Band *n*.

Byte (103 + *n* x 20): Number of tracks in Band *n* (LSB)

This byte shall specify the least significant byte of a number of tracks in Band *n*.

Byte (104 + *n* x 20): Number of sectors in Band *n* (MSB)

This byte shall specify the most significant byte of a number of sectors in Band *n*.

Byte (105 + *n* x 20): Number of sectors in Band *n*

This byte shall specify the middle byte of a number of sectors in Band *n*.

Byte (106 + *n* x 20): Number of sectors in Band *n* (LSB)

This byte shall specify the least significant byte of a number of sectors in Band *n*.

Byte (107 + *n* x 20): Number of Sectors in User Area of Band *n* (MSB)

This byte shall specify the most significant byte of a number of the sectors in User Area of Band *n*.

Byte (108 + *n* x 20): Number of Sectors in User Area of Band *n*

This byte shall specify the middle byte of a number of the sectors in User Area of Band *n*.

Byte (109 + *n* x 20): Number of Sectors in User Area of Band *n* (LSB)

This byte shall specify the least significant byte of a number of the sectors in User Area of Band *n*.

Byte (110 + *n* x 20): Reserved for Band *n*

This byte shall be set to (00).

Byte (111 + *n* x 20): Reserved for Band *n*

This byte shall be set to (00).

Byte (112 + *n* x 20): Number of the Pre-buffer Sectors in Band *n* (MSB)

This byte shall specify the most significant byte of a number of the Pre-buffer Sectors in Band *n*.

Byte (113+ *n* x 20): Number of the Pre-buffer Sectors in Band *n* (LSB)

This byte shall specify the least significant byte of a number of the Pre-buffer Sectors in Band *n*.

Byte (114+ *n* x 20): Number of the Post-buffer Sectors in Band *n* (MSB)

This byte shall specify the most significant byte of a number of the Post-buffer Sectors in Band *n*.

Byte (115+ *n* x 20): Number of the Post-buffer Sectors in Band *n* (LSB)

This byte shall specify the least significant byte of a number of the Post-buffer Sectors in Band *n*.

Byte (116+ *n* x 20): Number of segments per sector in Band *n*

This byte shall specify the number of a segments per sector in Band *n*.

Byte (117+ *n* x 20): Clock Ratio in Band *n*

This byte shall specify the clock ratio Q of the data clock to the servo clock in Band *n*. A frequency of data clock f_d is specified as a formula such that

$$f_d = \frac{Q}{24} \times f_s$$

where f_s is the frequency of the servo clock.

Bytes (118 + *n* x 20) to (119 + *n* x 20): Reserved for Band *n*

These bytes shall be set to (FF).

Table D.3 - Byte assignment of the band data in the SFP Zone

Band No.	First track number	Number of tracks	Number of sectors	Number of User Sectors	Number of Pre-buffer Sectors	Number of Post-buffer Sectors	Number of segments per sector	Clock ratio *Q*
0	Byte 100, 101	Byte 102, 103	Byte 104 to 106	Byte 107 to 109	Byte 112, 113	Byte 114, 115	Byte 116	Byte 117
1	Byte 120, 121	Byte 122, 123	Byte 124 to 126	Byte 127 to 129	Byte 132, 133	Byte 134, 135	Byte 136	Byte 137
2	Byte 140, 141	Byte 142, 143	Byte 144 to 146	Byte 147 to 149	Byte 152, 153	Byte 154, 155	Byte 156	Byte 157
3	Byte 160, 161	Byte 162, 163	Byte 164 to 166	Byte 167 to 169	Byte 172, 173	Byte 174, 175	Byte 176	Byte 177
4	Byte 180, 181	Byte 182, 183	Byte 184 to 186	Byte 187 to 189	Byte 192, 193	Byte 194, 195	Byte 196	Byte 197
5	Byte 200, 201	Byte 202, 203	Byte 204 to 206	Byte 207 to 209	Byte 212, 213	Byte 214, 215	Byte 216	Byte 217
6	Byte 220, 221	Byte 222, 223	Byte 224 to 226	Byte 227 to 229	Byte 232, 233	Byte 234, 235	Byte 236	Byte 237
7	Byte 240, 241	Byte 242, 243	Byte 244 to 246	Byte 247 to 249	Byte 252, 253	Byte 254, 255	Byte 256	Byte 257
8	Byte 260, 261	Byte 262, 263	Byte 264 to 266	Byte 267 to 269	Byte 272, 273	Byte 274, 275	Byte 276	Byte 277
9	Byte 280, 281	Byte 282, 283	Byte 284 to 286	Byte 287 to 289	Byte 292, 293	Byte 294, 295	Byte 296	Byte 297
10	Byte 300, 301	Byte 302, 303	Byte 304 to 306	Byte 307 to 309	Byte 312, 313	Byte 314, 315	Byte 316	Byte 317
11	Byte 320, 321	Byte 322, 323	Byte 324 to 326	Byte 327 to 329	Byte 332, 133	Byte 334, 335	Byte 336	Byte 337
12	Byte 340, 341	Byte 342, 343	Byte 344 to 346	Byte 347 to 349	Byte 352, 353	Byte 354, 355	Byte 356	Byte 357
13	Byte 360, 361	Byte 362, 363	Byte 364 to 366	Byte 367 to 369	Byte 372, 373	Byte 374, 375	Byte 376	Byte 377
14	Byte 380, 381	Byte 382, 383	Byte 384 to 386	Byte 387 to 389	Byte 392, 393	Byte 394, 395	Byte 396	Byte 397
15	Byte 400, 401	Byte 402, 403	Byte 404 to 406	Byte 407 to 409	Byte 412, 413	Byte 414, 415	Byte 416	Byte 417

D.2.5 Unspecified data

Byte 420 to 2047

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

D.2.6 Summary of the contents of the SFP Zone

Table D.4 summarizes the contents of the SFP Zone. In case of Partially Embossed disks, the values of bytes 35 to 46 vary. The values in these bytes shown in the table are one of the examples.

Table D.4 - Summary of the contents of the SFP Zone

	Fully Rewritable	**Partially Embossed**	**Fully Embossed**
Byte 0 to 19	Same as GEP Zone	Same as GEP Zone	Same as GEP Zone
Byte 20	137	137	137
Byte 21	-1	-1	-1
Byte 22	120	120	120
Byte 23 to 29	Reserved	Reserved	Reserved
Byte 30,31	17 665	17 665	17 665
Byte 32, 33, 34	321 099	321 099	321 099
Byte 35, 36, 37	0	0 *	-1
Byte 38, 39, 40	16	16 *	-1
Byte 41, 42, 43	321 068	103 904 *	-1
Byte 44, 45, 46	321 084	103 920 *	-1
Byte 47	5	5	5
Byte 48	32	32	32
Byte 49, 50	2 048	2 048	2 048
Byte 51, 52	2 352	2 352	2 352
Byte 53	66	66	66
Byte 54	4	4	4
Byte 55	12	12	12
Byte 56	16	16	16
Byte 57 to 69	Reserved	Reserved	Reserved
Byte 70 to 91	DDS Information	DDS Information	DDS Information
Byte 92 to 99	Reserved	Reserved	Reserved
Byte 100 to 419	Band data	Band data	Band data

NOTE : The values of bytes 35 to 46 in Partially Embossed in the table are the values in the case of the disk where band 0 to 4 are rewritable and band 5 to 15 embossed.

Tables D.5 and D.6 show the examples of the contents of band data. Values of band data depend on the Media Type. Numbers of the Pre-buffer Sectors and the Post-buffer Sectors are valid in case of Partially Embossed disks.

Notes to tables D.5 and D.6 :

Number of Sectors = Number of User Sectors + Number of Pre-buffer Sectors + Number of Post-buffer Sectors

Table D.5 - Contents of Band Data: example 1

GRP1/16-R/W or GRP1-ROM

Band No.	First track number	Number of tracks	Number of sectors	Number of User Sectors	Number of Pre-buffer Sectors	Number of Post-buffer Sectors	Number of segments per sector	Clock ratio *Q*
0	0	848	20 800	20 800	0	0	53	48
1	848	864	20 800	20 800	0	0	54	47
2	1 712	880	20 800	20 800	0	0	55	46
3	2 592	912	20 800	20 800	0	0	57	45
4	3 504	944	20 800	20 800	0	0	59	43
5	4 448	976	20 800	20 800	0	0	61	42
6	5 424	1 024	20 800	20 800	0	0	64	40
7	6 448	1 056	20 800	20 800	0	0	66	39
8	7 504	1 120	20 800	20 800	0	0	70	37
9	8 624	1 184	20 800	20 800	0	0	74	35
10	9 808	1 216	20 800	20 800	0	0	76	34
11	11 024	1 296	20 800	20 800	0	0	81	32
12	12 320	1 392	20 800	20 800	0	0	87	30
13	13 712	1 488	20 800	20 800	0	0	93	28
14	15 200	1 696	20 800	20 800	0	0	106	25
15	16 896	770	9 100	9 100	0	0	110	24

Table D.6 - Contents of Band Data: example 2

GRP16-PROM (0 to 4: R/W, Band 5 to 15: ROM, Buffer Sectors: 64)

Band No.	First track number	Number of tracks	Number of sectors	Number of User Sectors	Number of Pre-buffer Sectors	Number of Post-buffer Sectors	Number of segments per sector	Clock ratio *Q*
0	0	848	20 800	20 800	0	0	53	48
1	848	864	20 800	20 800	0	0	54	47
2	1 712	880	20 800	20 800	0	0	55	46
3	2 592	912	20 800	20 800	0	0	57	45
4	3 504	944	20 800	20 736	64	0	59	43
5	4 448	976	20 800	20 800	0	0	61	42
6	5 424	1 024	20 800	20 800	0	0	64	40
7	6 448	1 056	20 800	20 800	0	0	66	39
8	7 504	1 120	20 800	20 800	0	0	70	37
9	8 624	1 184	20 800	20 800	0	0	74	35
10	9 808	1 216	20 800	20 800	0	0	76	34
11	11 024	1 296	20 800	20 800	0	0	81	32
12	12 320	1 392	20 800	20 800	0	0	87	30
13	13 712	1 488	20 800	20 800	0	0	93	28
14	15 200	1 696	20 800	20 800	0	0	106	25
15	16 896	770	9 100	9 100	0	0	110	24

Annex E

(normative)

Level Clamping Circuit

A Level clamping circuit shall be used to measure the imbalance of the Channel 2 signal.

A Channel 2 signal shall be level-clamped to reduce the low frequency base line fluctuation. The circuit consists of a buffer amplifier, sample-holder 1, sample-holder 2, and an operational amplifier as shown in figure E.1.

A raw Channel 2 signal is added to the buffer amplifier input and the output is directly connected to the positive input of the operational amplifier. The output of the buffer amplifier is blanched through sample-holder 1, through sample-holder 2 and finally to the negative input of the operational amplifier.

The sample hold timing pulses are defined relating to the servo fields as shown in figure E.2 using a timing circuit which is not indicated in the figures, then they are added to each sample-hold control input entries.

The level-clamped channel 2 signal will appear on the operational amplifier output terminal.

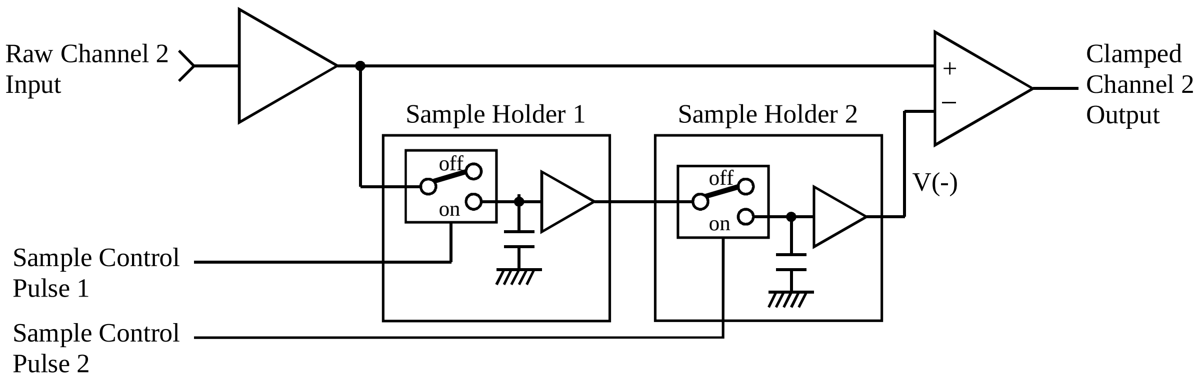


Figure E.1 - Level clamping circuit

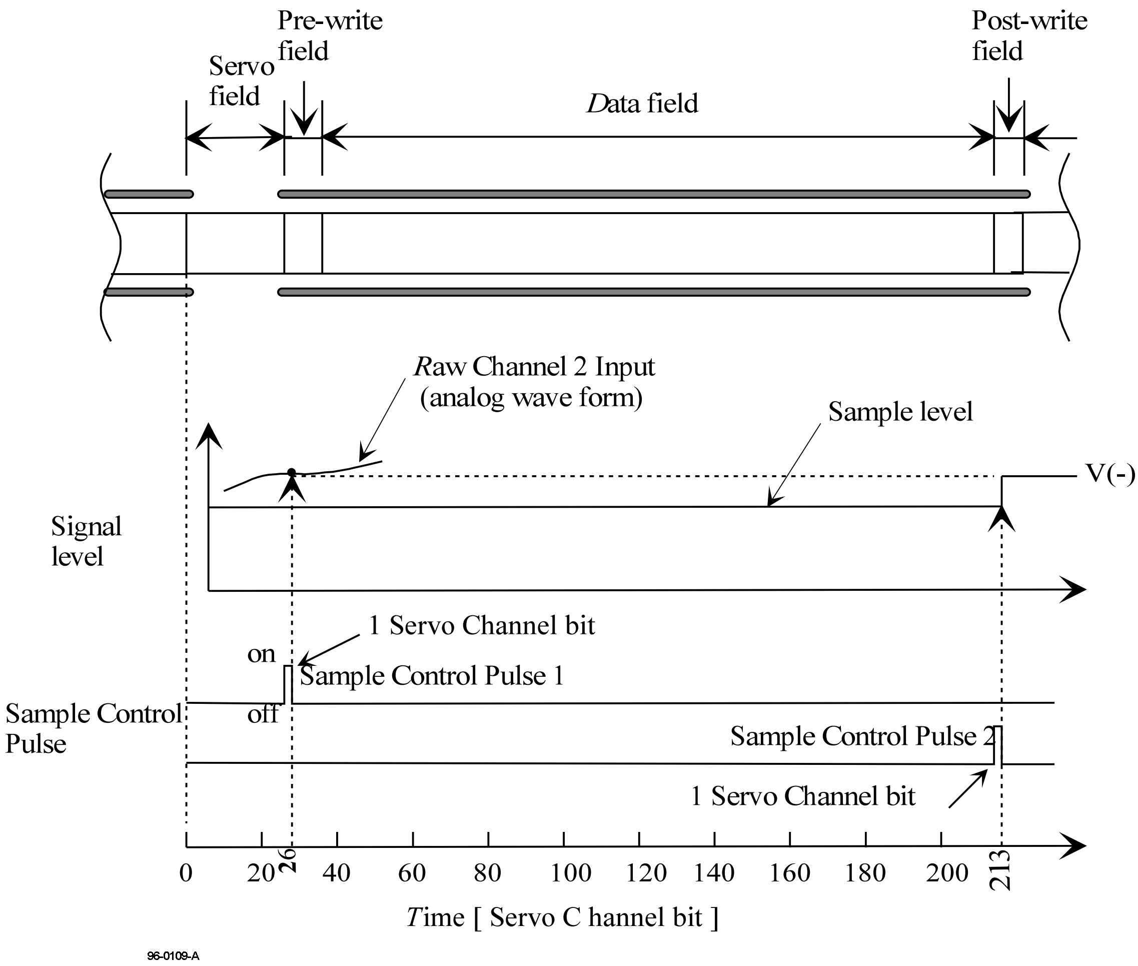


Figure E.2 - Sample hold timing

Annex F

(normative)

Measurement of the figure of merit

F.1 The figure of merit enables a drive designer to determine the amplitude of the signal in Channel 2 of the drive from magneto-optical marks recorded on the disk at a low spatial frequency in both the radial and tangential direction.

Determination of the figure of merit using a drive as the Reference Drive specified in clause 9 will measure not only media properties but also the optical retardation of the optical system of the drive. Therefore, a calibration of the drive is needed with a conventional determination of the figure of merit by measuring the reflectance, Kerr rotation and ellipticity. This calibration can only be executed reliably on media with low coercivity.

F.2 The drive shall be calibrated as follows. A test disk with negligible birefringence, e.g. a glass disk, and a low-coercivity magneto-optical layer is used for a conventional determination of the reflectance *R* , the Kerr rotation θ of the polarization between both opposite states of magnetization of the layer, and the Kerr ellipticity . The figure of merit of the media is then

A low-frequency test pattern is written on the same disk. The written domains shall be substantially larger than the focus spot, so as to work in the low spatial frequency region where the modulation transfer function of the optical system is one. This implies that for a disk rotation 40 Hz, a pattern of long domains with a frequency lower than 100 kHz has to be written on several consecutive tracks, while keeping the marks in neighbouring tracks radially aligned and overlapping.

The pattern is read with the drive to be calibrated. The resulting peak-to-peak amplitude *VL* of the signal in Channel 2 of the drive is the required calibration constant for this drive.

F.3 The figure of merit of any low- or high-coercivity disk can now be determined on the calibrated drive by writing the above test pattern and reading the peak-to-peak amplitude *V* of the signal in Channel 2. The figure of merit *F* of this disk is then

Annex G
(normative)
Write power

Write peak power P_W and the pulse width T_W shall be specified in table G.1.

Table G.1 - Write power and pulse width

Band	Write Peak Power [mW]	Pulse Width [ns]
0	13,4	19,1
4	11,9	23,0
15	11,9	23,0

Annex H

(normative)

Test method for measuring the absorbent force of the hub

H.1 The purpose of this test is to determine the magnetic characteristics of the magnetizable material of the hub.

H.2 The test drive (see figure H.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 = 5,1 mm ± 0,1 mm

D_e = 12,0 mm ± 0,1 mm

D_f = 11,0 mm max

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

H_c = 0,30 mm ± 0,01 mm

H_d = 1,20 mm ± 0,05 mm (Typical, to be adjust to meet the requirement of H.4)

H.3 The material of the test device shall be:

Magnet	: Nd - Fe - B
Back yoke	: Any suitable magnetizable material
Spacer	: Non-magnetizable material or air gap
Centre shaft	: Any suitable magnetizable material

H.4 The characteristics of the magnet with back yoke are as follows:

Number of poles : Axial one way

Maximum energy product (BH_{max}) : 66,4 KJ/m^3 ± 8,0 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 H.2), and the absorbent force of this plate at the point of H_c = 0,3 mm when spaced from the magnet surface shall be 2,8 N ± 0,2 N.

D_h = 5,0 mm ± 0,1 mm

D_i = 13,0 mm ± 0,1 mm

H_e = 0,40 mm ± 0,05 mm

H.5 **Test conditions for temperature**

These conditions shall be as specified in 8.1.1.

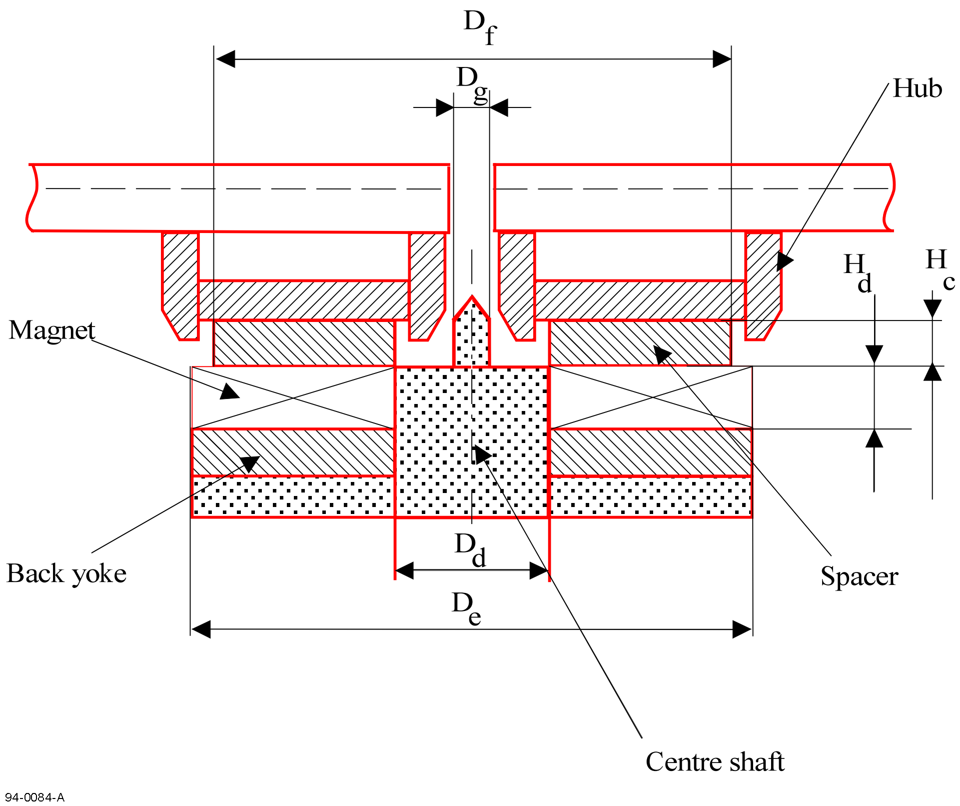


Figure H.1 - Test device for the clamping characteristic of the hub

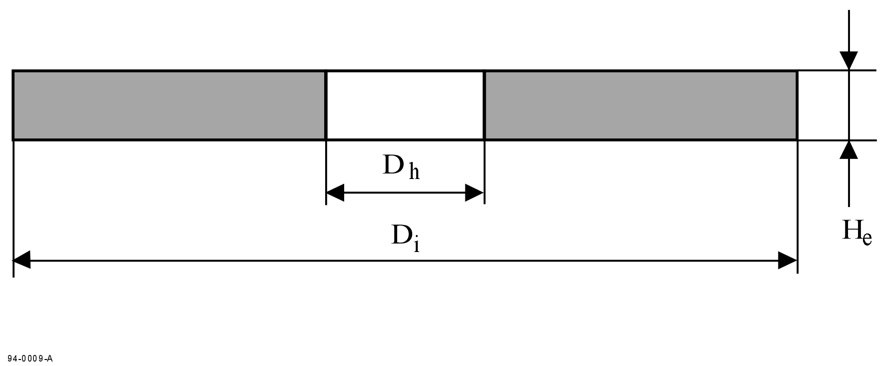


Figure H.2 - Calibration plate of the test device

Annex J

(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.

J.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 J.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 meter 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 meter are unreliable except when a large number of sampling is taken.

J.2 Test method

For particles of sizes of the 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.

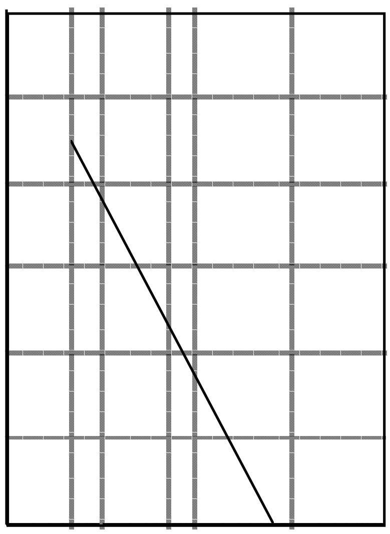


Figure J.1 - Particle size distribution curve

Annex K

(normative)

Position of the cartridge relative to the reference planes

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

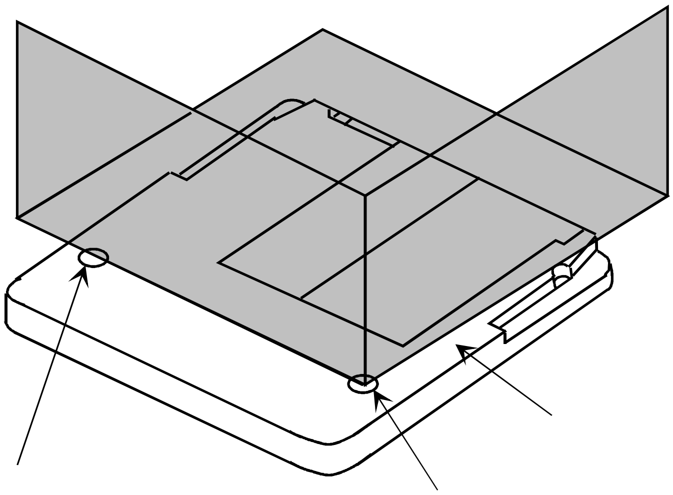


Figure K.1 - Position of the cartridge

Annex L

(normative)

Relaxation by zones of the requirement for signals

Table L.1 shows the zones in which the requirements specified in the body of this ECMA 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. The requirement for uniformity is extended from ± 12 % to ± 20 %.

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

Table L.1 - Requirements for signals in each zone

Clause	Signal	Zones										
		Outer GEP	Outer Buffer	Outer SFP	Outer Buffer	Outer Test	Data	Inner Test	Inner Buffer	Inner SFP	Inner Buffer	Inner GEP
11.5.3	Reflectance											
22.1	On-track modulation											
22.2	Off-track modulation											
22.3	Wobbled mark imbalance											
22.4	Tracking error modulation											
22.5	FWHM											
22.6	Jitter of wobbled marks											
23.1	Segment marks											
23.2	Address											
23.3	FWHM											
23.4	Segment mark position											
24.1	Groove offset											
24.2	On-track signal											
24.3	Phase depth											
25.1	Signal amplitude											
25.2	Signal asymmetry											
27.1	Figure of merit											
27.2	Imbalance of MO signal											
28.2	Resolution											
28.3	SNR											
28.4	Write sensitivity											

Annex M

(normative)

A method for calculation of the sector number

Sectors of optical disks according to this ECMA Standard do not have any sector ID fields. Thus, the sector number shall be calculated from the track number and the segment number in the following manner.

Find *n* from table M.1, which satisfies the condition

The sector number *SCN* shall be calculated by the formula.

where

TN : Track number

SN : Segment number

n : Band number

STN(*n*) : Track number of the first track of Band *n*

NS(*n*) : Number of segments per sector of Band *n*

Table M.1 - Number of segments per track and track number of the first track in each band

	n	***STN*(*n*)**	***NS*(*n*)**
Band 0	0	0	53
Band 1	1	848	54
Band 2	2	1 712	55
Band 3	3	2 592	57
Band 4	4	3 504	59
Band 5	5	4 448	61
Band 6	6	5 424	64
Band 7	7	6 448	66
Band 8	8	7 504	70
Band 9	9	8 624	74
Band 10	10	9 808	76
Band 11	11	11 024	81
Band 12	12	12 320	87
Band 13	13	13 712	93
Band 14	14	15 200	106
Band 15	15	16 896	110

Annex N

(normative)

Scrambling of recording data

The bit sequence of 2 352 bytes data in the sector data field shall be scrambled in the manner defined by the circuit in figure N.1. The output bit sequence is EXOR between the recording data sequence and the scrambled data sequence (see table N.1) generated by the maximum length linear feedback shift register, which is initialized to the all-ZERO state at the beginning of every sector. An LSB comes first in the bit sequence of the recording data byte and the scrambled data.

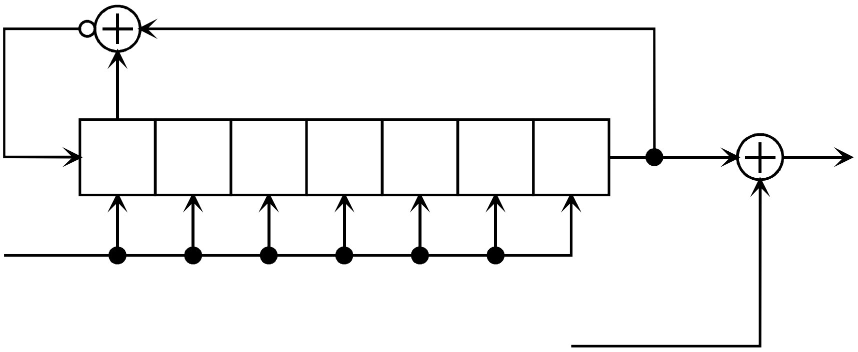


Figure N.1 - Scrambling circuit

Table N.1 - Scramble table

(80)	(6A)	(46)	(B4)	(9C)	(90)	(92)	(ED)	(78)	(C1)	(8A)	(E9)	(86)	(EB)	(F9)	(7E)
(40)	(35)	(23)	(5A)	(4E)	(48)	(C9)	(76)	(BC)	(60)	(C5)	(74)	(C3)	(F5)	(7C)	(3F)
(A0)	(9A)	(11)	(2D)	(27)	(A4)	(64)	(3B)	(5E)	(B0)	(62)	(BA)	(E1)	(7A)	(BE)	(1F)
(50)	(CD)	(88)	(96)	(13)	(52)	(B2)	(1D)	(2F)	(58)	(31)	(DD)	(70)	(3D)	(DF)	(0F)
(A8)	(66)	(44)	(CB)	(09)	(29)	(D9)	(8E)	(17)	(AC)	(98)	(6E)	(B8)	(9E)	(EF)	(07)
(54)	(33)	(A2)	(E5)	(84)	(94)	(6C)	(C7)	(0B)	(56)	(4C)	(37)	(5C)	(CF)	(F7)	(03)
(AA)	(19)	(D1)	(72)	(42)	(4A)	(B6)	(E3)	(05)	(2B)	(A6)	(1B)	(AE)	(E7)	(FB)	(01)
(D5)	(8C)	(68)	(39)	(21)	(25)	(DB)	(F1)	(82)	(15)	(D3)	(0D)	(D7)	(F3)	(FD)	(80)

Annex P

(informative)

Guidelines for sector replacement

Clause 20 assumes that if a sector is defective, it shall be replaced by defect management when any of the following conditions exist:

a) three consecutive Address field errors are found by parity check;

b) neither the last segment mark of the previous sector nor the first segment mark of the target sector can be recognized;

c) a column in the Sector Data field (see table C.1) contains more than three defective bytes A_n defined in annex C.1.

Annex Q

(informative)

Test method for measuring the friction force and wear in thickness

This test is available for rewritable and partially embossed disk. The measurement is executed by sensing friction force between a testing chip and disk under conditions described in notes and figure Q.1.

Notes;

1. Material of testing chip : CaTiO3 (Vickers hardness 800 ± 50)
2. Shape of testing chip : Spherical base
3. Air bearing surface roughness of testing chip : < 5 nm
4. Weight of testing chip : < 100 mg
5. Head loading force : 24 mN ± 3 mN
6. Minimum flying height : 4 µm (at load point under the condition of linear velocity 4,1 m/s)
7. Single rail structure
8. Orientation of mounted testing chip
   - pitch angle : 0,8 ° ± 0,4 °
   - roll angle : ± 0,5 °
   - load point : A load point is described by arrow A in figure Q.2.
9. Cut-off frequency of strain gauge : 250 Hz ± 50 Hz
10. Rotation speed : 40 Hz
11. Air cleanness : class 100 000 (see annex J)
12. Test cycle : Contact Start Stop cycle defined in figure Q.3

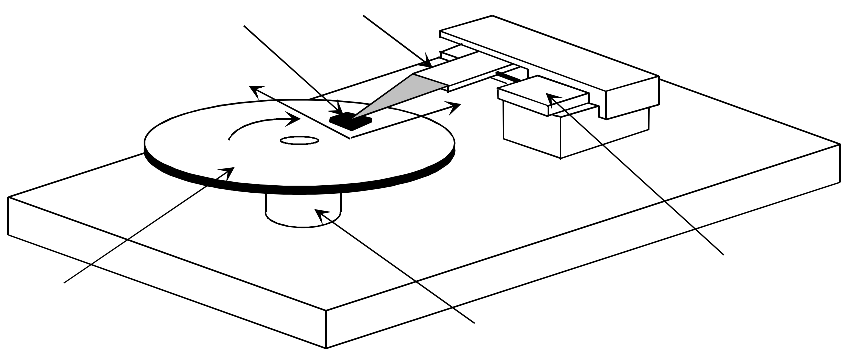


Figure Q.1 - Arrangement of testing chip and disk for the measurement of friction force

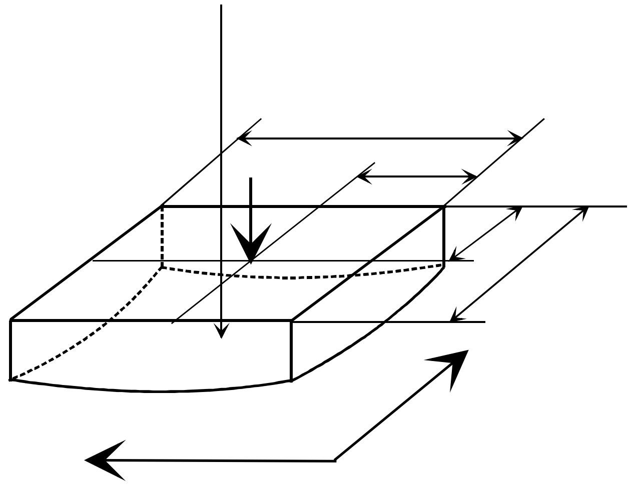


Figure Q.2 - Shape of testing chip

Dimensions of testing chip are

LI_1 = 6, 00 ± 0,05 mm

LI_2 = 5,00 ± 0,05 mm

RI_5 = 1 500 ± 100 mm

LI_6 = 2,5 ± 0,1 mm

LI_7 = 2,6 ± 0,1 mm

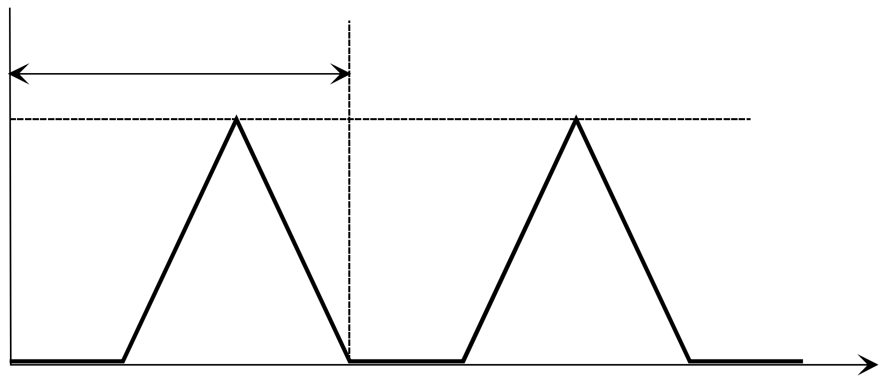


Figure Q.3 - Test cycle

Annex R

(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.

R.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 track (see 21.2.4). The relation between both is given in figure R.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.

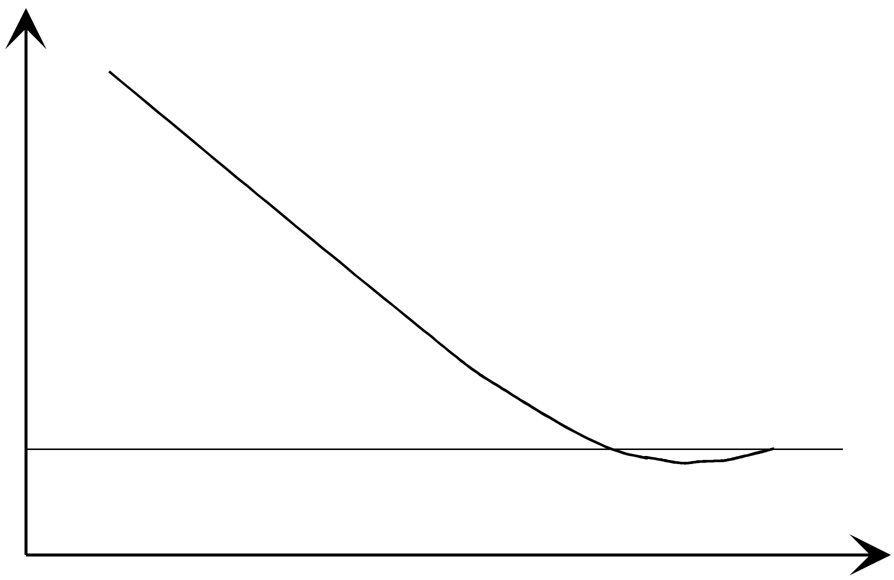


Figure R.1 - Maximum allowed amplitude of a sinusoidal track deviation

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

$$/ \quad , \qquad (1)$$

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

$$\qquad (2)$$

where e_{max} is the maximum allowed tracking error. The connection between both frequencies is given in R.3.

R.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 xmax to a tracking error emax as in figure R.1.

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

(3)

where , and , with 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 and the lag break frequency . The reduction of a track deviation to a tracking error *e* by the reference servo is given by

(4)

If the 0 dB frequency is specified as

(5)

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

(6)

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

(7)

At low frequencies (<) applies

(8)

Hence, it is permitted to use as specified for low frequencies in 11.4.6 and 11.4.8 for the calculation of of a reference servo.

R.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 emax during more than 17,8 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 40 Hz to 100 kHz. The constant c shall be 3. The 0 dB frequency shall be given by equation (5), where and for axial and radial tracking are specified in 21.2.4, 11.4.6 and 11.4.8.

R.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.

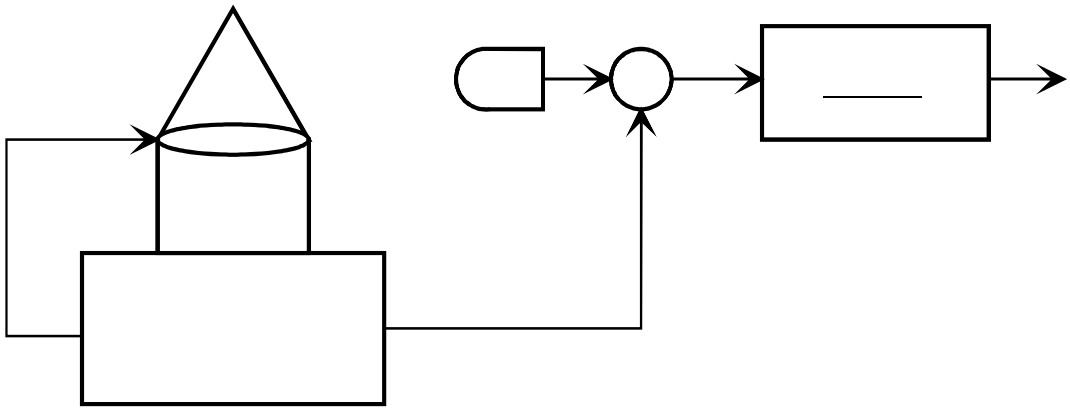


Figure R.2 - Implementation of a Reference Servo by filtering the track position signal with the reduction characteristics of the Reference Servo

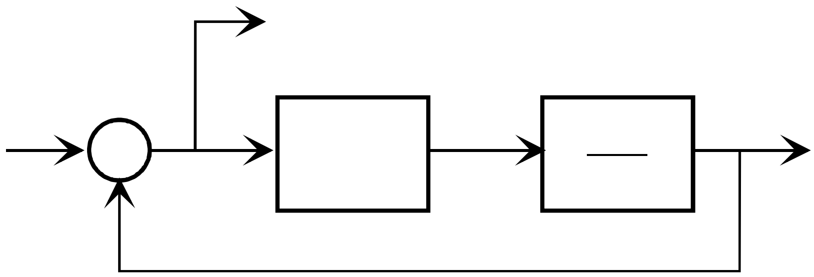


Figure R.3 - Implementation of a Reference Servo by changing the transfer function of the actual servo

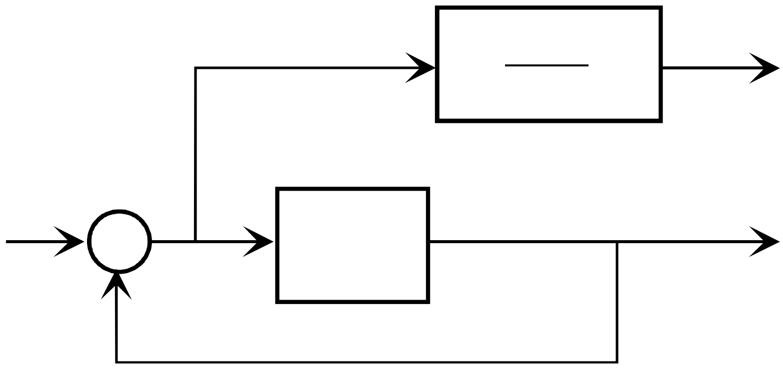


Figure R.4 - Implementation of a Reference Servo by changing the tracking error of the actual servo

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 R.2 is used in the low-frequency channel, while that of figures R.3 or R.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 current through the motor as a measure of the acceleration of the motor, provided the latter is free from hysterics. 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 / / , derived from equation (4).

Annex S

(informative)

Derivation of the operating climatic environment

This annex gives some background on how some of the conditions of the operating environment in clause 9.1.2 have been derived**.**

S.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. 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."

S.2 Overtemperature considerations

While IEC class 3K3 defines the limits for the room climate only, the ODC operating environment specification in this ECMA 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.

S.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 S.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 worldwide normal office environments.

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

- Absolute humidity

  The IEC 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 3K3 + 20 °C would have become 60 °C). For ODCs according to this ECMA Standard, however, the 55 °C limit is considered to be a physical limit above which operation (as well as storage) 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 3K3 limit of 40°C.

- Further

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

S.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 S.2 shows 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.

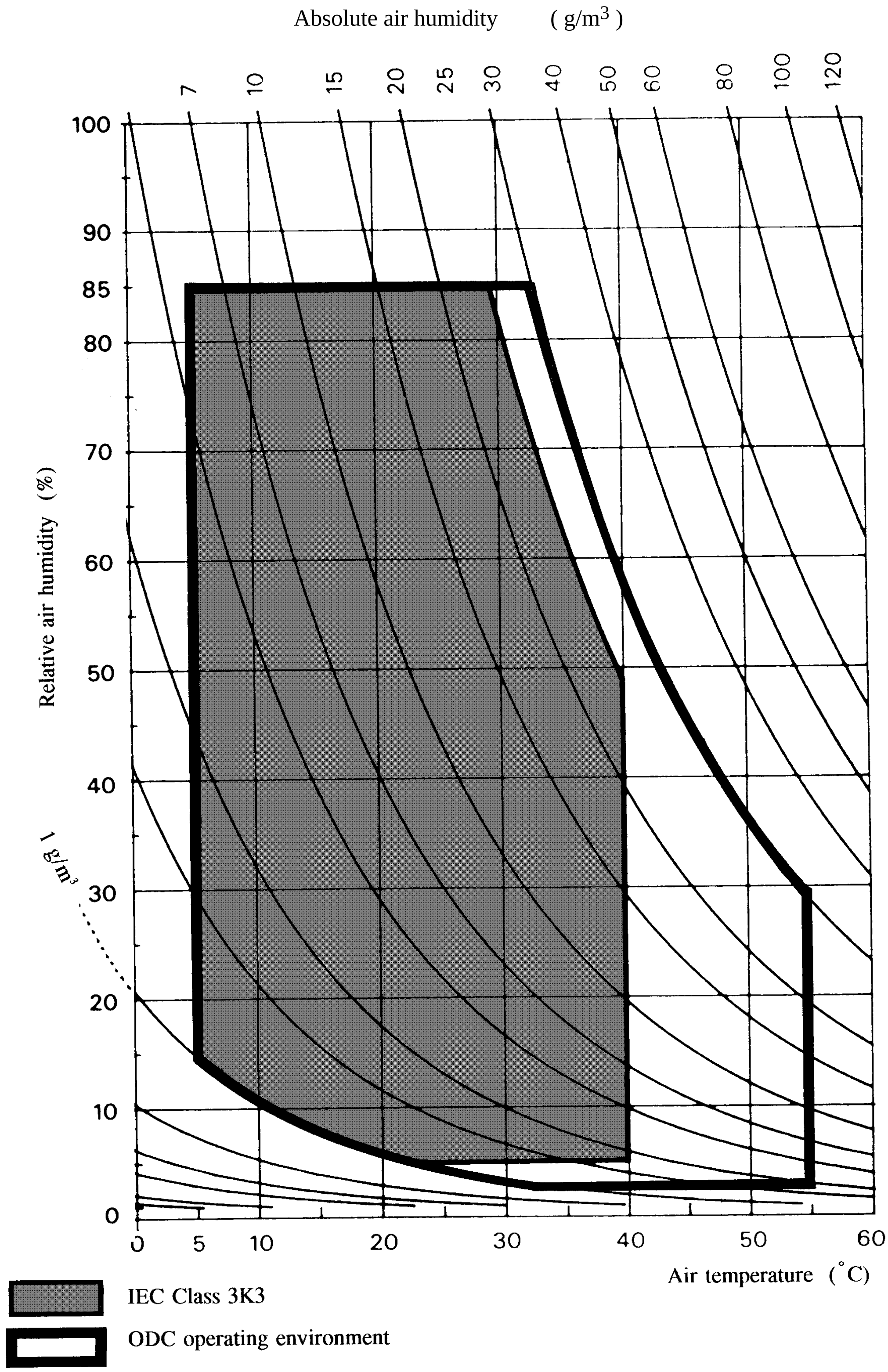


Figure S.1 - Climatogram of IEC Class 3K3 and the ODC operating environment

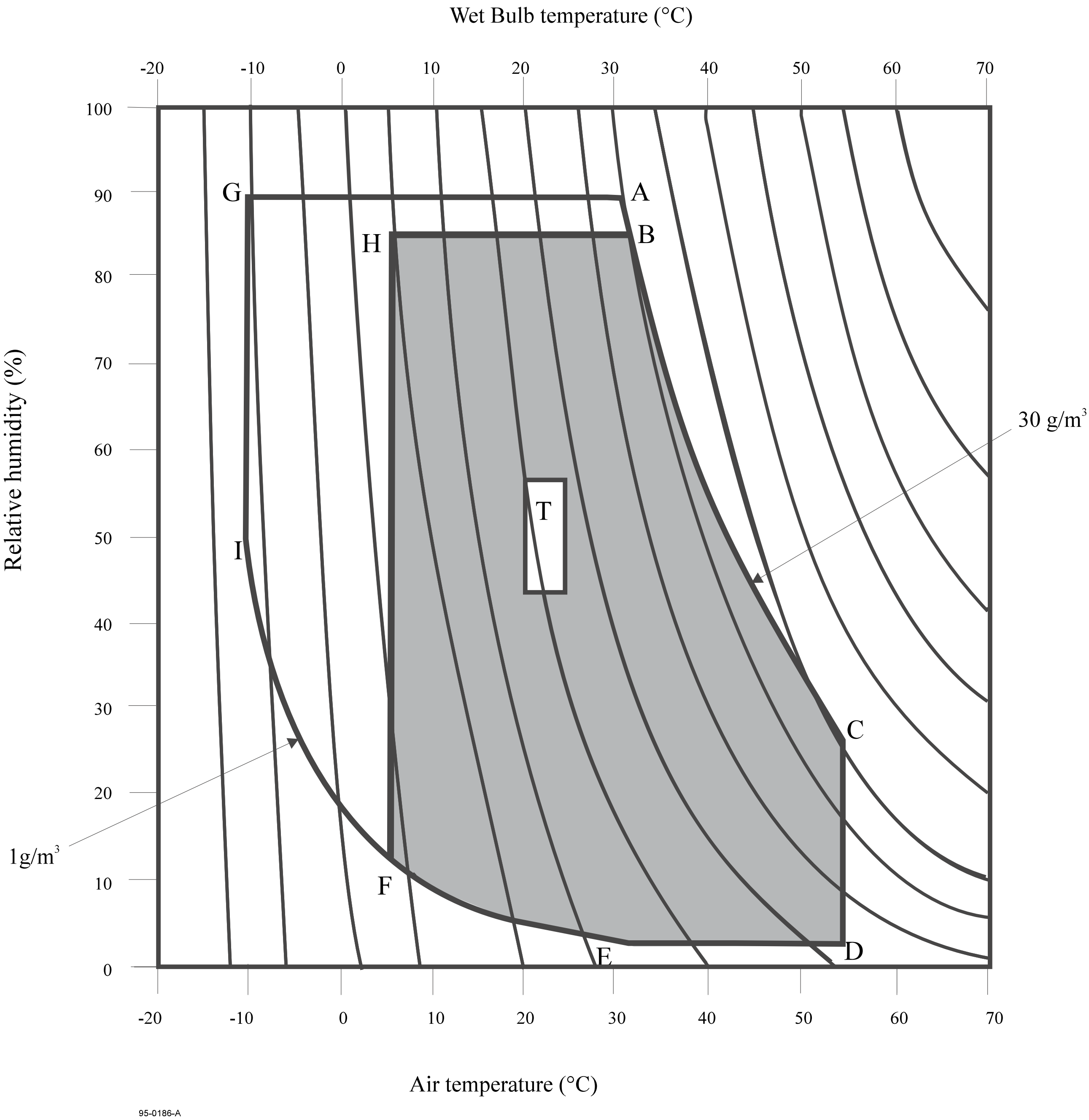


Figure S.2 - Wet bulb temperatures of the operating and storage environments

Table S.2 - Position of the main points

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	55,0 °C	28,8 %	35,5 °C
D	55,0 °C	3,0 %	21,9 °C
E	31,7 °C	3,0 %	12,1 °C
F	5,0 °C	14,6 %	-1,4 °C
G	-10,0 °C	90,0 %	-10,3 °C
H	5,0 °C	85,0 %	4,0 °C
I	-10,0 °C	46,9 %	-11,8 °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-A		
Operating environment	is determined by B-C-D-E-F-H-B		

Annex T

(informative)

Transportation

T.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.

T.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.

T.2.1 Temperature and humidity

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

T.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.

Annex U

(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 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.

Annex V

(informative)

Values to be implemented in existing and future specifications

This ECMA Standard specifies values for bytes which identify optical cartridges which conform to this ECMA 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.

V.1 Byte 1 of the SFP Zones

The setting of bits 7 to 4 has the indicated meaning

0000 Read-only ODCs (ROM)

0001 Write-once ODCs

0010 Rewritable ODCs

1001 Partial ROM of Write-once ODCs

1010 Partial ROM of MO

V.2 Byte 2 of the SFP Zones

The setting of bits 6 to 4 has 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 Zoned Logical Constant Angular Velocity (Logical ZCAV)

Annex W

(informative)

Detection of the Segment Mark positions

The position of the Segment Mark may be recognized using differential detection as shown in figure W.1.

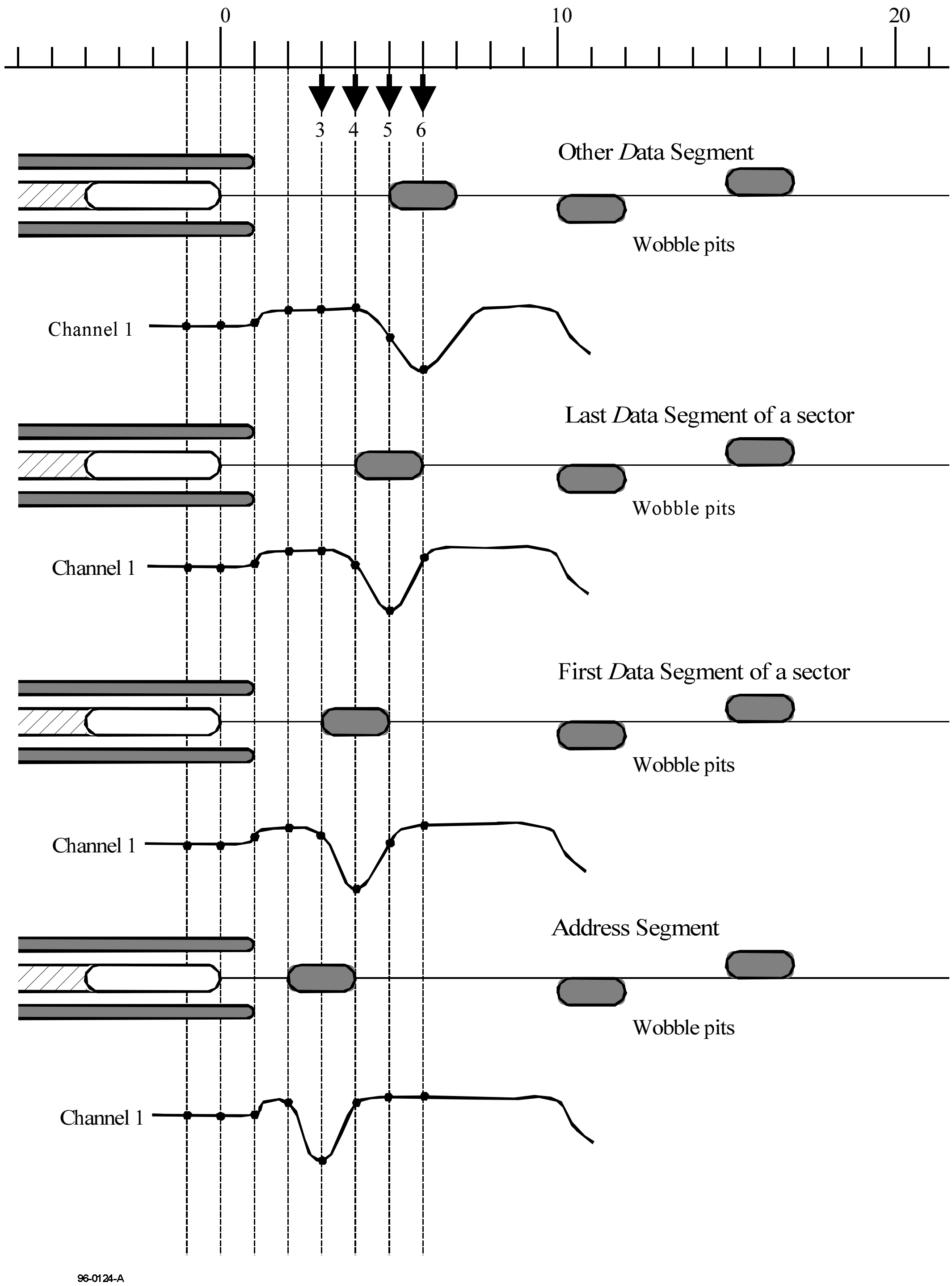


Figure W.1 - Detection of the segment mark positions

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The ECMA site can be reached also via a modem. The phone number is +41 22 735.33.29, modem settings are 8/n/1. Telnet (at ftp.ecma.ch) can also be used.

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