ECMA

Standardizing Information and Communication Systems

Data Interchange on 90 mm Optical Disk Cartridges - Capacity: 385 Megabytes per Cartridge

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Brief History

Technical committee ECMA TC31 for Optical Disk Cartridges (ODC) was set up in 1984. The committee made major contributions to ISO/IEC JTC1/SC23 for the development of standards for 90 mm, 120 mm, 130 mm, 300 mm and 356 mm ODCs. ECMA produced camera-ready copies for most International ODC Standards. In addition, ECMA published the following ODC Standards:

ECMA-130 (1988)	Data Interchange on Read-only 120 mm Optical Data Disks (CD-ROM)
ECMA-153 (1991)	Information Interchange on 130 mm Optical Disk Cartridges of the Write Once, Read Multiple (WORM) type, using the Magneto-Optical effect.
ECMA-154 (1991)	Data Interchange on 90 mm Optical Disk Cartridges, Read-Only and Rewritable M.O.
ECMA-183 (1992)	Data Interchange on 130 mm Optical Disk Cartridges - Capacity: 1 Gbyte
ECMA-184 (1992)	Data Interchange on 130 mm Optical Disk Cartridges - Capacity: 1,3 Gbytes
ECMA-189 (1993)	Information Interchange on 300 mm ODCs of the WORM type using the SSF Method.
ECMA-190 (1993)	Information Interchange on 300 mm ODCs of the WORM type using the CCS Method.
ECMA-195 (1993)	Data Interchange on 130 mm Optical Disk Cartridges - Capacity: 2 Gbytes
ECMA-201 (1994)	Data Interchange on 90 mm Optical Disk Cartridges - Capacity: 230 Mbytes

Most of these ECMA Standards have been adopted under the fast-track procedure of ISO/IEC.

ECMA Standard	ISO/IEC Standard
ECMA-130	ISO/IEC 10149
ECMA-153	ISO/IEC 11560
ECMA-154	ISO/IEC 10090
ECMA-183	ISO/IEC 13481
ECMA-184	ISO/IEC 13549
ECMA-189	ISO/IEC 13403
ECMA-190	ISO/IEC 13614
ECMA-195	ISO/IEC 13842
ECMA-201	ISO/IEC 13963

The present ECMA Standard is a standard in the 90 mm ODC series. It specifies the GCR recording code and unlike any previous ODC standard, it allows both user data areas and headers to be written by drives in the field. It provides a capacity of 385 MB per cartridge.

Accepted as an ECMA Standard by the General Assembly of June 1995.

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Section 1 - General

1 Scope

This ECMA Standard specifies the characteristics of 90 mm Optical Disk Cartridges, (ODCs) with a capacity of 385 Mbytes per cartridge. The Standard specifies one type of such cartridge, viz.

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

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, both embossed and user written; including the physical disposition of the tracks and sectors, the error correction codes and the modulation method used;

– the characteristics of the embossed information on the disk;

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

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

This ECMA Standard provides for media 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 90 mm optical disk cartridge claiming conformance with this ECMA Standard shall be in conformance if it meets all mandatory requirements specified herein.

Annex R specifies the zones of the disk in which the requirements for the signal characteristics given in the body of this ECMA Standard shall be met, and the zones in which a relaxation of these requirements is permitted.

2.2 Generating system

A system generating an ODC for interchange shall be entitled to claim conformance with this ECMA Standard if it meets all of the mandatory requirements of this Standard.

2.3 Receiving System

A system receiving an ODC for interchange shall be entitled to claim conformance to this ECMA Standard if it is able to process any recording made on the cartridge according to 2.1.

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/or International Standard(s) supported. This statement shall specify the number of the Standard(s), the ODC type(s) supported (where appropriate) and whether support includes reading or both reading and writing.

3 References

The following Standards contain provisions which, through reference in this text, constitute provisions of this ECMA Standard. At the time of publication, the edition indicated was valid. All Standards are subject to revision, and parties

to agreements based on this ECMA Standard are encouraged to investigate the possibility of applying the most recent edition of the Standards listed below.

ECMA-129 (1994),   Information Technology Equipment - Safety

ECMA-201 (1994)   Data Interchange on 90 mm Optical Disk Cartridges - Capacity: 230 Megabytes

4 Definitions

For the purpose of this ECMA Standard the following definitions apply.

4.1 band

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 of data on a disk. It is recorded as either a space or a mark. Nine Channel bits are used to represent eight input bits.

4.4 clamping zone

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

4.5 control track

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

4.6 Cyclic Redundancy Check (CRC)

A method for detecting errors in data.

4.7 defect management

A method for handling the defective areas on the disk.

4.8 disk reference plane

A plane defined by the perfectly flat annular surface of an ideal spindle onto which the clamping zone of the disk is clamped, and which is normal to the axis of rotation.

4.9 embossed mark

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

4.10 entrance surface

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

4.11 Error Correction Code (ECC)

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

4.12 field

A subdivision of a sector.

4.13 format

The arrangement or layout of information on the disk.

4.14 fully rewritable disk

An optical disk in which all fields in the Data Zone can be rewritten by an optical beam.

4.15 groove

See land and groove

4.16 hub

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

4.17 interleaving

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

4.18 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.

4.19 land and groove

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

4.20 logical track

A contiguous length of 25 sectors that may be less than one complete revolution of the disk. The first sector of each logical track is assigned sector number 0.

4.21 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

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

4.21.1 Mark edge recording

A recording method which uses a mark edge to represent a Channel bit.

4.22 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.

4.23 optical disk cartridge (ODC)

A device consisting of a case containing an optical disk.

4.24 physical track

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

4.25 physical track group

A fixed number of consecutive physical tracks in the Data Zone.

4.26 pitch

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

4.27 polarization

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

4.28 read power

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

Note

It is specified as a maximum power that may be used without damage to the written data. Lower power may be used provided that the Signal-to-Noise Ratio, (SNR) and other requirements of this ECMA Standard are met.

4.29   recording layer

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

4.30   Reed-Solomon code

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

4.31   rewritable optical disk

An optical disk in which data in specified areas can be written, erased and rewritten by an optical beam.

4.32   sector

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

4.33   spindle

That part of the disk drive which contacts the disk and hub.

4.34   substrate

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

4.35   ZCAV format

A recording format for a disk in which each group of adjacent tracks is written using an increasing Write Clock frequency when moving from groups at the ID to those at the OD of the disk.

4.36   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 ZEROs and ONEs.

– Numbers in binary notation and bit combinations are shown with the most significant bit to the left.

– Negative values of numbers in binary notation are given in TWO's complement.

– In each field the data is recorded so that the most significant byte (byte 0) is recorded first. Within each byte the least significant bit is numbered 0 and is recorded last, the most significant bit (numbered 7 in an 8-bit byte) is recorded first. This order of recording applies also to the data input of the Error Detection and Correction circuits and to their output.

– Unless otherwise stated, all track numbers refer to logical tracks.

– Unless otherwise stated, groups of decimal digits of the form xx...x/yy...y indicate that the value xx...x applies to 1 024-byte sectors and that the value yy...y applies to 512-byte sectors.

5.2   Names

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

6   List of acronyms

AM	Address Mark
CCS	Continuous Composite Servo (tracking method)
CRC	Cyclic Redundancy Check
DDS	Disk Definition Structure
DMA	Defect Management Area
ECC	Error Correction Code
FA1	Functional Area 1
FA2	Functional Area 2
GCR	Group Code Recording
ID	Identifier
LSB	Least Significant Byte
MO	Magneto Optic
MSB	Most Significant Byte
ODC	Optical Disk Cartridge
PA	Postamble
PDL	Primary Defect List
RLL	Run Length Limited (code)
R/W	Rewritable
SDL	Secondary Defect List
SM	Sector Mark
VFO	Variable Frequency Oscillator
ZCAV	Zoned Constant Angular Velocity

7   General description of the optical disk cartridge

The optical disk cartridge which is the subject of this 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 erased from it 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 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   Testing environment

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

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

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 Q)
Magnetic field strength at the recording layer for any condition under which a beam is in focus	: 32 000 A/m max.
Magnetic field strength at the recording layer during any other condition	: 48 000 A/m max.

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

8.1.3 Storage environment

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

temperature	: -10 °C to 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 Q)
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 P.

8.2 Temperature shock

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

8.3 Safety requirements

The cartridge shall satisfy the safety requirements of 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 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, read and erase 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, read and erase 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	G	Optical disk
B	Collimator lens	H	Optional half-wave plate
C	Optional shaping prism	I	Phase retarder
Ch.1	Channel 1	J	Polarizing beam splitter
Ch.2	Channel 2	K_1,K_2	Photodiodes for Channels 1 and 2
D	Beam splitter	K_3	Split photodiode
E	Polarizing beam splitter	L_1,L_2	d.c.-coupled amplifiers
F	Objective lens	M	Tracking Channel (see 20.3)
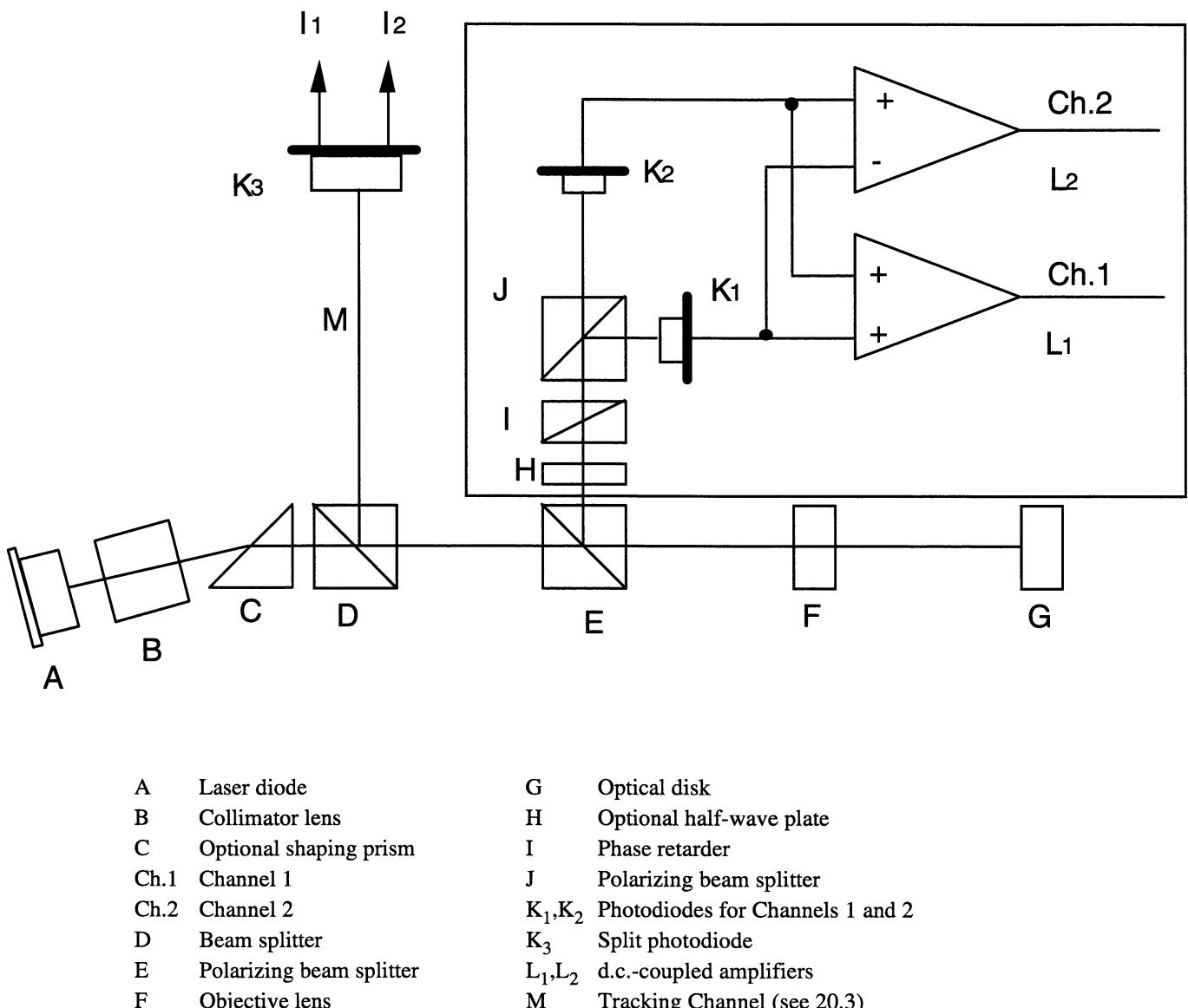
Figure 1 - Optical system of the Reference Drive

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 I 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 narrow-band signal-to-noise ratio (see 26.2).

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 reflectances. If the measurement is made on a drive with reflectances R_p' and R_s' for beam splitter E, then the measured imbalance shall be multiplied by

$$\sqrt{\frac{R_s R'_p}{R_p R'_s}}$$

to make it correspond to the nominal beam splitter E.

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

9.2 Optical beam

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

a) Wavelength (λ) $780 \text{ nm}^{+15 \text{ nm}}_{-10 \text{ nm}}$

b) Wavelength (λ) divided by the numerical aperture of the objective lens (NA) λ /NA = 1,423 µm ± 0,023 µm

c) Filling D/W of the aperture of the objective lens 1,0 max.

d) Variance of the wavefront of the optical beam near the recording layer $\lambda^2 / 180$ max.

e) Polarization Linear, parallel or perpendicular to the groove, where appropriate

f) Extinction ratio 0,01 max.

g) The optical power and pulse width for writing, reading and erasing, and the magnetic field shall be as specified in 20.2.2, 24.2.2, 24.3, 24.4, and 28.2.2.

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 100 kHz to 22,3 MHz.

9.4 Tracking

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

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

9.5   Rotation of the disk

The spindle shall position the disk as specified in 12.4. It shall rotate the disk at 30,0 Hz ± 0,3 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 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, write-inhibit and reflectance detection features, and gripper slots for an autochanger.

10.2 Reference planes of the case

The dimensions of the case shall be referred to three orthogonal reference planes X, Y and Z. The case shall be constrained such that four reference surfaces S_1 to S_4 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 in the X plane (see annex N). 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

$L_1 = 94,0$ mm $\pm$ 0,3 mm

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

$L_2 = 76,0$ mm $\pm$ 0,2 mm

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

$L_3 = 18,0$ mm $\pm$ 0,2 mm

The total width of the case shall be

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

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

$L_5 = 85,0$ mm $\pm$ 0,3 mm

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

$L_6 = 5,0$ mm $\pm$ 0,1 mm

The corner at the top shall be rounded with a radius

$R_1 = 1,5$ mm $\pm$ 0,2 mm

and the two corners at the bottom with a radius

$R_2 = 2,0$ mm $\pm$ 0,2 mm

In the zones extending

$L_7 = 8,6$ mm min.

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

$L_8 = 6,0$ mm $\pm$ 0,2 mm

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

$$R_3 = 0,3 \text{ mm}^{+\,0,2\text{ mm}}_{-\,0,0\text{ mm}}$$

10.3.2 Location hole (see figure 3)

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

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

held to a depth

$$L_9 = 1,5 \text{ mm min.}$$

The location hole shall extend below plane Z by

$$L_{10} = 4,0 \text{ mm min.}$$

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

$$R_4 = 0,5 \text{ mm max.}$$

10.3.3 Alignment hole (see figure 3)

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

$$L_{11} = 80,0 \text{ mm} \pm 0,2 \text{ mm}$$

from reference plane Y.

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

$$L_{12} = 3,60 \text{ mm}^{+\,0,00\text{ mm}}_{-\,0,06\text{ mm}}$$

$$L_{13} = 4,4 \text{ mm}^{+\,0,2\text{ mm}}_{-\,0,0\text{ mm}}$$

held to a depth L_9, below which the alignment hole shall extend to L_{10}, with dimensions equal to, or greater than, L_{12} and L_{13}, respectively.

The alignment hole shall not extend through Side B.

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

10.3.4 Reference surfaces (see figure 4)

Side A of the case shall contain four reference surfaces S_1, S_2, S_3 and S_4.

Surfaces S_1 and S_2 shall be circular with a diameter

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

S_1 shall be centred on the location hole, and S_2 shall be centred on the alignment hole.

Surfaces S_3 and S_4 shall be circular with a diameter

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

with their centres located at

$$L_{14} = 54,0 \text{ mm} \pm 0,2 \text{ mm}$$

$$L_{15} = 1,0 \text{ mm} \pm 0,2 \text{ mm and}$$

$L_{16} = 81,0$ mm $\pm$ 0,2 mm

No portion of the case or of the shutter mechanism (see 10.3.8) shall protrude more than

$L_{17} = 0,15$ mm max.

beyond plane Z.

10.3.5 **Detents (see figure 5)**

The case shall have two symmetrical detents intended for autoloading. Each detent shall extend from plane Z up to

$L_{18} = 5,0$ mm min.

and shall not extend through Side B.

Each detent is defined by a semi-circular section with a radius

$R_5 = 2,1$ mm $\pm$ 0,1 mm

which stretches out to the side of the case along two straight lines extending from the semi-circle. The radii of the two detents originate from

$L_{19} = 65,5$ mm $\pm$ 0,2 mm

$L_{20} = 4,0$ mm max.

$L_{21} = 84,0$ mm max.

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

$R_6 = 0,5$ mm $\pm$ 0,2 mm

10.3.6 **Functional Areas (see figure 6)**

The case shall have an opening in Side A the length of which shall be

$L_{22} = 8,2$ mm min.

Its width shall be at least equal to L_{23}, and its centreline shall be located on the intersection of planes Y and Z.

Functional Area FA1 shall have the dimensions

$L_{23} = 4,4$ mm min.

$L_{24} = 3,6$ mm min.

Its centreline shall be in plane Z, and parallel to plane X at a distance

$L_{25} = 7,8$ mm $\pm$ 0,2 mm

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

Functional Area FA2 shall have the dimensions L_{23}, L_{24} and

$L_{26} = 4,0$ mm min.

Its centreline shall be in plane Z, and parallel to plane X at a distance

$L_{27} = 12,8$ mm $\pm$ 0,2 mm

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).

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Table 1 - Use of the Functional Areas FA1 and FA2

FA1	FA2	Writing	Reflectance	Type of Cartridge
Open	Closed	Inhibited	Low	R/W
Closed	Open	Permitted	Low	
Closed	Closed			
Open	Open	Not permitted by this ECMA Standard		

The surface of the device shall be at a distance

$L_{28} = 0{,}3$ mm max.

from plane Z.

10.3.7 **Spindle and head windows (see figure 7)**

Side A of the case shall have a window to enable the spindle and the optical head of the drive to access the disk. The dimensions of the window are referenced to a centreline, located at a distance

$L_{29} = 40{,}0$ mm $\pm$ 0,2 mm

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

$L_{30} = 11{,}0$ mm $^{+\,0{,}2\,mm}_{-\,0{,}0\,mm}$

and

$L_{31} = 11{,}0$ mm $^{+\,0{,}2\,mm}_{-\,0{,}0\,mm}$

The top of the window shall be given by radius

$R_7 = 43{,}7$ mm min.

originating from L_{29} and

$L_{32} = 27{,}0$ mm $\pm$ 0,2 mm

The area bounded by R_7 and the top of the case shall be recessed from plane Z by

$L_{33} = 2{,}0$ mm $^{+\,0{,}2\,mm}_{-\,0{,}0\,mm}$

over the width of the window.

The bottom of the window shall be the arc of the semi-circle which smoothly joins the sides of the window. The centre of the semi-circle shall be defined by L_{29} and L_{32}.

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_{29} from plane Y. The width of the window shall be given by L_{30} and L_{31}. The window shall extend from

$L_{34} = 40{,}0$ mm max.

to the arc of R_7, originating from L_{29} and L_{32}.

The area bounded by R_7 and the top of the case shall be, over the width of the window, at a distance

$L_{35} = 4{,}2$ mm $^{+\,0{,}0\,mm}_{-\,0{,}4\,mm}$

from plane Z.

The two inside corners shall be rounded with a radius

$R_8 = 2,0$ 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 semi-circle at the bottom of the window up to the top of the case, and from L_{30} to L_{31};

on Side B: from L_{34} up to the top of the case, and from L_{30} to L_{31};

on the top: from plane Z to L_{33}, from L_{30} to L_{31}, from L_{35} up to Side B, and from L_{30} to L_{31}.

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_8 by more than 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

$$L_{36} = 79,0 \text{ mm} \quad {}^{+\,0,0\text{ mm}}_{-\,0,3\text{ mm}}$$

from plane Y. A movement of the edge to

$$L_{37} = 55,5 \text{ mm min.}$$

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

$$L_{38} = 54,7 \text{ mm max.}$$

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 figure 9)**

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

The path shall run from

$$L_{39} = 81,0 \text{ mm} \pm 0,3 \text{ mm}$$

to

$$L_{40} = 57,5 \text{ mm} \quad {}^{+\,0,3\text{ mm}}_{-\,0,0\text{ mm}}$$

at a distance

$$L_{41} = 74,0 \text{ mm} \pm 0,3 \text{ mm}$$

from plane X.

The lead-in edge at L_{39} shall be a ramp to the top of the case with an angle

$$A_1 = 45° \pm 5°$$

The path shall end in a notch with a width at the bottom from L_{40} to

$$L_{42} = 54,7 \text{ mm max.}$$

and a depth

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

below L_{41}. The lead-in edge at the right-hand side of the notch shall be rounded with a radius

$$R_9 = 1,2 \text{ mm} \pm 0,2 \text{ mm}$$

When the shutter edge is moved to L_{37}, a length of at least ($L_{40} - L_{37}$) of the notch shall be exposed. This enables a drive to confirm that the shutter is fully open.

10.3.10   Mis-insert protections (see figure 10)

The profile on the top of the case shall have two features to prevent the case from being inserted in the drive upside-down.

The first feature is a notch intended to capture and block the shutter opener of the drive if the case is loaded upside-down. It shall have a width from

L_{44} = 4,6 mm ± 0,2 mm

to

L_{45} = 1,0 mm ± 0,2 mm

and a depth

L_{46} = 3,1 mm ± 0,2 mm

below the top of the case.

The right-hand edge of the notch shall be

L_{47} = 75,4 mm ± 0,2 mm

above plane X.

The corners of this notch shall be rounded off by radii

R_{10} = 0,3 mm max.

R_{11} = 0,5 mm ± 0,3 mm

The second feature is a chamfer and a tooth. If the case is correctly loaded, the chamfer pushes aside a possible pawl in the side of the sledge of the drive. If the case is loaded upside-down, the pawl catches the tooth and prevents further insertion of the case. The tooth is formed by the ramp specified in 10.3.10. The chamfer shall have an angle

A_2 = 45° ± 2°

and a height

L_{48} = 5,0 mm ± 0,3 mm

10.3.11   Gripper slots (see figure 11)

The case shall have two symmetrical gripper slots. The slot shall have a depth of

L_{49} = 2,5 mm $^{+\,0,3\ mm}_{-\,0,0\ mm}$

from the edge of the case and a width of

L_{50} = 4,0 mm $^{+\,0,3\ mm}_{-\,0,0\ mm}$

The lower edge of a slot shall be

L_{51} = 23,0 mm $^{+\,0,0\ mm}_{-\,0,3\ mm}$

above the bottom of the case.

The corners of the gripper slots shall be rounded off by radii

R_{12} = 0,4 mm ± 0,2 mm

R_{13} = 0,5 mm ± 0,2 mm

10.3.12 Label area (see figure 12)

The case shall have one connected label area on Side A, the bottom and Side B, with dimensions

$L_{52} = 4,0 \text{ mm} \pm 0,3 \text{ mm}$

$L_{53} = 76,0 \text{ mm} \pm 0,3 \text{ mm}$

$L_{54} = 30,0 \text{ mm} \pm 0,2 \text{ mm}$

and

$L_{55} = 1,2 \text{ mm} \pm 0,2 \text{ mm}$

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

$R_{14} = 2,0 \text{ mm max.}$

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

$L_{56} = 0,2 \text{ mm min. on all three sides.}$

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 50 g.

10.4.3 Edge distortion

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

10.4.4 Compliance

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

10.4.5 Shutter opening force

The spring force on the shutter shall be such that the force required to open the shutter does not exceed 1,5 N. It shall be sufficiently strong to close a free-sliding shutter, irrespective of the orientation of the case.

Shutter
figure 8

Shutter sensor notch
figure 9

Slot for shutter opener
figure 9

Side B

Label area
figure 12

Detent for autoloading
figure 5

Mis-insert protection
figure 10

Detent for autoloading
figure 5

Reference surface S4
figure 4

Reference surface S3
figure 4

Alignment hole
figure 3

Reference surface S2
figure 4

Gripper slot
figure 11

Label area
figure 12

Location hole
figure 3

Side A

Reference surface S1
figure 4

Spindle and head windows
figure 7

FA1 and FA2
figure 6

Figure 2 - General view of the case

Figure 3 - Overall dimensions, viewed on Side A
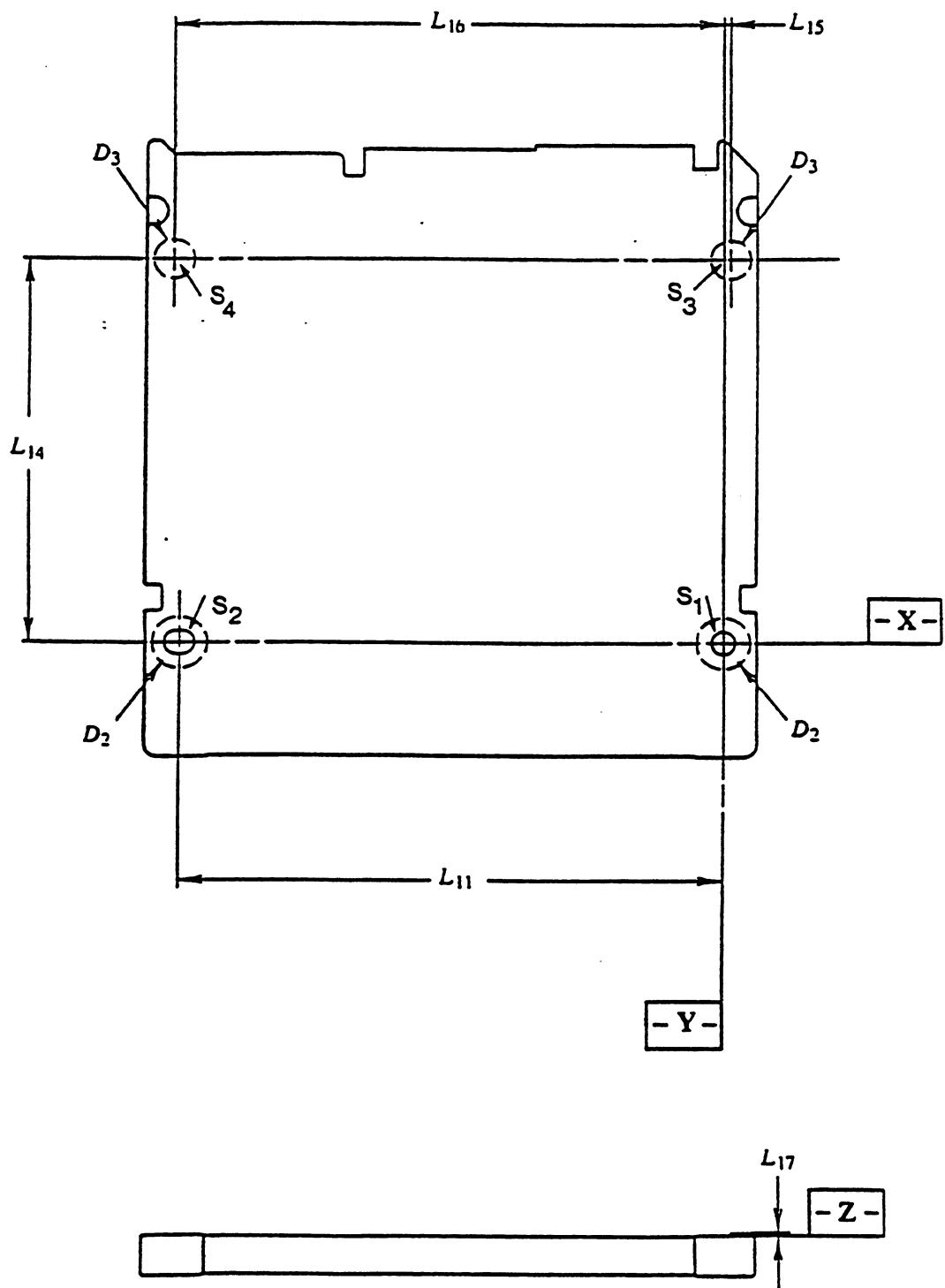
Figure 4 - Reference surfaces on Side A
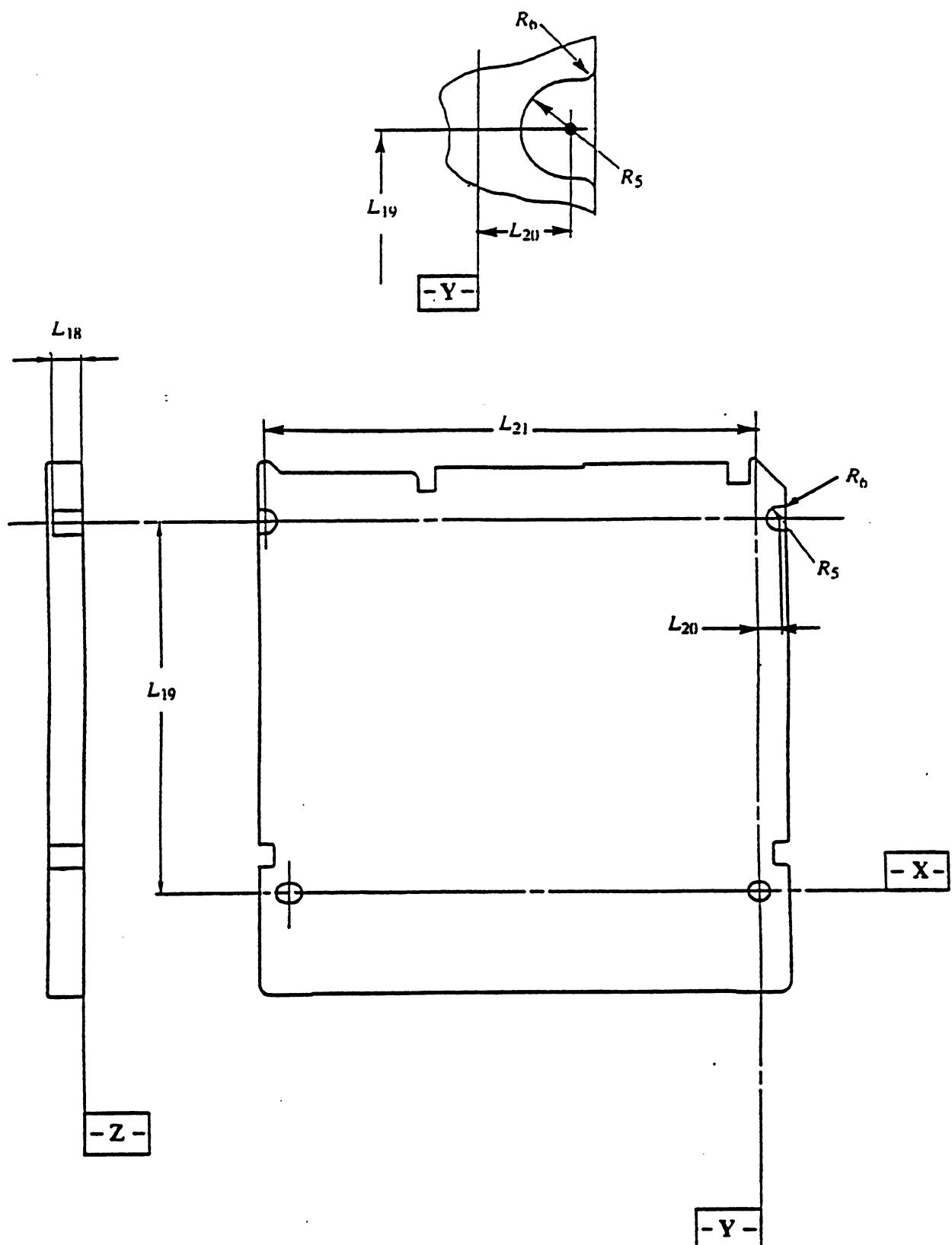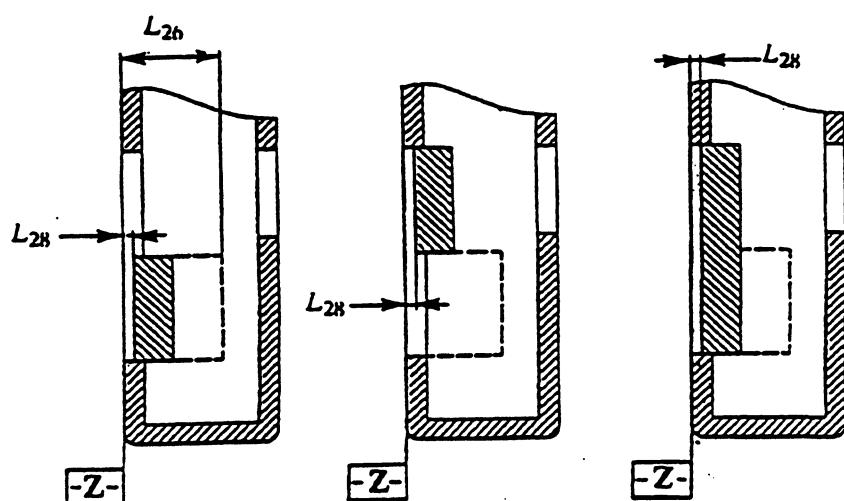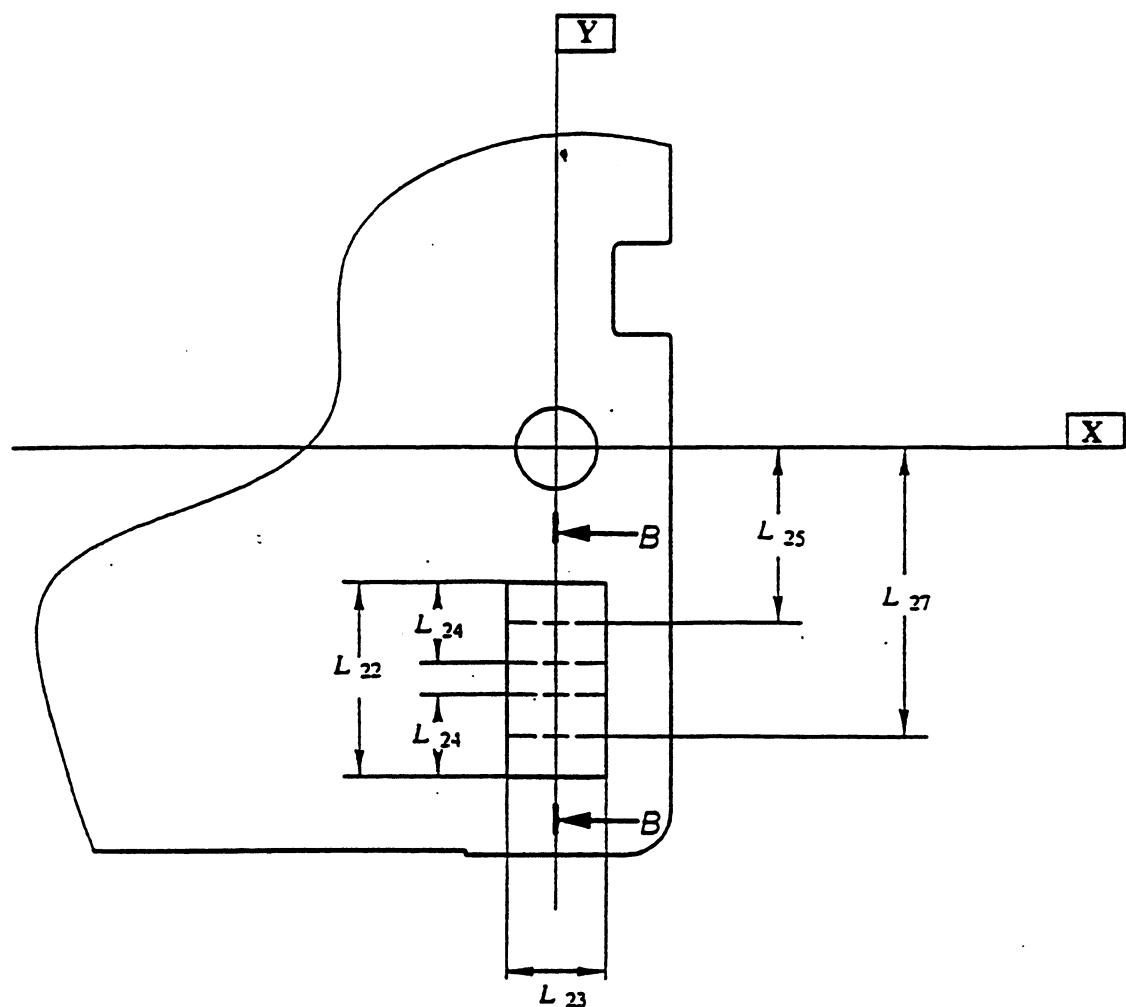
Figure 5 - Detents, seen on Side A

Figure 6 - Functional Areas FA1 and FA2, seen on Side A and in cross-section
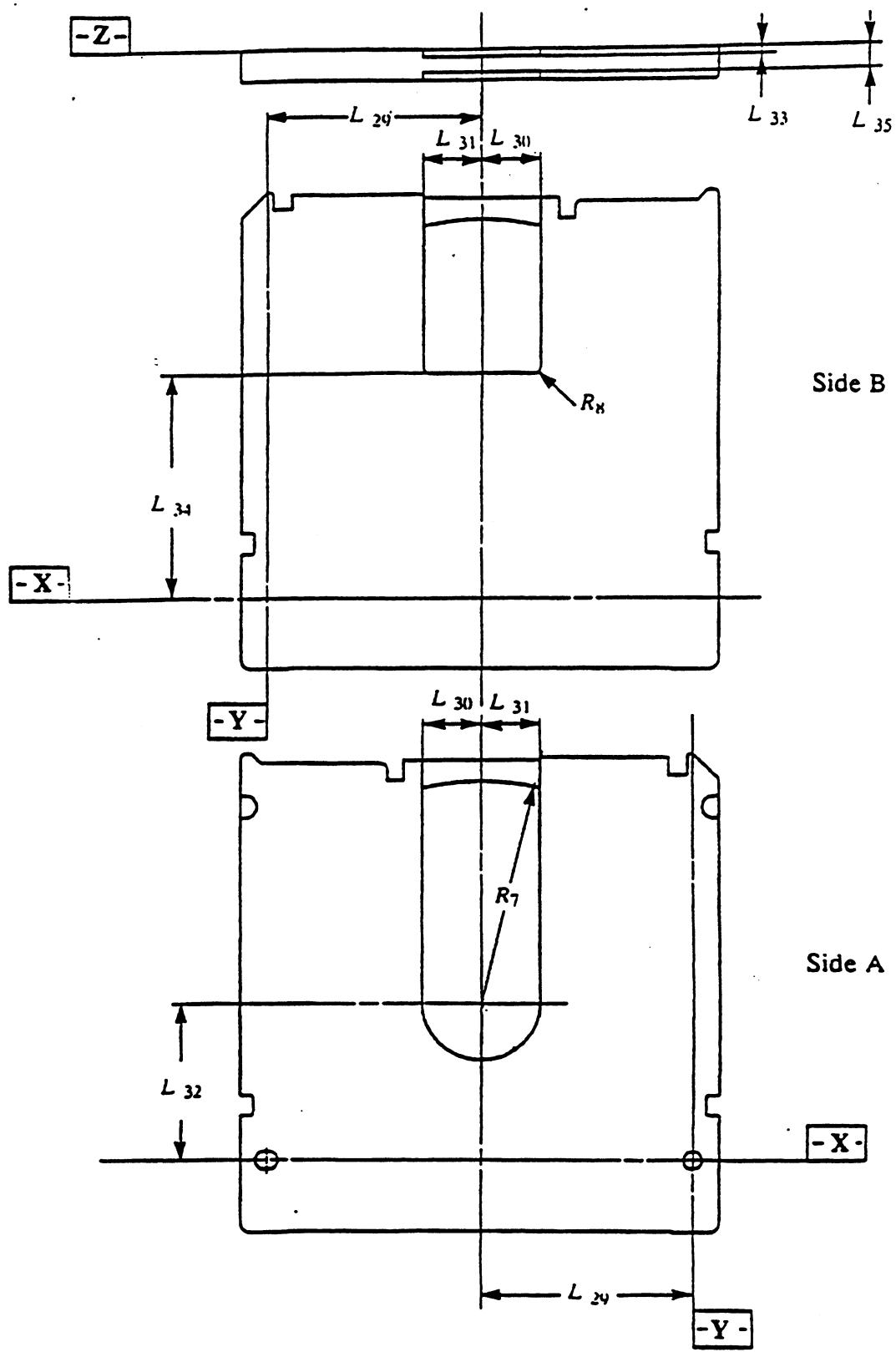
Figure 7 - Spindle and head windows on Side A (bottom) and B (top) of the case without shutter
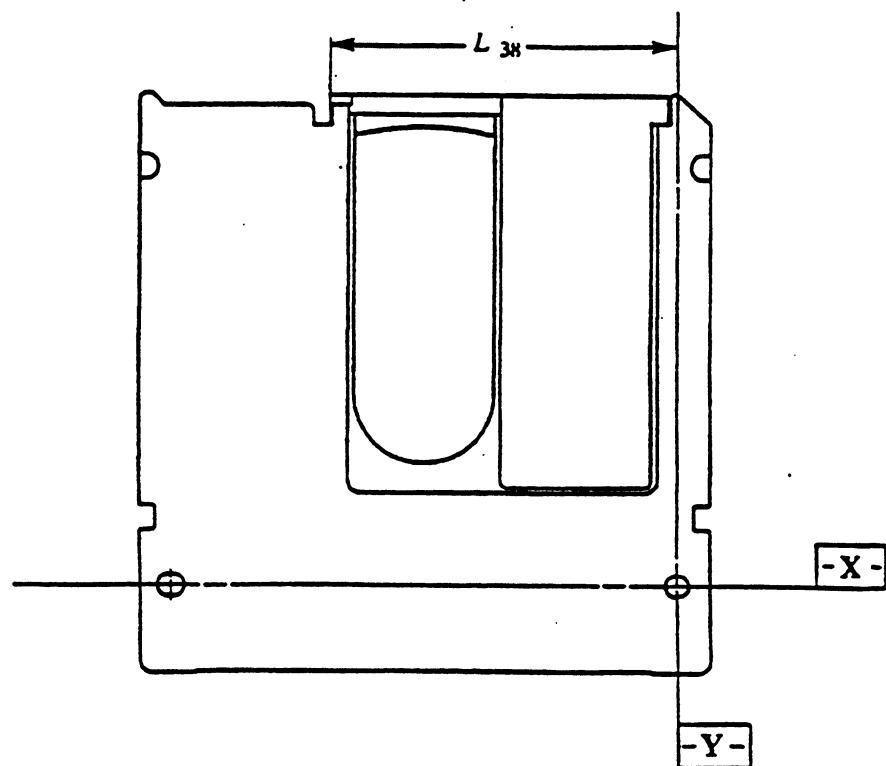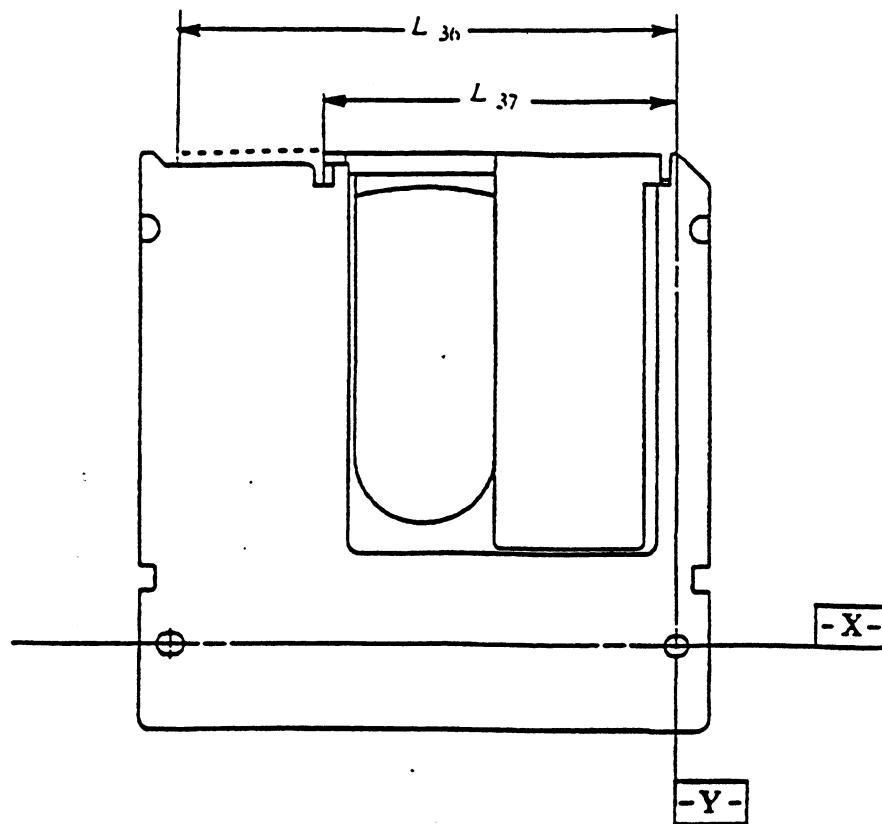
Figure 8 - Shutter in just open position (top) and maximum open position (bottom). The dashed line indicates the position of the shutter edge when the shutter is closed.
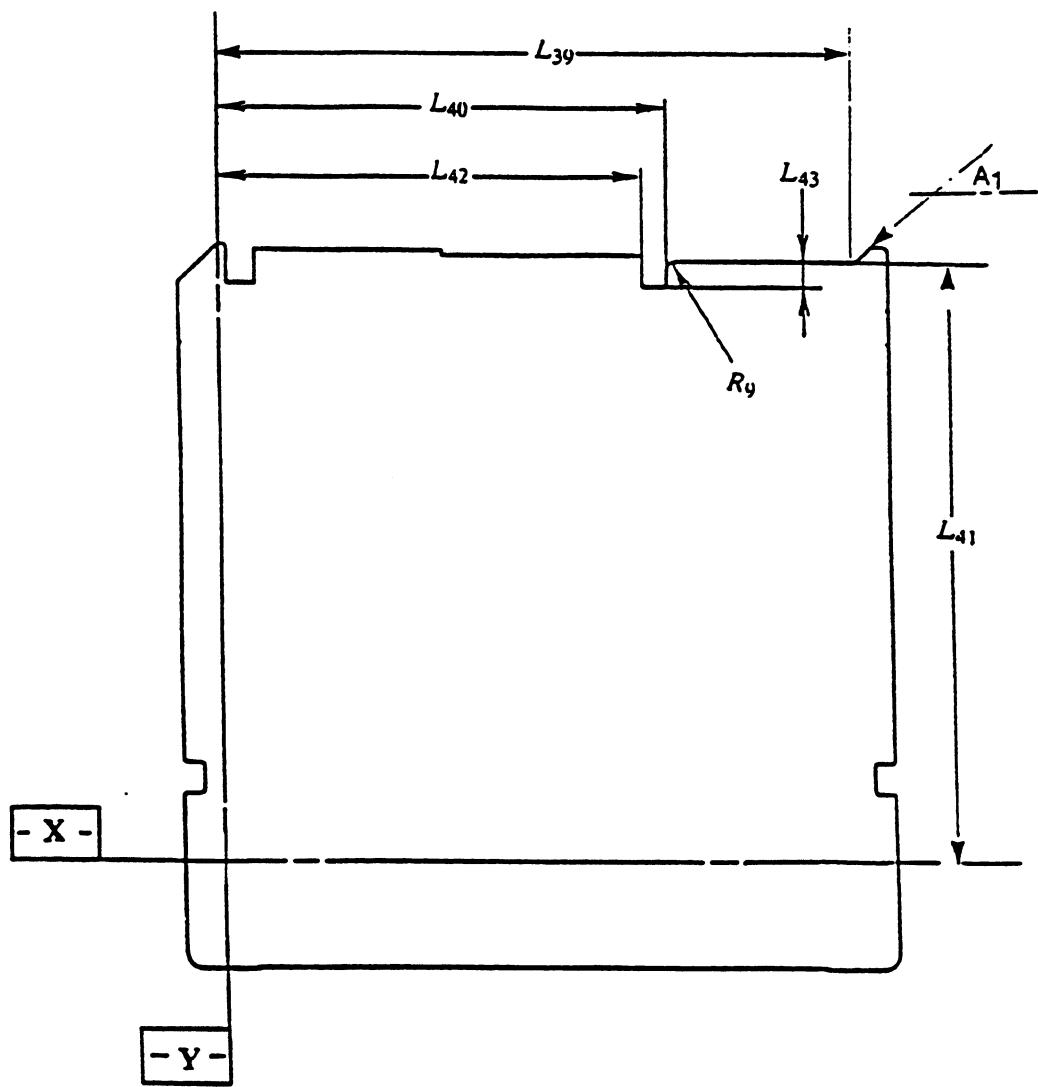
Figure 9 - Path for the shutter opener, seen from Side B without shutter
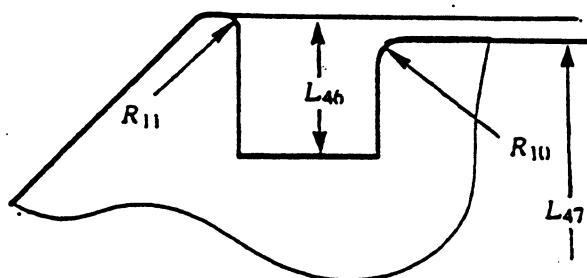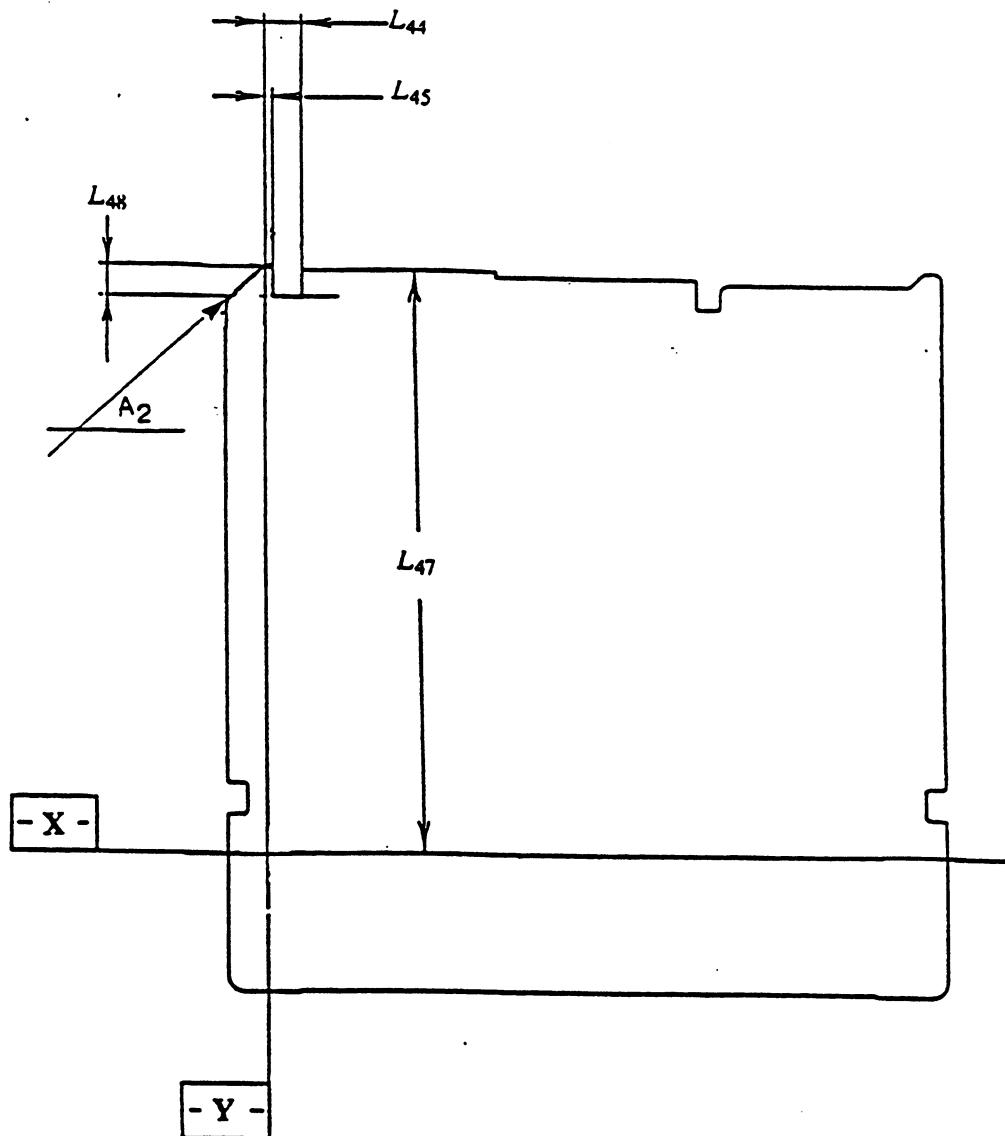
Figure 10 - Mis-insert protections, seen from Side B of the case without shutter

R_{13}

R_{12}
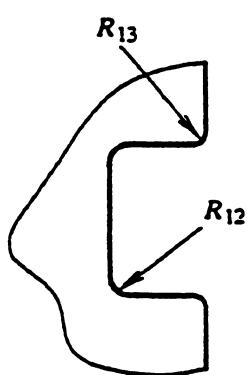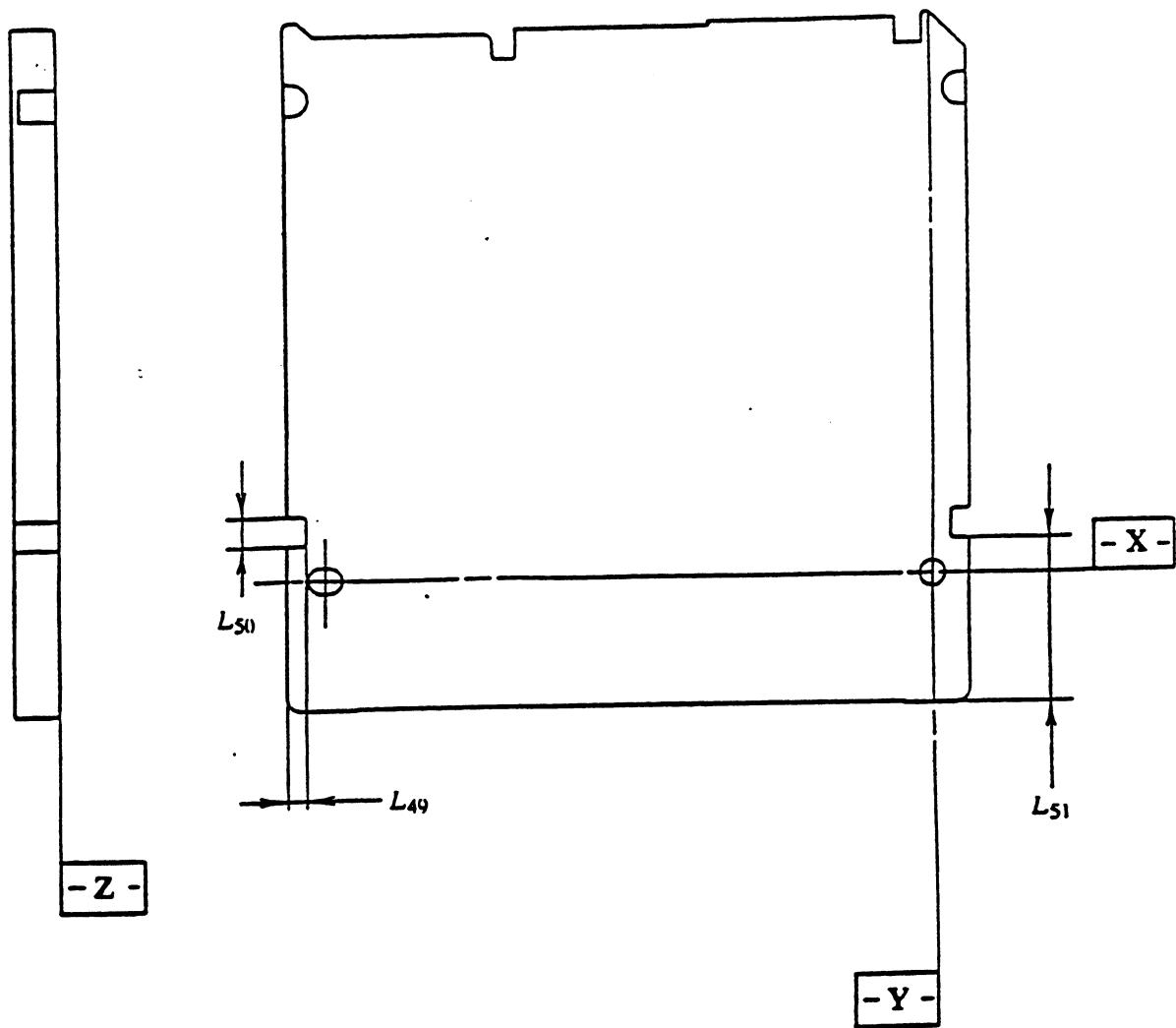
Figure 11 - Gripper slots seen from Side B of the case without shutter
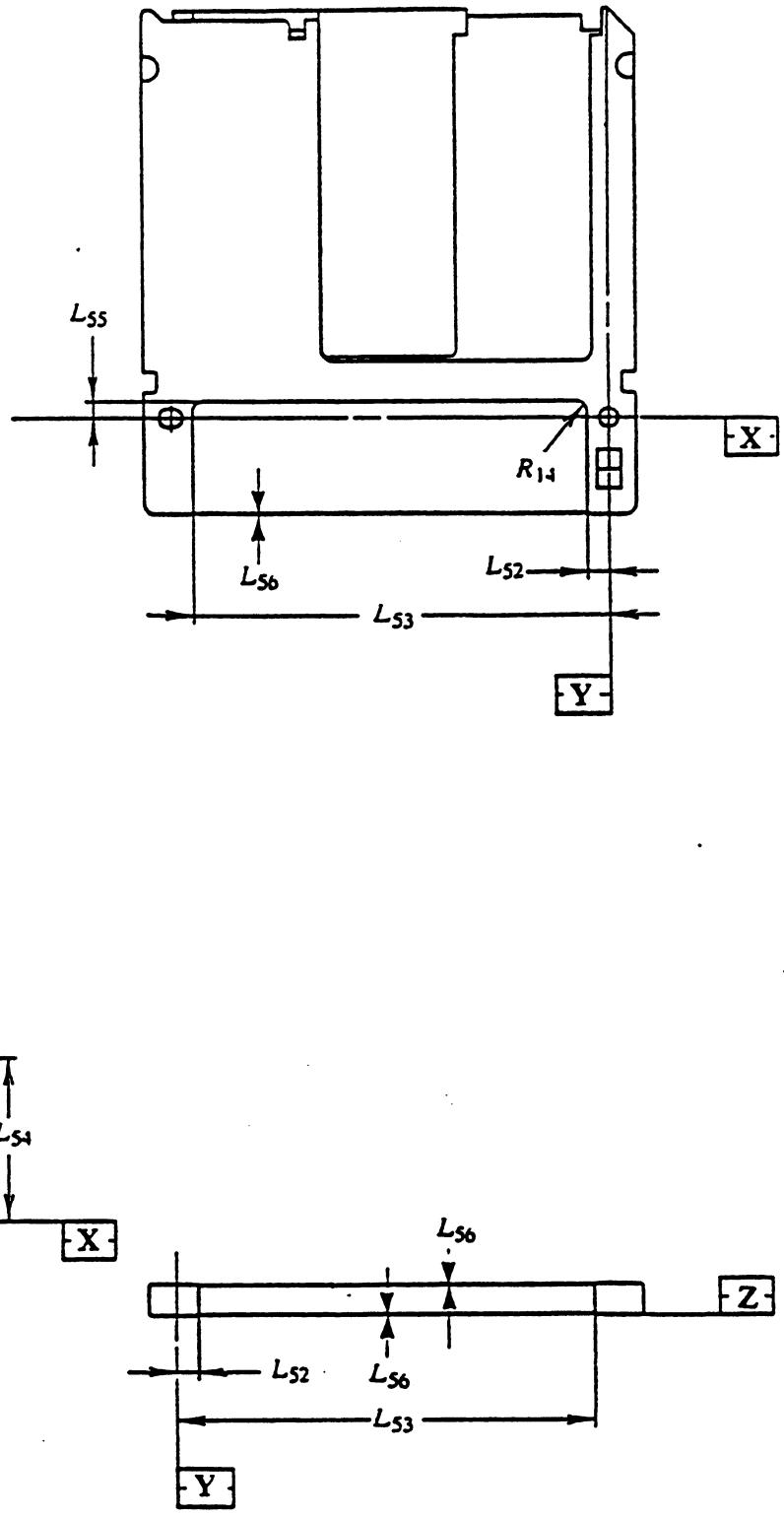
Figure 12 - Label area

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 can be protected from environmental influences 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 opposite to the recording layer. The hub interacts with the spindle of the drive, 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 disk 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 13)

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

$$86,0 \text{ mm} \begin{array}{l} +0,0 \text{ mm} \\ -0,5 \text{ mm} \end{array}$$

Excluding axial deflection (see 11.4.5), the total thickness of the disk without the hub shall not exceed 1,4 mm.

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

$$D_4 = 6,0 \text{ mm min.}$$

11.3.1 Hub dimensions (see figure 13)

The diameter of the centre hole of the hub shall be

$$D_5 = 4,004 \text{ mm} \begin{array}{l} +0,012 \text{ mm} \\ -0,000 \text{ mm} \end{array}$$

The outer diameter of the hub shall be

$$D_6 = 15,0 \text{ mm} \begin{array}{l} +0,0 \text{ mm} \\ -0,2 \text{ mm} \end{array}$$

The height of the hub shall be

$$h_1 = 1,2 \text{ mm} \begin{array}{l} +0,0 \text{ mm} \\ -0,2 \text{ mm} \end{array}$$

The position of the top of the magnetizable surface shall be

$$h_2 = 1,20 \text{ mm} \begin{array}{l} +0,00 \text{ mm} \\ -0,15 \text{ mm} \end{array}$$

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

$$h_3 = 0,8 \text{ mm min.}$$

The centring length at a diameter D_5 shall be

$$h_4 = 0,15 \text{ mm min.}$$

The lead-in edge of the centre hole shall have chamfer c_1 of 45° by 0,2 mm ± 0,1 mm or shall be rounded off by radius

$$R_{15} = 0,2 \text{ mm} \pm 0,1 \text{ mm}$$

The outer edge of the centre hole shall have a chamfer c_2 of 45° by 0,4 mm ± 0,1 mm or shall be rounded off by radius

$R_{16} = 0,4$ mm $\pm$ 0,1 mm

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

$D_9 = 13,0$ mm min.

$D_{10} = 6,0$ mm max.

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

11.3.2 Clamping zone (see figure 13)

The outer diameter of the clamping zone shall be

$D_7 = 21,0$ mm min.

The inner diameter of the clamping zone shall be
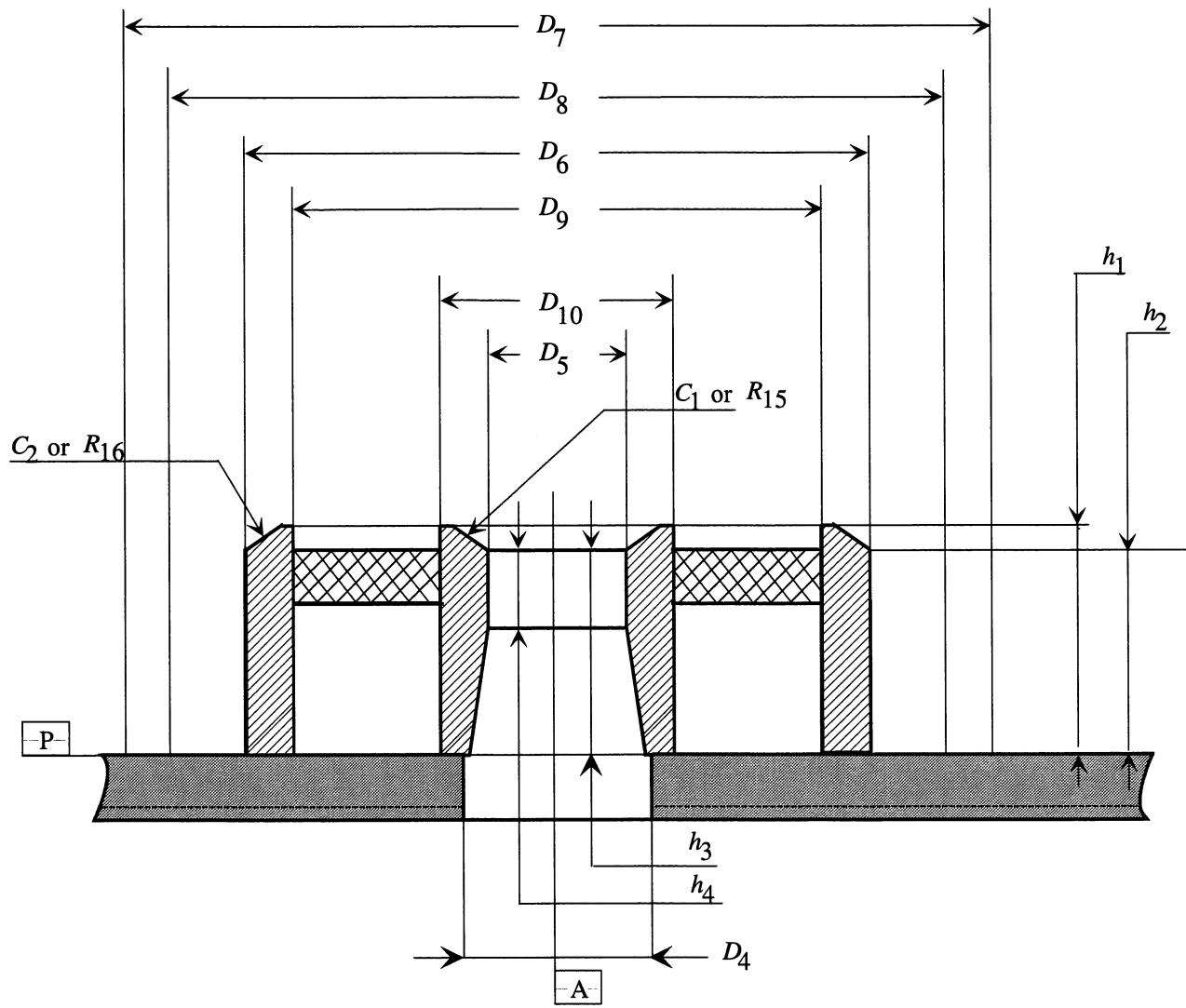
$D_8 = 16,0$ mm max.

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).

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Figure 13 - Hub dimensions and clamping zone

11.4.2 Mass

The mass of the disk shall not exceed 24,0 g.

11.4.3 Moment of inertia

The moment of inertia of the disk relative to axis A shall not exceed $0,020$ 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 $\pm 0,22$ mm for rotational frequencies of the disk up to 30 Hz.

11.4.6 Axial acceleration

The maximum allowed tracking error e_{max} (see annex C) shall not exceed $\pm$ 1,0 μm, measured using the Reference Servo for axial tracking of the recording layer. The rotational frequency of the disk shall be 30,0 Hz $\pm$ 0,18 Hz. The stationary part of the motor is assumed to be motionless (no external disturbances). The measurement shall be made using a servo with the transfer function

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

where

$\omega = 2\pi f$

$\omega_0/2\pi = 870$ Hz

$i = \sqrt{-1}$

or any other servo with $|1+H|$ within 20% of $|1+H_s|$ in the bandwidth of 30 Hz to 100 kHz. Thus, the disk shall not require an axial acceleration of more than 10 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 minimum distance of the centre of any track from the axis of rotation, measured along a fixed radial line over one revolution of the disk, shall not exceed 50 μm at a rotational frequency of the disk of 30,0 Hz $\pm$ 0,18 Hz.

11.4.8 Radial acceleration

The maximum allowed tracking error e_{max} (see annex C) shall not exceed $\pm$ 0,15 μm, measured using the Reference Servo for radial tracking of the tracks. The rotational frequency of the disk shall be 30,0 Hz $\pm$ 0,18 Hz. The stationary part of the motor is assumed to be motionless (no external disturbances). The measurement shall be made using a servo with the transfer function

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

where

$\omega = 2\pi f$

$\omega_0/2\pi = 1230$ Hz

$i = \sqrt{-1}$

or any other servo with $|1+H|$ within 20% of $|1+H_s|$ in the bandwidth of 30 Hz to 100 kHz. Thus, the disk shall not require a radial acceleration of more than 3 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

$$0,509 \times \frac{n^3}{n^2 - 1} \times \frac{n^2 + 0,265}{n^2 + 0,593} \text{ mm } \pm 0,050 \text{ mm}$$

where n is the index of refraction.

11.5.3 Birefringence

The effect of the birefringence of the substrate is included in the measurement of the imbalance of the signals in Channel 2 of the Reference Drive (see 25.2).

11.5.4 Reflectance

The reflectance of the recording layer is the value of the reflectance of an unrecorded, grooved 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 3 and byte 19 of the Control Tracks (see annex F).

The value of R at the wavelength specified in 9.2 shall lie within the range from 0,12 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 0,50 to 0,90 for high reflectance fully embossed disks (see annex R).

The measured value R_m shall be obtained under conditioned a) to f) of clause 9.2. Measurement shall be made in the Data Zone in any track without embossed data fields. At any point in the Data Zone of disks with the value R in the Control Track, the value R_m shall be equal to R(1 ± 0,15) and lie within the allowed range. At any point in the Data Zone of one disk, the following requirement shall be met, (see annex R).

$$\frac{(I_{OL \text{ max}} - I_{OL \text{ min}})}{(I_{OL \text{ max}} + I_{OL \text{ min}})} \leq 0,12$$

See clause 20.3 for the definition of I_{OL}

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 K) 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 not exceed 5 N.

12.3 Capture cylinder (see figure 14)

The capture cylinder is defined as the volume in which the spindle can expect the centre of the hole in the hub to be, just prior to capture, with the cartridge constrained as in 10.4.4. The centre of the hole is defined as the point on axis A at a distance h_1 below plane P (see 11.3.1 and figure 13).

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

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

$L_{57} = 0,7$ mm min.

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

$L_{58} = 2,3$ mm max.

above plane Z. The radius of the cylinder shall be

$R_{17} = 1,4$ mm max.

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

12.4   Disk position in operating condition (see figure 14)

When the disk is in the operating condition within the drive, the position of plane P of the disk shall be
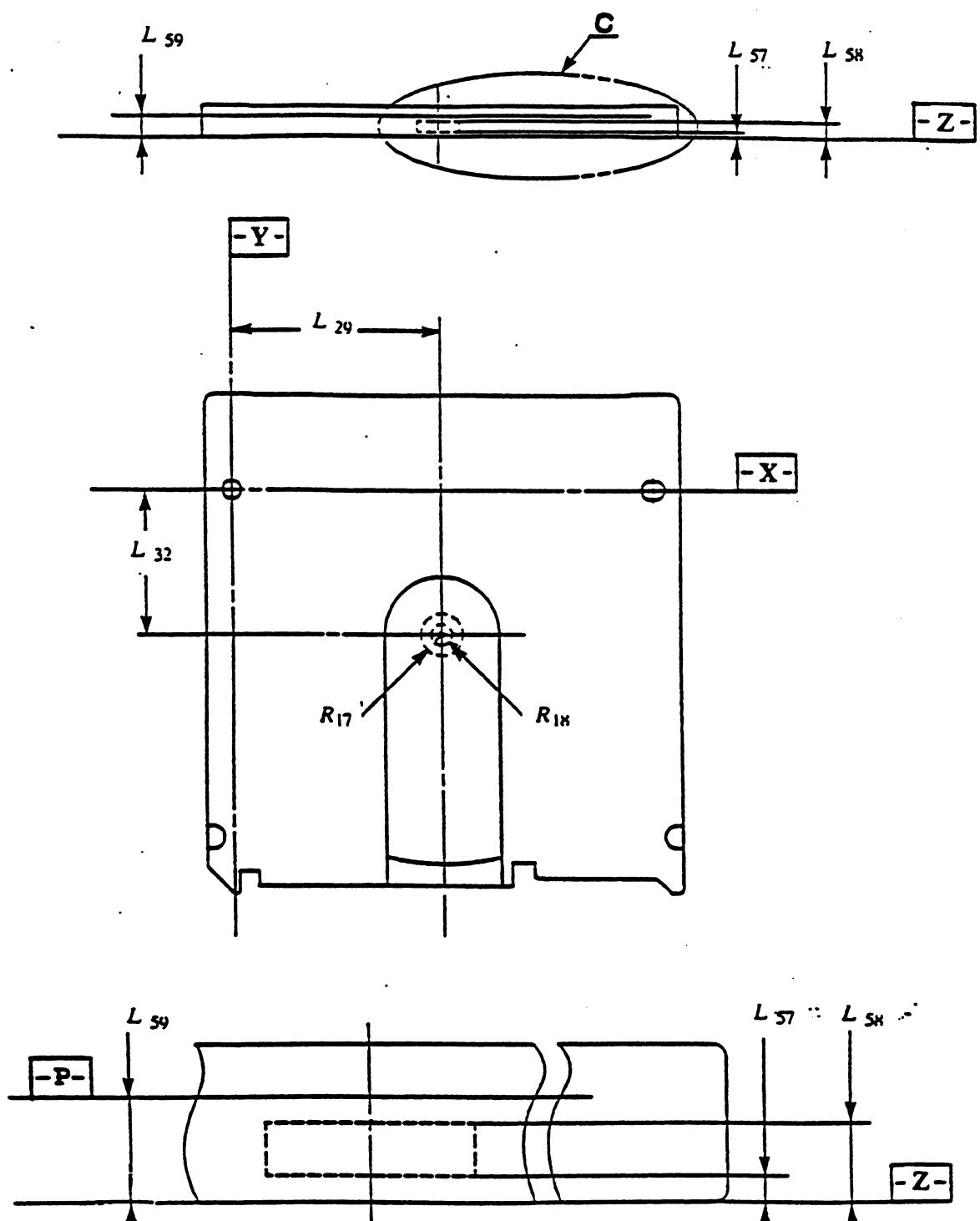
$L_{59} = 2,4$ mm $\pm$ 0,1 mm

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_{29} and L_{32}.

The torque to be exerted on the disk in the operating condition in order to maintain a rotational frequency of 30 Hz shall not exceed 0,01 N•m.

Detail C

Figure 14 - Capture cylinder and disk position in operating condition

Section 3 - Format of information

13 Geometry of physical tracks

13.1 Track shape

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

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

This ECMA Standard distinguishes between physical and logical tracks. A physical track forms a 360° turn of a continuous spiral. A logical track comprises a fixed number of consecutive sectors; it may form part of a physical track but it may also extend over more than one physical track.

13.2 Direction of track spiral

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

13.3 Physical track pitch

The Physical Track Pitch is the distance between adjacent track centrelines, measured in a radial direction. It shall be 1,39 μm ± 0,08 μm.

The width of a band of 10 000 tracks shall be 13,90 mm ± 0,10 mm.

14 Track format

14.1 Track number

Each logical track shall be identified by a track number. Unless otherwise stated, all track numbers refer to logical tracks only. Both logical track 0 and physical track 0 shall begin with sector 0 of track 0.

Track 0 shall be the first track of the Data Zone. It shall be located at a radius of 22,90 mm ± 0,10 mm.

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

The track numbers located at radii smaller than that of track 0 shall be negative, and decrease by 1 for each track. Their value is given in the ID field of the Header in TWOs complement notation, thus track -1 is indicated by (FFFF).

14.2 Track layout

Physical tracks shall be grouped into a number of Bands, (see 18.0 and Tables 2 and 3).

Within each of these Bands there shall be a fixed number of sectors in each physical track. This number ranges from 21/38 to 38/70 for the different Bands.

There shall be 25 sectors in each logical track.

For disks with 1 024-byte sectors, each sector shall comprise 1 349 bytes. A byte is represented on the disk by 9 Channel bits. Hence, the length of one Channel bit is determined by the requirement that there are (21 to 38) x 1 349 x 9 = 254 961 to 461 358 Channel bits in a physical track. The sectors shall be equally spaced over a track in such a way that the distance between the first Channel bit of a sector and the first Channel bit of the next sector shall be 9 216 Channel bits ± 3 Channel bits.

For disks with 512-byte sectors, each sector shall comprise 721 bytes. A byte is represented on the disk by 9 Channel bits. Hence, the length of one Channel bit is determined by the requirement that there are (38 to 70) x 721 x 9 = 246 582 to 454 230 Channel bits in a physical track. The sectors shall be equally spaced over a track in such a way that the distance between the first Channel bit of a sector and the first Channel bit of the next sector shall be 6 525 Channel bits ± 3 Channel bits.

Note

All calculations of the number of Channel bits in physical tracks do not include the Sector Mark, (SM), as this redundant frequency pattern is not written in GCR recording code and is not measured in Channel bit times. For all tracks in all bands the Sector Mark is written at a fixed frequency of 8,700 mHz.

14.3 Clock frequencies and periods

The nominal Channel clock frequency for each data band at the rotational speed of 30 Hz is shown in tables 2 and 3 below. These values are for reference only. The absolute frequency and period shall be adjusted so that there are the correct number of Channel bits in one physical track by the formulas below.

For 1 024 byte sector format:

$(20 + B) \times 9 \times 1349$ = Number of Channel bits in each physical track

where B= odd Data Band numbers >1.

Even numbered Data Bands have the identical number of Channel bits as the preceding Band. Data Band 1 is a special case.

For 512 byte sector format:

$(37 + \text{Data Band Number}) \times 9 \times 721$ = Number of Channel bits in each physical track

14.4 Sector number

The sectors on a logical track shall be numbered consecutively from 0 to 24.

Table 2 - Parameters of the zones, (1 024 byte sector size)

Zone or Band	Nominal radius Start-end (mm)	Number of Sectors	Sectors per physical track	Number of logical tracks	Physical track number Start-end	Number of physical tracks per zone	Chan clk. MHz (1 800 rpm) Nominal
Initial Zone Aquire Zone	22,60 - 22,65	N/A	N/A	N/A	N/A	N/A	
Lead-in	22,66 - 22,70	N/A	N/A	N/A	-172 to -141	32	
Focus Test Zone	22,70 - 22,71	N/A	N/A	N/A	-140 to -137	4	
Media	22,71 - 22,74	N/A	N/A	N/A	-136 to -117	20	
Drives	22,74 - 22,87	N/A	N/A	N/A	-116 to -017	100	
Inner Ctl	22,88 - 22,90	375	25	N/A	-016 to -002	15	8,700(RLL)
Buffer Data:	22,90 - 22,90	N/A	N/A	N/A	-001 to -001	1	7,748
Band 1	22,90 - 23,39	7 497	21	299.88	000 - 356	357	7,748
Band 2	23,40 - 23,92	7 875	21	315	357 - 731	375	7,932
Band 3	23,92 - 24,44	8 250	22	330	732 - 1 106	375	8,118
Band 4	24,44 - 24,96	8 250	22	330	1 107 - 1 481	375	8,298
Band 5	24,96 - 25,48	8 625	23	345	1 482 - 1 856	375	8,488
Band 6	25,48 - 26,00	8 625	23	345	1 857 - 2 231	375	8,681
Band 7	26,00 - 26,52	9 000	24	360	2 232 - 2 606	375	8,855
Band 8	26,52 - 27,04	9 000	24	360	2 607 - 2 981	375	9,041
Band 9	27,04 - 27,56	9 375	25	375	2 982 - 3 356	375	9,227
Band 10	27,57 - 28,09	9 375	25	375	3 357 - 3 731	375	9,413
Band 11	28,09 - 28,61	9 750	26	390	3 732 - 4 106	375	9.600
Band 12	28,61 - 29,13	9 750	26	390	4 107 - 4 481	375	9,783
Band 13	29,13 - 29,65	10 125	27	405	4 482 - 4 856	375	9,979
Band 14	29,65 - 30,17	10 125	27	405	4 857 - 5 231	375	10,163
Band 15	30,17 -30,69	10 500	28	420	5 232 - 5 606	375	10,340
Band 16	30,69 - 31,21	10 500	28	420	5 607 - 5 981	375	10,531
Band 17	31,21 - 31,73	10 875	29	435	5 982 - 6 356	375	10,714
Band 18	31,74 - 32,26	10 875	29	435	6 357 - 6 731	375	10,906
Band 19	32,26 - 32,78	11 250	30	450	6 732 - 7 106	375	11,085
Band 20	32,78 - 33,30	11 250	30	450	7 107 - 7 481	375	11,273
Band 21	33,30 - 33,82	11 625	31	465	7 482 - 7 856	375	11,462
Band 22	33,82 - 34,34	11 625	31	465	7 857 - 8 231	375	11,645
Band 23	34,34 - 34,86	12 000	32	480	8 232 - 8 606	375	11,832
Band 24	34,86 - 35,38	12 000	32	480	8 607 - 8 981	375	12,022
Band 25	35,38 - 35,90	12 375	33	495	8 982 - 9 356	375	12,204
Band 26	35,91 - 36,43	12 375	33	495	9 357 - 9 731	375	12,391
Band 27	36,43 - 37,95	12 750	34	510	9 732 - 10 106	375	12,582
Band 28	36,95 - 37,47	12 750	34	510	10 107 - 10 481	375	12,766
Band 29	37,47 - 37,99	13 125	35	525	10 482 - 10 856	375	12,955
Band 30	37,99 - 38,51	13 125	35	525	10 857 - 11 231	375	13,139
Band 31	38,51 - 39,03	13 500	36	540	11 232 - 11 606	375	13,331
Band 32	39,03 - 39,55	13 500	36	540	11 607 - 11 981	375	13,516
Band 33	39,55 - 40,07	13 875	37	555	11 982 - 12 356	375	13,709
Band 34	40,08 - 40,60	13 875	37	555	12 357 - 12 731	375	13,886
Band 35	40,60 - 40,83	6 384	38	256	12 732 - 12 899	168	14,074
Buffer	40,83 - 40,83	38	38	N/A	12 900 - 12 900	1	14,074
Outer Ctl. Test Zone	40,84 - 40,85	25	25	N/A	12 901 - 12 915	15	8,700(RLL
Drives	40,86 - 40,99	N/A	N/A	N/A	12 916 - 13 015	100	
Media	41,00 - 41,02	N/A	N/A	N/A	13 016 - 13 035	20	
Lead Out	41,03 - 41,14	N/A	N/A	N/A	13 036 - 13 115	80	

Table 3 Parameters of the Zones, (512 Byte sector size)

Zone or Band	Nominal radius Start-end (mm)	Number of Sectors	Sectors per physical track	Number of logical tracks	Physical track number Start-end	Number of physical tracks per zone	Chan Clk. MHz (1 800 rpm)
Initial Zone	22,60 - 22,65	N/A	N/A	N/A	N/A	N/A	
Aquire Zone							
Lead-in	22,65 - 22,70	N/A	N/A	N/A	-172 to -141	32	
Focus	22,70 - 22,70	N/A	N/A	N/A	-140 to -137	4	
Test Zone							
Media	22,71 - 22,74	N/A	N/A	N/A	-136 to -117	20	
Drives	22,74 - 22,88	N/A	N/A	N/A	-116 to -017	100	
Inner Ctl.	22,88 - 22,89	375	25	N/A	-016 to -002	15	8,700(RLL)
Buffer	22,89 - 22,90	N/A	N/A	N/A	-001 to -001	1	
Data:							
Band 1	22,90 - 23,12	5 966	38	236.64	000 - 156	157	7,529
Band 2	23,12 - 23,67	15 600	39	624	157 - 556	400	7,733
Band 3	23,67 - 24,23	16 000	40	640	557 - 956	400	7,923
Band 4	24,23 - 24,78	16 400	41	656	957 - 1 356	400	8,125
Band 5	24,79 - 25,34	16 800	42	672	1 357 - 1 756	400	8,327
Band 6	25,34 - 25,90	17 200	43	688	1 757 - 2 156	400	8,526
Band 7	25,90 - 26,45	17 600	44	704	2 157 - 2 556	400	8,727
Band 8	26,45 - 27,01	18 000	45	720	2 557 - 2 956	400	9,927
Band 9	27,01 - 27,56	18 400	46	736	2 957 - 3 356	400	9,128
Band 10	27,57 - 28,12	18 800	47	752	3 357 - 3 756	400	9,330
Band 11	28,12 - 28,68	19 200	48	768	3 757 - 4 156	400	9,529
Band 12	28,68 - 29,23	19 600	49	784	4 157 - 4 556	400	9,730
Band 13	29,23 - 29,79	20 000	50	800	4 557 - 4 956	400	9,943
Band 14	29,79 - 30,34	20 400	51	816	4 957 - 5 356	400	10,133
Band 15	30,35 - 30,90	20 800	52	832	5 357 - 5 756	400	10,333
Band 16	30,90 - 31,46	21 200	53	848	5 757 - 6 156	400	10,537
Band 17	31,46 - 32,01	21 600	54	864	6 157 - 6 556	400	10,737
Band 18	32,01 - 32,57	22 000	55	880	6 557 - 6 956	400	10,941
Band 19	32,57 - 33,12	22 400	56	896	6 957 - 7 356	400	11,142
Band 20	33,13 - 33,68	22 800	57	912	7 357 - 7 756	400	11,348
Band 21	33,68 - 34,24	23 200	58	928	7 757 - 8 156	400	11,547
Band 22	34,24 - 34,79	23 600	59	944	8 157 - 8 556	400	11,750
Band 23	34,79 - 35,35	24 000	60	960	8 557 - 8 956	400	11,963
Band 24	35,35 - 35,90	24 400	61	976	8 957 - 9 356	400	12,154
Band 25	35,90 - 36,46	24 800	62	992	9 357 - 9 756	400	12,357
Band 26	36,46 - 37,02	25 200	63	1008	9 757 - 10 156	400	12,558
Band 27	37,02 - 37,57	25 600	64	1024	10 157- 10 556	400	12,766
Band 28	37,57 - 38,13	26 000	65	1040	10 557 - 10 956	400	12,965
Band 29	38,13 - 38,68	26 400	66	1056	10 957 - 11 356	400	13,171
Band 30	38, 68 - 39,24	26 800	67	1072	11 357 - 11 756	400	13,371
Band 31	39, 24 - 39,80	27 200	68	1088	11 757 - 12 156	400	13,577
Band 32	39,80 - 40,35	27 600	69	1104	12 157 - 12 556	400	13,784
Band 33	40,35 - 40,83	23 940	70	958	12 557 - 12 899	342	13,982
Buffer	40,83 - 40,83	70	70	N/A	12 900 - 12 900	1	13,982
Outer Ctl.	40,83 - 40,86	375	25	N/A	12 901 - 12 915	15	8,700(RLL)
Test Zone							
Drives	40,86 - 40,99	N/A	N/A	N/A	12 916 - 13 015	100	
Media	40,99 - 41,02	N/A	N/A	N/A	13 016 - 13 035	20	
Lead Out	41,02 - 41,14	N/A	N/A	N/A	13 036 - 13 115	80	

15 Sector format

15.1 Sector layout (data zone)

A sector shall comprise a Header and a Recording field in which 1 024/512 user data bytes can be recorded. All sectors in the Data Zone shall be of the same size. The Header of each sector shall be written at the first time the data field is written. The Recording field can be empty or user-written. The length of the sector shall be 1 349/721 bytes nominally. Tolerances allowed by 14.2 are taken up by the Buffer, i.e. the last field of the sector. The length of the Header field is 48 bytes and the length of the Recording field is 1301/673 bytes. All Data Zone sectors on a given disk shall be the same size.

The layout of a sector is shown in figures 15 and 16. The numbers under each field name indicate the length of the field in bytes. The Sector Mark, (SM) field is not written in GCR recording code and is a frequency pattern that may vary in length. Headers and Sector Marks in the Data Zone are written using the thermo-magnetic effect in GCR code.

Track No.	ID No.	Sector No.	CRC
2	1		2

ID Field

SM	GAP1	VFO$_1$	AM	ID$_1$	VFO$_2$	AM	ID$_2$	VFO$_2$	AM	ID$_3$	PA	GAP2	VFO$_3$	Sync	Data Field	PA	BUF
*	1	12	1	5	8	1	5	8	1	5	1	6	12	3	1259	1	20

| Header 48 bytes | | | Recording Field 1301 bytes | |
| Sector 1349 bytes | | | | |

Figure 15 - Sector Field Layout, 1 024 byte Sectors

* = Sector Mark not counted as part of sector byte count because it is a pattern.

Track No.	ID No.	Sector No.	CRC
2	1		2

ID Field

SM	GAP1	VFO$_1$	A M	ID$_1$	VFO$_2$	A M	ID$_2$	VFO$_2$	A M	ID$_3$	P A	GAP2	VFO$_3$	S y n c	Data Field	P A	B U F
*	1	12	1	5	8	1	5	8	1	5	1	6	12	3	639	1	12

Header 48 bytes	Recording Field 673 bytes

Sector 721 bytes
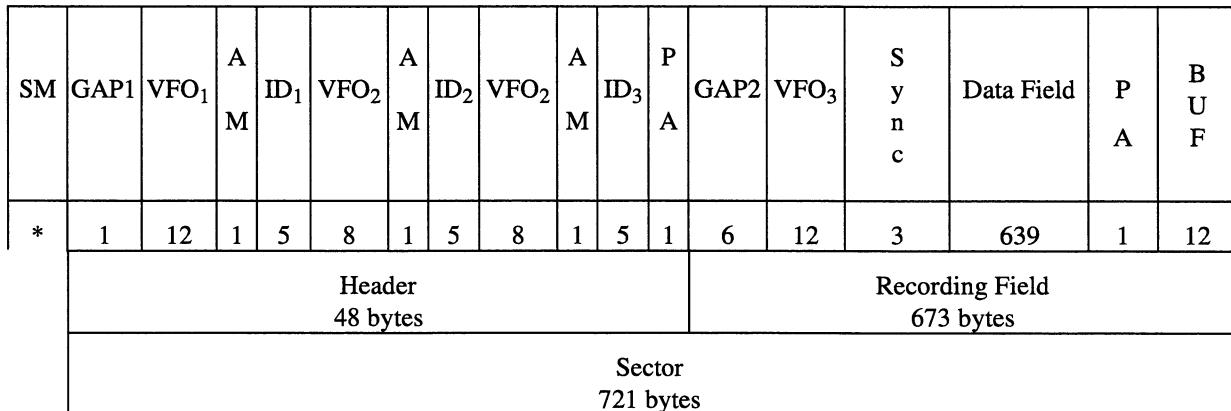
Figure 16 - Sector Field Layout, 512 Byte Sectors

* = Sector Mark not counted as part of sector byte count because it is a pattern.

15.2 Sector Mark

The Sector Mark in the Data Zone shall consist of a pattern written by a drive that does not occur in GCR code nor in RLL 2,7 code and is intended to enable the drive to identify the start of the sector without recourse to a phase-locked loop. The Sector Mark is written at a fixed frequency of 8,7 MHz, independent of all zones or sector sizes for a disk rotating at 30 Hz. Sector Marks in zones other than the Data Zone are embossed.

The Sector Mark shall have a length of 80 Channel bits and shall consist of written, continuous long marks of different length followed by a one byte gap field. The timing pattern of the Sector Mark shall be as shown in figure 17, where T is the period of one Channel bit. The signal obtained from a mark is less than a signal obtained from no mark. The lead-in shall have the Channel bit pattern:
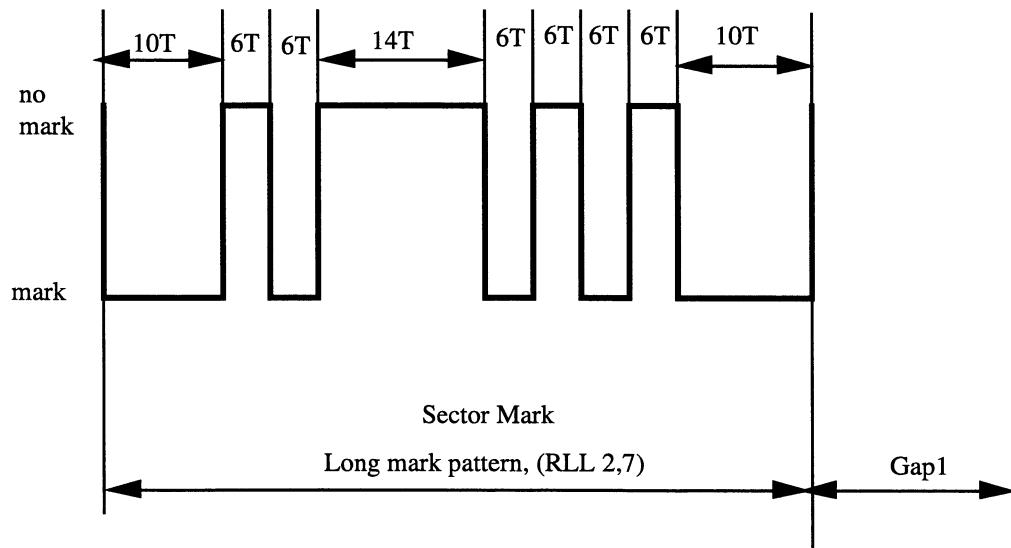
Figure 17 - Pattern of the Sector Mark

15.3 VFO fields

There shall three VFO fields, (VFO_1 VFO_2 and VFO_3) in the Header and one, (VFO_3) in the Recording field to give the voltage-frequency-oscillator of the phase-locked loop of the read Channel Channel bit synchronization. The information in VFO_1 and VFO_3 shall have the same length of 108 Channel bits. Both VFO_2 fields shall have a length of 72 Channel bits. All VFO fields shall have the identical pattern.

The continuous Channel bit pattern for the VFO fields shall be:

VFO_1 + VFO_3: 118 Channel bits:10101010101010.............101010 (GCR)

VFO_2:   72 Channel bits:10101010101010.............101010 (GCR)

15.4 Address Mark (AM)

The Address Mark shall consist of a pattern that does not occur in GCR code nor in RLL 2,7 code. The field is intended to give the drive byte synchronization for the following ID field. It shall have a length of 9 Channel bits with the following pattern:

1100 0010 1

15.5 ID fields

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

1st and 2nd bytes	MSB, LSB of the physical track number
3rd byte	
bits 7 and 6	00 shall indicate the ID_1 field
	01 shall indicate the ID_2 field
	10 shall indicate the ID_3 field
bit 5	shall be set to ZERO
bits 4 to 0	sector number in binary notation
4th and 5th bytes	CRC field containing the CRC bits computed over the first three bytes according to annex D.

15.6 Postambles (PA)

The Postamble field shall be equal in length to 9 Channel bits. There shall be a Postamble following ID_3 and a Postamble following the Data field. The Postamble is necessary to be able to start the following field in a predictable manner.

The Postamble Field shall have the following pattern:

1000 1000 1

15.7 Gap1

Gap1 shall be a field with a nominal length of 9 Channel bits. Its contents are not specified and shall be ignored on interchange, but shall not be embossed. It is the first field of the Recorded Header, and gives the drive some time for processing after it has finished reading the Sector Mark and before it has to erase, write or read the VFO_1 field.

15.8 Gap2

Gap2 shall be a field with a nominal length of 54 Channel bits. Its contents are not specified and shall be ignored on interchange, but shall not be embossed. It is the first field of the Recording field, and gives the drive some time for processing after it has finished reading the header and before it has to erase, write or read the VFO_3 field.

The length of Gap2 has a tolerance of ± 4,5 Channel bits, i.e. the following VFO_3 field can start between 49,5 and 58,5 Channel bits after the Postamble. Moreover, it need not start exactly on a Channel bit position as extrapolated from the header. The tolerance is subtracted from the length of the Buffer field, e.g. a Gap length of 58,5 Channel bits results in a reduction of the Buffer length by 4,5 Channel bits.

15.9 Sync

The Sync field is intended to allow the drive to obtain byte synchronization for the following Data field. It shall have a length of 27 Channel bits and be recorded with the following Channel bit pattern

1010 0011 1110 1100 0111 1000 111

15.10 Data field

The Data field is intended for recording user data. It shall have a length of 1259/639 bytes and shall comprise

Type of data	1 024 byte sector format	512 byte sector format
User data	1 024 bytes	512 bytes
Not specified	12 bytes	4 bytes
CRC	4 bytes	4 bytes
ECC	160 bytes	80 bytes
Resync	59 bytes	39 bytes

The disposition of these bytes in the Data field with their 10-way/5-way interleave and the contents of the last three categories is specified in annex E.

15.10.1 User data bytes

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

15.10.2 CRC and ECC bytes

The Cyclic Redundancy Check bytes and Error Correction Code bytes are used by the error detection and correction system to rectify erroneous data. The ECC is a Reed-Solomon code of degree 16, (1 024-byte sectors) or 5 (512-byte sectors). The sectors in the Control Zone shall always be 512 bytes long and have ECC degree 5. The bytes shall be as specified in annex E.

15.10.3 Resync bytes

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

1000 1000 1

15.10.4 Buffer field

The Buffer field shall have a length of 189/108 Channel bits ± 27 Channel bits and shall not contain any data. The tolerance is needed for four reasons. Firstly, the tolerance on the header-to-header distance as specified in 14.1. Secondly, the tolerance in the start of the VFO_3 field as specified in 14.5. Thirdly, the actual length of the written data, as determined by the runout of the track and the speed variations of the disk during writing of the data. Fourthly, erasing these entire written data whose length has the tolerance explained above, (see 14.2 and 15.7).

16 Recording code

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

The recording code used to record all data in the Information Zone on the disk shall be the code known as GCR. All 8 bit byte to 9 bit GCR code conversions are shown in annex S.

The coding shall start at the first bit of the first byte of the field to be converted. After a Resync field the GCR coding shall start again with the first bit of the next byte of input data.

17 Format of the Information Zone

17.1 General description of the Information Zone

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

17.2 Division of the Information Zone

The Information Zone is divided into three parts; a Lead-in Zone, a Data Zone and a Lead-out Zone. The Data Zone is intended for the 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 the drive.

The division of the Information Zone shall be as given in Tables 2 and 3. The tolerance on the inner radius of the Data Zone is specified in 14.1; the tolerance on other radii is determined by the tolerance on the track pitch as specified in 13.3. The Data Zone shall have Header information for every sector written during the initialization and certification process. The Lead-in and Lead-out Zones have embossed header information in every sector, but no data recorded in the data field.

17.2.1 Initial Zone

The Initial Zone is intended to enable a drive to lock its axial tracking (focusing) servo. It shall have either a flat reflective layer, or such a layer with uninterrupted grooves over complete tracks as specified in clause 21 or such tracks with embossed Headers or any combination of the above.

17.2.2 Acquire Zone

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

The second part shall be a band of focus tracks with a repeated RLL 2,7 Channel bit pattern 100100... embossed in the VFO_3, SYNC and the data fields of each sector. These tracks are intended to enable a drive to remove focus offsets by maximizing the read signal from the Channel bit pattern.

17.2.3 Test Zones

There shall be an inner Test Zone and an outer Test Zone, each containing embossed grooves and Headers. Each of these zones shall consist of a Test Zone for drives and a Test Zone for the manufacturer.

The Test Zone for drives is intended for tests to set a drive's write power and shall not consist of embossed data. The tracks used for testing should be chosen from the Test Zone for drives in a random way so as to insure a gradual degradation of the zone due to use. Then each track in this Zone will remain representative of characteristics of tracks in the Data Zone of the disk.

The Test Zone for the manufacturer is intended for quality tests by the media manufacturer. The Test Zone for drives shall not be used by media manufacturers for testing as it may cause serious degradation of the zone.

17.2.4 Control Zones

There shall be an Inner Control Zone and an Outer Control Zone. Each Control Zone shall contain 15 physical tracks with embossed grooves, headers and sectors formatted according to Standard ECMA 201, clause 15, (RLL 2,7 modulation) and one track, called Buffer track with an embossed groove and headers according to clause 15 of Standard ECMA 201. In the Inner Control Zone, physical track -1 is the Buffer track, in the Outer Control Zone, physical track 12 900 is the Buffer track. The data fields of all sectors in the two Control Zones, except in the Buffer tracks, shall be identical and contain embossed control data for the drive. The control data in a data field is specified in annex F.

The recording fields of all sectors of the two Buffer tracks shall be without embossed data.

Note

For purposes of backwards compatibility, the Control Track information is always recorded in RLL 2,7 modulation and in accordance with Standard ECMA 201 rules for sector format. This is the only area on the media not recorded in GCR modulation.

17.2.5 Data Zone

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

The data zone shall be divided into 35/33 bands numbered 1 to 35/33. The Bands shall comprise the physical tracks specified in tables 2 and 3. Within any band, the angular recording density shall be constant.

The data zone shall start with physical track 0 and end with physical track 12 899.

17.2.6 Buffer Zone
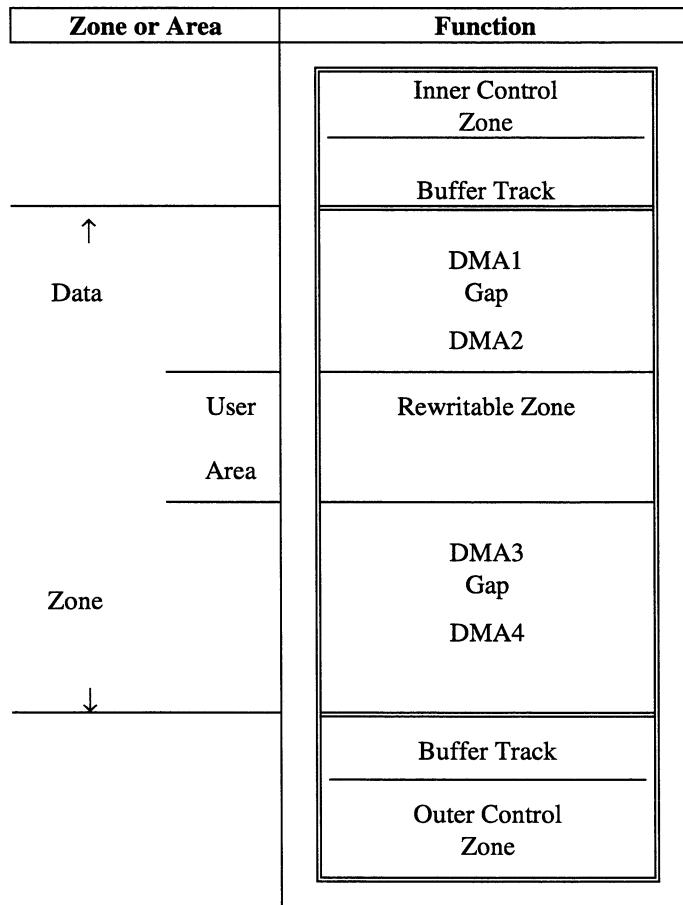
The Buffer Zone shall contain embossed grooves and Headers.

18 Format of the Data Zone

The Data Zone shall contain four Defect Management Areas (DMAs), two at the beginning of the zone and two at the end. The area between the two sets of DMAs is called the User Area. The User Area shall contain a Rewritable Zone.

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

Table 4 - Layout of the Data Zone, the Control Zones and the Buffer Tracks

Zone or Area	Function
↑ Data User Area Zone ↓	Inner Control Zone
	Buffer Track
	DMA1 Gap DMA2
	Rewritable Zone
	DMA3 Gap DMA4
	Buffer Track
	Outer Control Zone

18.1 Defect Management Areas (DMAs)

The four Defect Management Areas contain information on the structure of the Data Zone and on the defect management. The length of each DMA shall be 34 sectors. Two of the DMAs, DMA1 and DMA2, shall be located near the inner diameter of the disk; two others, DMA3 and DMA4, shall be located near the outer diameter of the disk. The logical track boundaries of the DMAs are indicated in tables 5 and 6.

Table 5 - Locations of the DMAs (1 024-byte sector format)

	Beginning		Ending		Length (sectors)
	Logical Track	Sector No.	Logical Track	Sector No.	
DMA1	0	0	1	8	34
Reserved	1	9	2	2	19
DMA2	2	3	3	11	34
DMA3	15023	17	15025	0	34
Reserved	15025	1	15025	23	23
DMA4	15025	24	15027	7	34
Reserved	15027	8	15027	24	17

Table 6 - Locations of the DMAs, (512-byte sector format)

	Beginning		Ending		Length (sectors)
	Logical Track	Sector No.	Logical Track	Sector No.	
DMA1	0	0	2	15	66
Reserved	2	16	3	17	27
DMA2	3	18	6	8	66
DMA3	27969	0	27971	15	66
Reserved	27971	16	27973	4	39
DMA4	27973	5	27975	20	66
Reserved	27975	21	27975	24	4

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

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

- The first DMA sector shall contain the DDS.

- The second DMA Sector shall be the first sector of the PDL.

- The SDL shall be located immediately after the PDL.

The lengths of the PDL and SDL are determined by the number of entries in each.

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

The contents of the DDS are specified in 18.2, those of the PDL and SDL are specified in 19.1.7 and 19.1.8.

18.2 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 zone into groups, 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..

The following information on the disk structure shall be recorded in each of the four DDSs.

Table 7 - Byte Assignment of the DDS

Byte	DDS Content	Mandatory settings
0	DDS Identifier	(0A)
1	DDS Identifier	(0A)
2	Reserved	(00)
3	Disk has been certified	(01)
	Disk has not been certified	(02)
4	Number of R/W Groups MSB	(00)
5	Number of R/W Groups LSB	(01)
6	Group 1 Type	(01)
7	Reserved	(00)
8	Reserved	(00)
9	Reserved	(00)
10	Reserved	(00)
11	Reserved	(00)
12	Reserved	(00)
13	Reserved	(00)
14	Reserved	(00)
15	Reserved	(00)
16	Start Address of PDL, Track MSB	-
17	Start Address of PDL	-
18	Start Address of PDL, Track LSB	-
19	Start Address of PDL, Sector	-
20	Start Address of SDL, Track MSB	-
21	Start Address of SDL	-
22	Start Address of SDL, Track LSB	-
23	Start Address of SDL, Sector	-
24 - 511	(00)	(00)

In table 9,

the symbol hyphen (-) means that the appropriate value is to be entered in the DDS, and

"n.a." means "not applicable".

For bytes 6 to 15, the setting (01) means rewritable, (02) embossed and (00) not applicable.

18.3 Media types

This standard allows only media type R/W.

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 sectors of this zone shall contain no embossed information, neither in the Headers nor in the Data fields.

The Rewritable Zone shall extend from sector 0 of logical track 5/8 to sector 3 of logical track 14 859/27 805. Every band shall be recorded in bytes 6 to 15 of the DDS as being rewritable.

18.4 Partitioning

During initialization of the disk, the Rewritable Zone shall be partitioned into 1 group of tracks and it shall span the entire user area, (371 371/694 929 sectors). It is followed by 4 096 spare sectors. The group shall comprise full logical tracks of data sectors followed by full logical tracks of spare sectors.

19 Defect management

19.1 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 optionally, a sector Slipping Algorithm. The total number of Defective Sectors replaced shall not be greater than 4 096.

19.1.1 Initialization of the disk

During initialization of the disk, the four DMAs are recorded prior to the first use of the disk. The Rewritable Zone shall be partitioned into one group because the disk is fully rewritable, (371 371/694 929) Data Sectors and 4 096 Spare Sectors as specified in 18.4.1. The spare sectors can be used as replacements for defective data sectors. Initialization can include certification of the Rewritable Zone, in which 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.

19.1.2 Certification

If a disk is to be certified, the certification shall be applied to the data sectors and to the spare sectors in the rewritable group. The method of certification is not stated by this ECMA Standard. It may involve erasing, writing, and reading all sectors in the group. Defective sectors found during certification shall be handled by the Slipping Algorithm or, where applicable by the Linear Replacement Algorithm (see 19.1.3). Defective sectors shall not be used for reading or writing. Guidelines for replacing Defective sectors are given in annex G.

19.1.3 Slipping Algorithm

The Slipping Algorithm shall be applied to the entire rewritable group in the rewritable zone when ever 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 into 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 disk shall be deemed defective. The space sector area has 4 096 spare sectors ands once all of these are used, the disk is no longer capable of reliable operation.

19.1.4 Linear Replacement Algorithm

The Linear Replacement Algorithm is used to handle Defective Sectors found after certification.

The defective sector shall be replaced by the first available good spare sector of the group. If there are no spare sectors left in the group, the disk shall be deemed defective. 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.

19.1.5 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 sector of the group. If there are no spare sectors left in the group, the disk shall be deemed defective. The addresses of the Defective Sector and of the Replacement Sector shall be recorded in the SDL.

If there exists a list of addresses of defective sectors in the PDL, these sectors shall be skipped for use even if the disk is not certified. This process is the same as the process specified in Clause 19.1.2 for certified disks.

19.1.6 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 entry in the SDL, according to the Linear Replacement Algorithm.

19.1.7 Primary Defect List, (PDL)

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

Note

The disk formatted according to ECMA-201 may not have a PDL.

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 forth user data byte of the first sector. All unused bytes of the last sector in the PDL shall be set to (FF). The information in Table 10 shall be recorded in each PDL.

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

In an empty PDL bytes 2 and 3 shall be set to (00) and bytes 4 to 511 shall be set to (FF).

Table 8 - 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, (Track Number MSB)
5	Address of the First Defective Sector, (Track Number)
6	Address of the First Defective Sector, (Track Number LSB)
7	Address of the First Defective Sector (Sector Number)
	...
X-3	Address of the Last Defective Sector, (Track Number MSB)
X-2	Address of the Last Defective Sector, (Track Number)
X-1	Address of the last Defective Sector, (Track Number LSB)
X	Address of the Last Defective Sector, (Sector Number)

19.1.8   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 sectors necessary, and it shall begin in the 16th user data byte of the first sector. All unused bytes of the last sector of the SDL shall be set to (FF). Table 9 describes the information that shall be recorded in each of the four SDLs.

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

If a replacement sector listed in the SDL is later found to be defective, a 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 15 in table 9 shall be present only in the first sector.

Table 9 - Content of the SDL

Byte	SDL Content
0	(00), SDL Identifier
1	(02), SDL Identifier
2	(00)
3	(01)
4	List Length in bytes in the SDL, MSB
5	List Length in bytes in the SDL, LSB
	(The list starts at byte 6)
6-7	(00)
8	(02)
9	(01)
10-13	(00)
14	Number of Entries in the SDL, MSB
15	Number of Entries in the SDL, LSB
	(Each entry is 8 bytes long)
16	Address of the First Defective Sector (Track Number, MSB)
17	Address of the First Defective Sector (Track Number)
18	Address of the First Defective Sector (Track Number, LSB)
19	Address of the First Defective Sector (Sector Number)
20	Address of the First Replacement Sector (Track Number, MSB)
21	Address of the First Replacement Sector (Track Number)
22	Address of the First Replacement Sector (Track Number, LSB)
23	Address of the First Replacement Sector (Sector Number)
	...
y-7	Address of the Last Defective Sector (Track Number, MSB)
y-6	Address of the Last Defective Sector (Track Number)
y-5	Address of the Last Defective Sector (Track Number, LSB)
y-4	Address of the Last Defective Sector (Sector Number)
y-3	Address of the Last Replacement Sector (Track Number, MSB)
y-2	Address of the Last Replacement Sector (Track Number)
y-1	Address of the Last Replacement Sector (Track Number, LSB)
y	Address of the Last Replacement Sector (Sector Number)

Section 4 - Characteristics of embossed information

20 Method of testing

The format of the embossed information on the disk is defined in clause 17. Clauses 21 to 23 specify the requirements for the signals from grooves and embossed data, as obtained when using the Reference Drive defined in clause 9.

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

20.1 Environment

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

20.2 Use of the Reference Drive

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

20.2.1 Optics and Mechanics

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

20.2.2 Read Power

For the wavelength of 780 nm, 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

$$1,3 \text{ mW} \leq P_{max} \leq 1,7 \text{ mW}$$

P_{max} shall be specified in bytes 21 and 135 of the Control Zone.

For other wavelengths the values for this range are not specified by this ECMA Standard.

Note

The recommended values for P_{max} at other rotational frequencies are given in annex J.

20.2.3 Read Channels

The drive shall have a read Channel, in which the total amount of light in the exit pupil of the objective lens is measured. This Channel can have the implementation as given by Channel 1 in 9.1.

20.2.4 Tracking

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

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

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

$$e_{max}(\text{radial}) = 0,09 \text{ μm}$$

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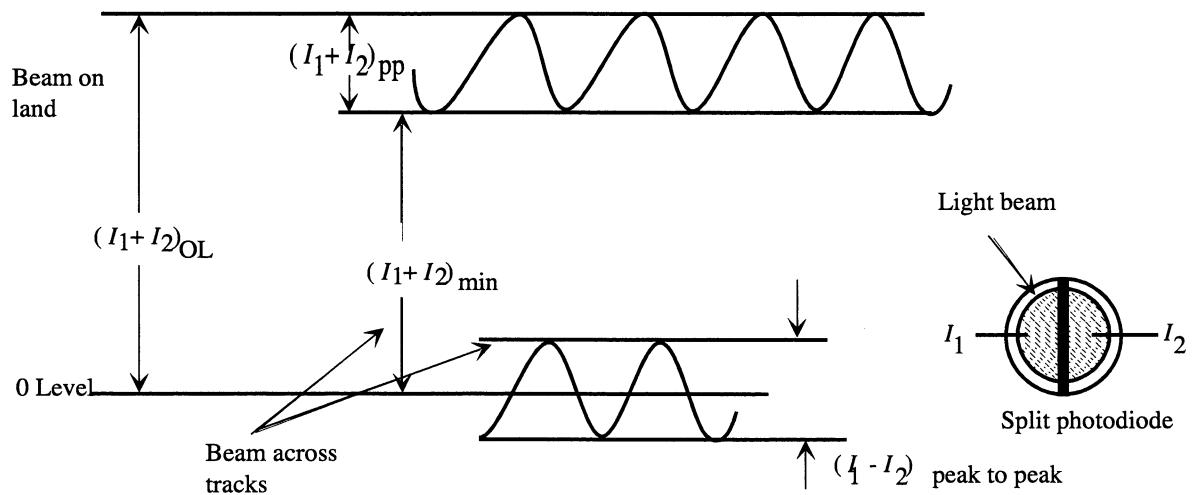
20.3 Definition of signals

All signals are linearly related to currents through a photo-diode detector, and are therefore linearly related to the optical power falling on the detector.
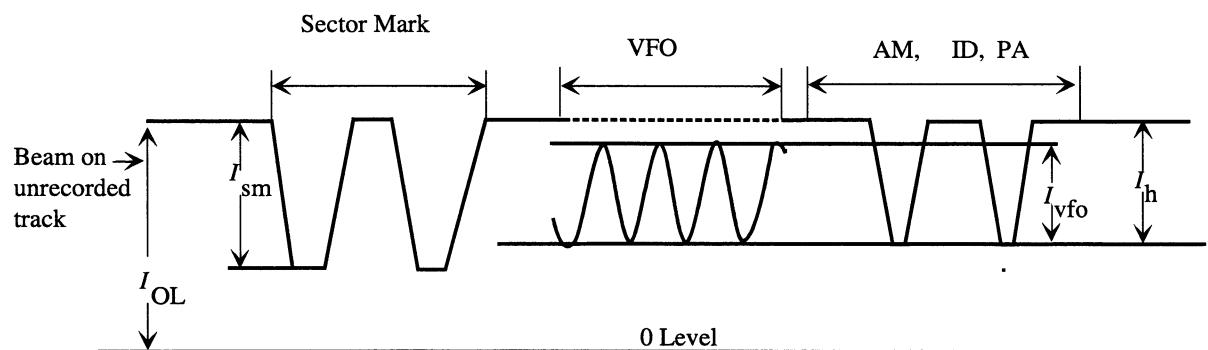
The signals from the two halves of the split photo-diode detector in the tracking Channel are indicated by I_1 and I_2. The signals in the tracking Channel are referenced to the signal $(I_1 + I_2)_{OL}$, which is the maximum level of the sum of the signals in the user zone when the beam crosses the tracks without embossed marks.

The signals in Channel 1 are referenced to the signal I_{OL}, which is the signal in Channel 1 from an unrecorded, grooved area in the Information Zone.
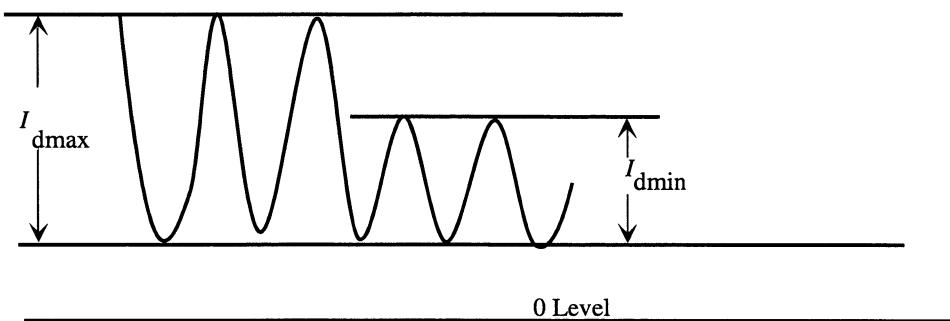
Figure 18 shows the signals specified in clauses 21, 22 and 23.

Beam on land

$(I_1 + I_2)_{pp}$

$(I_1 + I_2)_{OL}$

$(I_1 + I_2)_{min}$

0 Level

Beam across tracks

Light beam

I_1 I_2

Split photodiode

$(I_1 - I_2)$ peak to peak

Signals from grooves in the tracking channel

Sector Mark

VFO

AM, ID, PA

Beam on unrecorded track

I_{sm}

I_{vfo}

I_h

I_{OL}

0 Level

Signals from Headers in Channel 1

I_{dmax}

I_{dmin}

0 Level

Signals from Recording fields in Channel 1

Figure 18 - Signals from embossed areas

21 Signals from grooves

The signals $(I_1 + I_2)$ and $(I_1 - I_2)$ shall be filtered in order that frequencies above 1 MHz are attenuated by at least 40 dB thereby eliminating the effect of modulation due to embossed marks. This condition shall not apply to the measurement of the signal $(I_1 + I_2)_{OL}$. The requirements in this clause for the signals refer to conditions in which the plane of polarization of the incident beam is parallel to the track.

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

21.1 Cross-track signal

The cross-track signal is the sinusoidal sum signal $(I_1 + I_2)$ in the tracking Channel, when the focus of the optical beam crosses the tracks. The signal can be used by the drive to locate the centre of the tracks. The peak-to-peak value of the cross-track signal shall meet the following requirements:

a) in Control Tracks containing embossed headers and embossed Recording fields:

$$0,14 \leq \frac{(I_1 + I_2)_{pp}}{(I_1 + I_2)_{OL}} \leq 0,59$$

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

$$0,254 \leq \frac{(I_1 + I_2)_{pp}}{(I_1 + I_2)_{OL}} \leq 0,71$$

The uniformity of the cross-track signal shall be such that the above ratio shall not vary by any more than 15 % over any grooved area in the Information Zone without embossed Recording fields.

21.2 Cross-track minimum signal

The cross-track minimum signal is the minimum of the sum signal $(I_1 + I_2)_{min}$ in the tracking Channel, when the optical beam crosses the tracks.

The Cross-track minimum signal is obtained by the following formula.

Cross-track minimum = 1 -(Cross-track signal)

21.3 Push-pull signal

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

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

$$0,38 \leq \frac{(I_1 - I_2)_{pp}}{(I_1 + I_2)_{OL}} \leq 0,71$$

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

$$0,52 \leq \frac{(I_1 - I_2)_{pp}}{(I_1 + I_2)_{OL}} \leq 0,71$$

21.4 Divided push-pull signal

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

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

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

The first term shall meet the following requirements:

$$0,74 \leq \left[\frac{(I_1 - I_2)}{(I_1 + I_2)} \right]_{pp} \leq 1,05$$

The second term shall satisfy:

$$\frac{\left[\frac{(I_1 - I_2)}{(I_1 + I_2)} \right]_{pp_{min}}}{\left[\frac{(I_1 - I_2)}{(I_1 + I_2)} \right]_{pp_{max}}} \geq 0,7$$

21.5 Phase depth

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

21.6 Track location

The tracks are located at those radii on the disk where the push-pull signal equals 0 and the cross-track signal has its maximum value.

22 Signals from embossed Headers

The signals from recorded Headers in the Data Zone shall meet the same requirements specified in clause 21 as Headers in the Data Zone are not embossed in this format. Headers and data fields in the Control Zone are embossed.

The signals from embossed headers shall be measured in Channel 1 of the Reference Drive.

The signal from an embossed mark in the recording layer is defined as the peak-to-peak value of the modulation of the signal n Channel 1 caused by the mark when the beam follows a track in the Control Zone (see annex R).

The level of all signals from embossed marks shall be lower than I_{OL}.

22.1 Embossed Sector Mark

The signal ISM from the embossed sector mark shall meet the following requirements:

$$I_{SM}/I_{OL} \geq 0,55$$

22.2 Embossed VFO$_1$ and VFO$_2$ Fields

The signal I_{vfo} from the marks in the VFO$_1$ and VFO$_2$ fields shall meet the following requirements:

$$I_{vfo}/I_{OL} \geq 0,15$$

In addition the condition

$$I_{vfo}/I_{hmax} \geq 0{,}35$$

shall be satisfied within each header, where I_{hmax} is the maximum signal from marks of that header in the fields defined in 23.3.

22.3 Embossed Address Mark, ID and Postamble

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

$$I_h/I_{OL} \geq 0{,}15$$

$$I_{hmin}/I_{hmax} \geq 0{,}35$$

The last requirement applies over any embossed Header. I_{Hin} and I_{Hax} are the signals with minimum and maximum amplitude in those fields of a sector mentioned above.

23 Signals from embossed Recording fields

The Control Zone of the disk is always embossed. The Recording field of all sectors in this Zone shall contain embossed marks. The signals from these marks shall be measured in Channel 1 (see 9.1 and annex R). Acceptable defects of the marks are specified in section 6. The signal from all embossed Recording fields is defined as the peak-to-peak value of the modulation of the signal.

The signal I_d from marks in the Recording fields of the Embossed Zone shall meet the following requirements:

$$I_d / I_{OL} \geq 0{,}17$$

$$I_{dmin} / I_{dmax} \geq 0{,}35$$

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

For the Focus tracks in the Acquire Zone, only I_d / I_{OL} is defined.

Section 5 - Characteristics of the recording layer

24 Method of testing

Clauses 25 to 27 describe a series of tests to assess the magneto-optical properties of the recording layer, as used for writing and erasing data. The tests shall be performed only in the Recording field of the sectors in the Rewritable Zone. If there is no Rewritable Zone for user recording, clauses 26 to 28 shall not apply. The write, read and erase operations necessary for the tests shall be made on the same Reference Drive (see also annex J).

Clauses 25 to 27 specify only the average quality of the recording layer. Local deviations from the specified values, called defects, can cause write or erase problems. These defects are covered by section 6.

24.1 Environment

All signals in clauses 25 to 27 shall be within their specified ranges with the cartridge in any environment in the range of allowed operating environments defined in 8.1.2.

24.2 Reference Drive

The write and erase tests described in clauses 25 to 27 shall be measured in Channel 2 of the Reference Drive. The drive shall have the following characteristics for the purpose of these tests.

24.2.1 Optics and mechanics

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

24.2.2 Read power

The optical power incident on the entrance surface of the disk and used for reading the information shall be in the range from 1,4 mW to 1,6 mW (P_{max}).

24.2.3 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.

24.2.4 Tracking

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

24.3 Write conditions

Marks are written on the disk by pulses of optical power superimposed on a bias power, in the presence of a magnetic field.

24.3.1 Write pulse

The shape of the write pulse shall be as given in figure 19. Figure 20 defines the relationship between the Write pulse signals and the signals for encoded Data, Write clocks and idealized marks on the media.

24.3.2 Write power and pulse width

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

The bias power P_b shall be set between 0,9 mW and 1,1 mW.

The tests shall be carried out at a temperature of 23 °C ± 2 °C, at either

- one of the two constant pulse widths T_p and a write power P_W appropriate to the bands, as given in bytes 22 to 27 and 136 to 141 of the Control data (see annex F).

- a constant pulse power P_W given in bytes 31 and 145, and a pulse width appropriate to the bands given in bytes 32 to 34 and 146 to 148 respectively, of the Control data (see annex F).

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

For other temperatures, the values should be compensated as shown in annex J, in which recommended maximum write powers for two optional rotational frequencies are also shown.

The required write power shall not exceed

$$K\left(\frac{1}{T_p} + \frac{1}{\sqrt{T_p}}\right) \text{ mW} \quad \text{for } 10 \text{ ns} \leq T_p \leq 44 \text{ ns}$$

$K = 24{,}0$ at radius 24,0 mm
$K = 27{,}5$ at radius 40,0 mm
$T_p = 20 \text{ n sec} \pm 5\%$
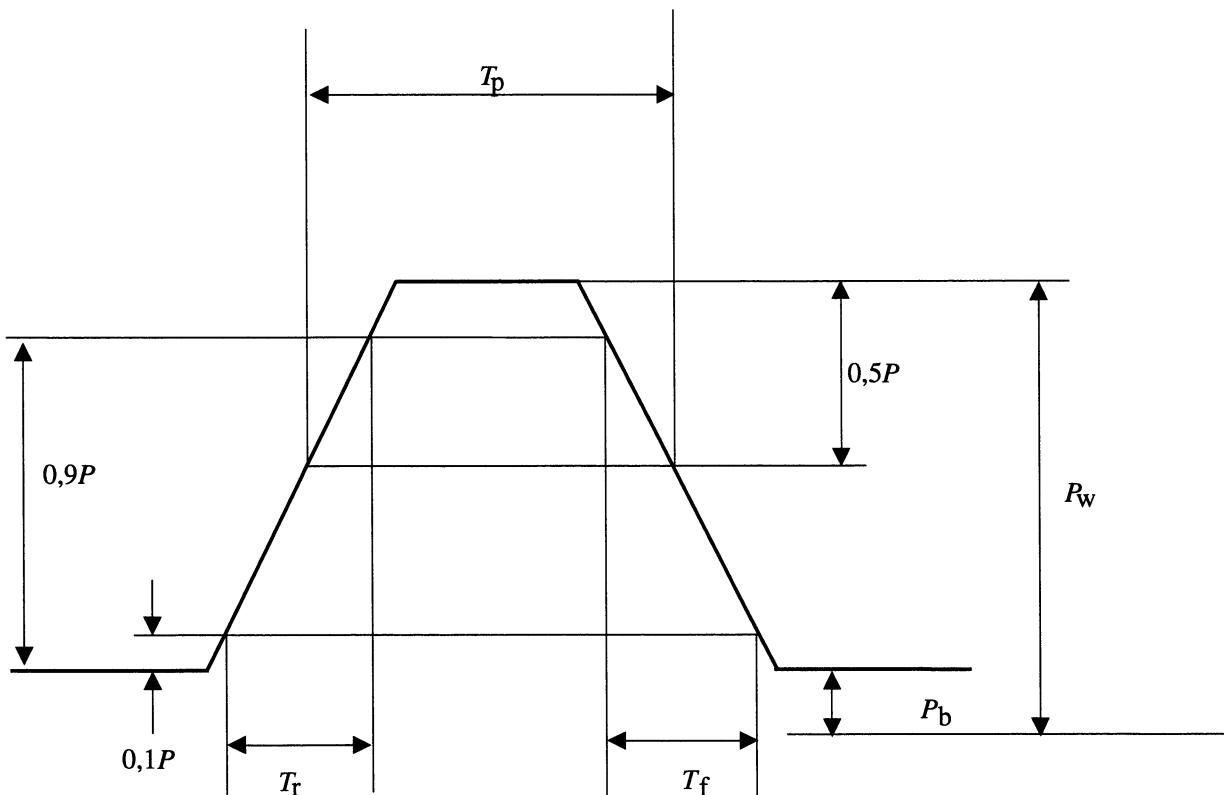
24.3.3 Write magnetic field

The requirements of all tests shall be met for all magnetic field intensities at the recording layer during writing in the range from 16 000 A/m to 32 000 A/m.

The write magnetic field, pointing in the North to South direction, shall be within 15° from the normal to the disk reference plane P, in the direction of the incident beam, i.e. from the entrance surface to the recording layer.

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P_w: write power P_b: bias power
T_r: rise time T_f: fall time
T_p: write pulse width $P: P_w - P_b$

Figure 19 Shape of write pulse

The rise and fall times T_r and T_f shall each be less than $(0{,}1\ T_p + 5)$ns.
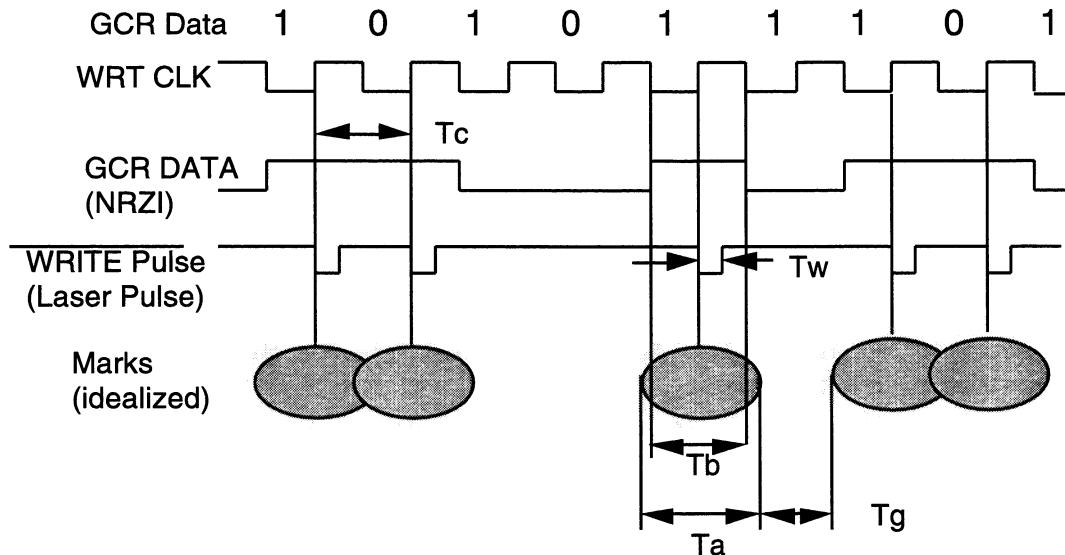
Figure 20 - Relationship of Write Pulse to data and marks

24.4 Erase conditions

Marks are erased from the disk by a constant optical power in the presence of a magnetic field.

24.4.1 Erase power

The erase power is the optical power incident on the entrance surface of the disk and used for erasing marks. The erase power shall not exceed the value calculated according to the formula in 24.3.2.

The tests shall be carried out at a temperature of 23 °C ± 2 °C and with an erase power appropriate to the radius given in bytes 45 to 47 and 159 to 161 of the Control data (see annex F).. For radii other than those specified the values shall be linearly interpolated. The actual power used shall be within ± 10 % of that selected.

For other temperatures the values should be compensated as shown in annex J, in which recommended maximum erase powers for two optional rotational frequencies are also shown.

24.4.2 Erase magnetic field

The requirements of all tests shall be met for all magnetic field intensities at the recording layer during erasing in the range from 16 000 A/m to 32 000 A/m.

The erase magnetic field, pointing in the North to South direction, shall be within 15° from the normal to the disk reference plane P, in the direction of the reflected beam, i.e. from the recording layer to the entrance surface.

24.5 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).

25 Magneto-optical characteristics

25.1 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 of the disk expressed as a decimal fraction, θ is the Kerr rotation of the optical polarization between a mark and no-mark, and β is the ellipticity of the reflected beam, averaged over the aperture. The polarity of the figure of merit is defined to be negative for a

magneto-optical mark written in an Fe-rich Fe-Tb alloy recording layer with the write magnetic field in the direction specified in 22.3.3. In this case the direction of the Kerr rotation is counter-clockwise as seen from the incident beam.

The polarity and magnitude of the value of the figure of merit shall be as specified in byte 10 and 11 of the Control data (see annex F). The figure of merit shall comply with

$$00,0025 < |F| < 0,0050$$

The measurement of the actual value Fm shall be made according to annex H. This value shall be within 12% of the nominal value.

25.2 Imbalance of the magneto-optical signal

The imbalance of the magneto-optical signal is the d.c. offset of the signal from Channel 2 of the Reference Drive, which can be due to birefringence of the substrate. The offset can be measured by writing marks on the disk in the low-frequency region where the modulation transfer function of the optical system is one, as in annex H. One can also use a series of marks that give a 50 % duty cycle read signal. The offset is now the signal level halfway between the extremes of the signal.

The imbalance shall be such that the offset in Channel 2 divided by the signal in Channel 1 shall not exceed 0,06 in the Recording field of any sector in the Rewritable Zone. The imbalance shall be measured in a bandwidth from d.c. to 40 kHz. The imbalance is specified for a Reference Drive with a beam splitter E with nominal values for the reflectances, the phase retarder shall be in the neutral position (see 9.1).

26 Write characteristics

26.1 Resolution

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

Write two series of marks, 1T marks spaced 1T apart and 4T marks spaced 4T apart.. The write conditions shall be as specified in 24.3.

Read the signals in Channel 2 under the conditions specified in 24.2.2 and 24.2.3. IL is the peak-to-peak value of the signal obtained from the widely spaced marks. IH is the peal-to-peak value of the signal obtained from the narrowly spaced marks.

The resolution IH/IL shall not be less than 0,12 within any sector in the Rewritable Zone for all allowed values of the write magnetic field. It shall not vary more than 0,2 over a track.

26.2 Narrow-band signal-to-noise ratio

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

Write a series of marks 1T marks spaced 1T apart and 4T marks spaced 4T apart. The write conditions shall be as specified in 24.3.

Read the Recording fields in Channel 2 under the conditions specified in 24.2.2 and 24.2.3, using a spectrum analyser with a bandwidth of 30 kHz. Measure the amplitudes of the signal from the 1T pattern of marks and spaces at the frequency appropriate to the band and the noise at this frequency as indicated in figure 21. The narrow-band signal-to-noise ratio is

$$20 \log_{10}\left(\frac{signal\_level}{noise\_level}\right)$$

The narrow-band signal-to-noise ratio after correction for any instrumentation error shall be greater than 36 dB in any sector in the Rewritable Zone for all allowed values of the write magnetic field and for all phase differences between -15° and +15° in the optical system as defined in 9.1.

Amplitude

Signal Level

Noise Level

Frequency

f_0
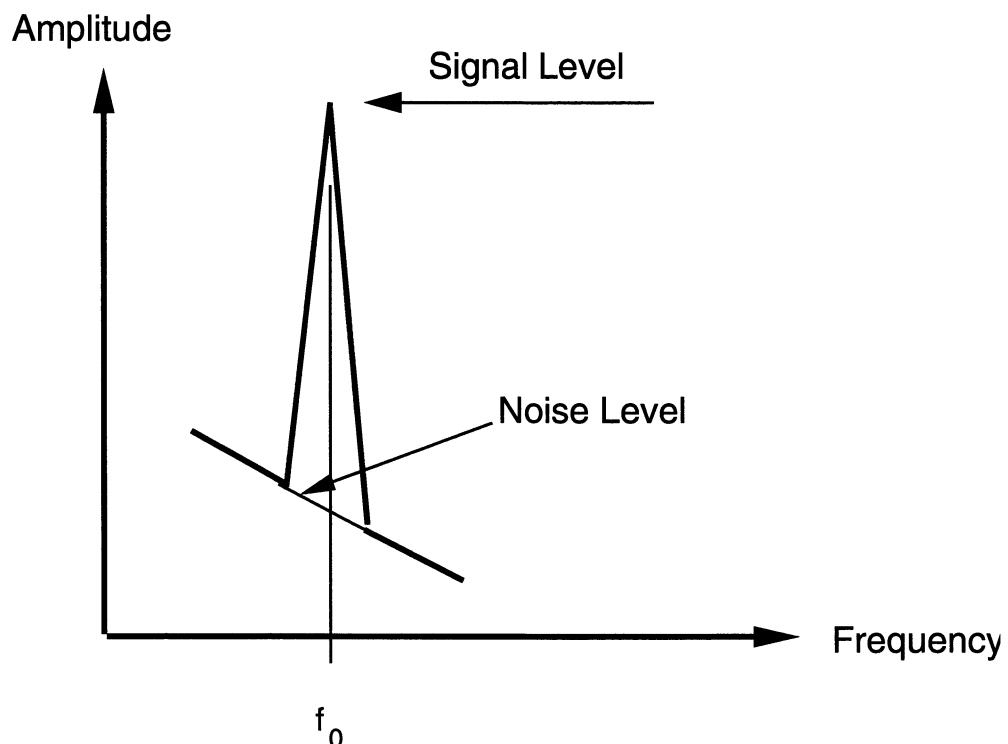
Figure 21 - Spectrum analyzer display

26.3   Cross-talk

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

— Erase the Recording field of each of the sectors in these tracks.

— Write a series of 1T marks spaced 1T apart in the Recording fields of the sectors in track n. The write conditions shall be as specified in 24.3.

— Read the Recording fields of the sectors in the tracks (n-1), n and (n+1) under the conditions specified in 24.2.2 and 24.2.3.

The cross-talk from a track n to track (n-1) and to track (n+1) shall be lower than -30 dB.

27   Erase characteristics

Procedure:

a) Write a series of 1T marks spaced 2T apart in the Recording fields of any series of sectors in the Rewritable Zone. The write conditions shall be as specified in 24.3.

b) Read the Recording fields under the conditions specified in 24.2.2 and 24.2.3, using a spectrum analyzer with a bandwidth of 30 kHz. Note the amplitude of the signal (as specified in 26.2).

c) Erase under the conditions specified in 24.4.

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

e) Repeat a).

f) Repeat b); note the amplitude of the signal and the noise (as specified in 26.2).

g) Repeat c); note the amplitude of the residual signal of the written mark at the same frequency as in f).

Requirements:

1) The narrow-band signal-to-noise ratio calculated from the readings in f) shall be greater than 36 dB.

2) The residual signal in g) shall be less than -33 dB relative to the signal level of the written marks in b).

Section 6 - Characteristics of user data

28   Method of testing

Clauses 29 and 30 describe a series of measurements to test conformance of the user data on the disk with this ECMA Standard. It checks the legibility of both embossed and user-written data. The data is assumed to be arbitrary. The user-written data may have been written by any drive in any environment. The read tests shall be performed on the Reference Drive.

Whereas clauses 20 to 27 disregard defects, clauses 29 and 30 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 29 and 30 define a minimum quality of the data, necessary for data interchange.

28.1   Environment

All signals in clauses 29 to 30 shall be within their specified ranges with the cartridge in any environment in the range of allowed operating environments defined in 8.1.2. It is recommended that before testing the entrance surface of the optical disk shall be cleaned according to the instructions of the manufacturer of the disk.

28.2   Reference Drive

All signals specified in clauses 29 to 30 shall be measured in the indicated channels of the Reference Drive. The drive shall have the following characteristics for the purpose of these tests:

28.2.1   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.

28.2.2   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}.

28.2.3   Read amplifiers

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

28.2.4   Analog-to-binary converters

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

The converter for Channel 1 shall operate correctly for analog signals from embossed marks with amplitudes as determined by clauses 20 and 21.

The converter for Channel 2 shall operate correctly for analog signals from user-written marks with an amplitude as determined by clauses 25 and 26.

28.2.5   Error correction

Correction of errors in the data bytes shall be carried out by an error detection and correction system based on the definition in E.3 of annex E. There shall be an additional correction system for the embossed data, based on the Parity Sectors as defined in 19.2

28.2.6   Tracking

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

29   Minimum Quality of a Sector

This clause specifies the minimum quality of the Header and Recording field of a sector as required for interchange of the data contained in that sector. The quality shall be measured on the Reference Drive specified in 28.2.

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.

29.1 Headers

29.1.1 Sector Mark

At least three of the five long marks of the Sector Mark shall have the timing specified in 15.2 and the signal amplitude shall not be less than that obtained from a series of 4T marks spaced 4T apart in that band.

29.1.2 ID fields

At least one of the three ID fields in a Header read in Channel 1 shall not have any byte errors, as checked by the CRC in the field.

29.2 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 the error correction defined in 28.2.5.

30 Data interchange requirements

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

30.1 Tracking

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

30.2 User-written data

Any sector written in the Rewritable Zone that does not comply with 29.1 and 29.2 shall have been replaced according to the rules of the defect management as defined in clause 19.

30.3 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 4 096 replaced sectors.

Annex A

(normative)

Edge distortion test

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

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

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

$$L_a = 96,0 \text{ mm min.}$$

$$L_b = 91,0 \text{ mm} \pm 0,1 \text{ mm}$$

$$L_c = 8,6 \text{ mm} \begin{array}{l} +0,1 \text{ mm} \\ -0,0 \text{ mm} \end{array}$$

$$L_d = 6,30 \text{ mm} \pm 0,01 \text{ mm}$$

$$L_e = 6,80 \text{ mm min.}$$

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.

ECMA-95-0055-A
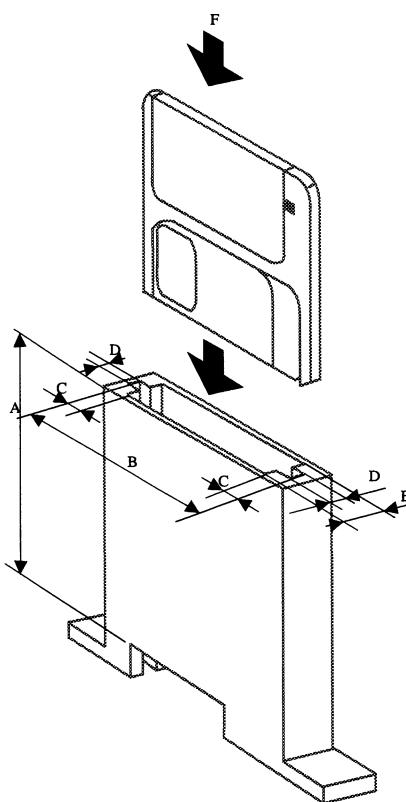
Figure A.1 Distortion Gauge

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 posts 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

$D_a = 6{,}50 \text{ mm} \pm 0{,}01 \text{ mm}$

$D_b = 3{,}50 \text{ mm} \begin{array}{l} + 0{,}00 \text{ mm} \\ - 0{,}02 \text{ mm} \end{array}$

$H_a = 1{,}0 \pm 0{,}1 \text{ mm}$

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

Posts P3 and P4

$D_c = 5{,}50 \text{ mm} \pm 0{,}01 \text{ mm.}$
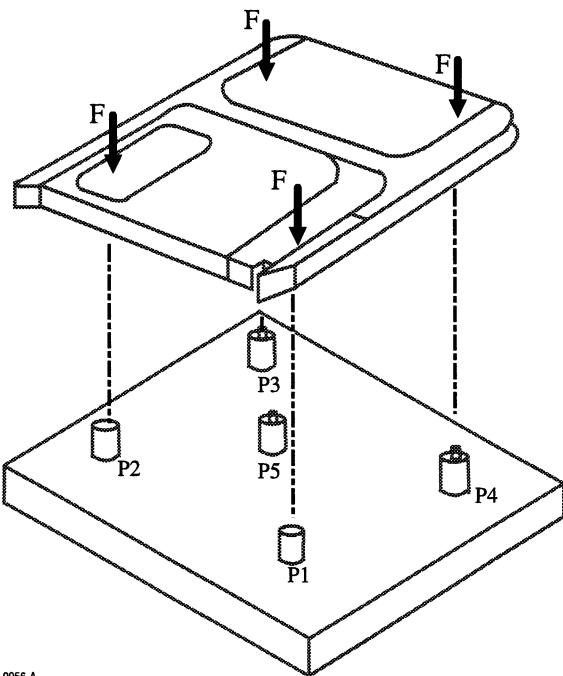
The top area ($H_b - H_a$) of posts P1 and P2 has a chamfer.

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 0,4 N shall be exerted on the cartridge opposite each of the four posts.
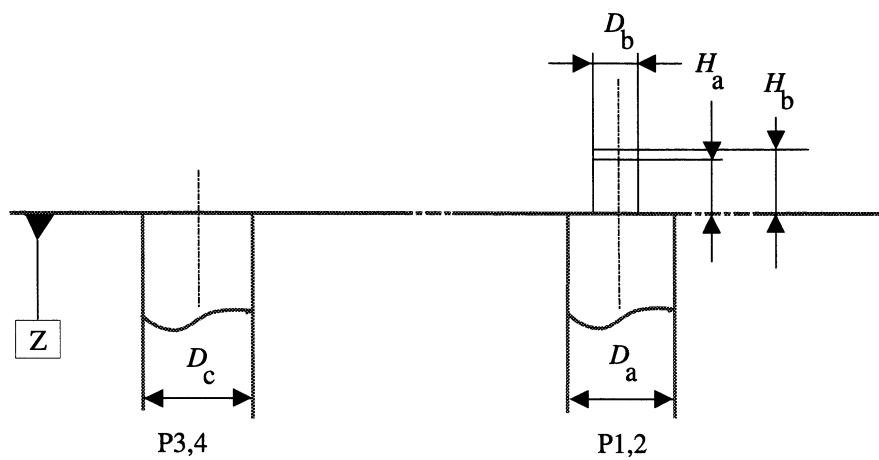
B.5 Requirements

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

ECMA-95-0056-A

Figure B.1 - Compliance gauge

ECMA-95-0057-A

Figure B.2 - Detail of posts

Annex C

(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.

C.1 Relation between requirements

The acceleration required by the motor of the tracking servo to make the focus of the optical beam follow the tracks on the disk (see 11.4.6 and 11.4.8) is a measure for the allowed deviations of the tracks. An additional measure is the allowed tracking error between the focus and the track (see 20.2.4). The relation between both is given in figure C.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.

ECMA-94-0145-A
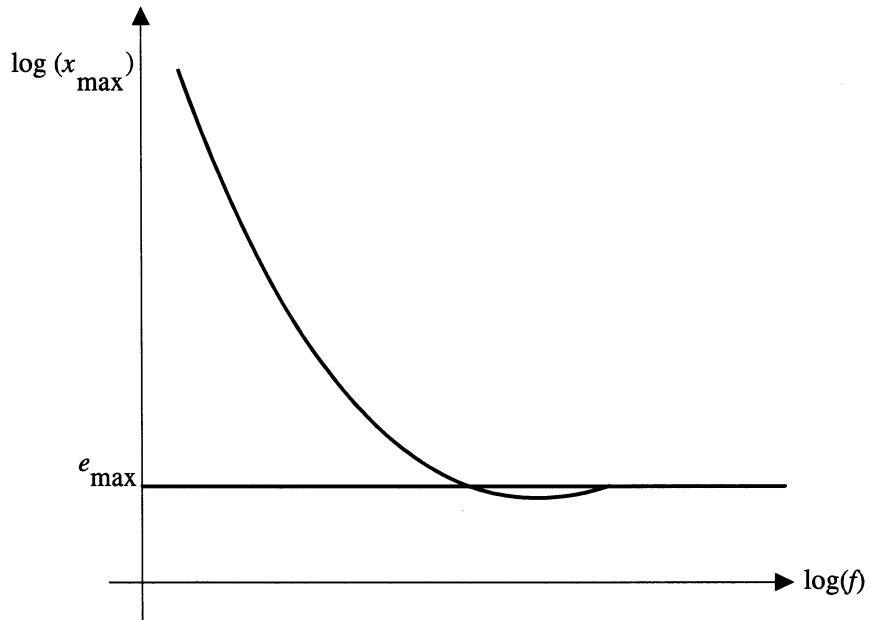
Figure C.1 - Maximum allowed amplitude of a single, sinusoidal track deviation

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

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

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

$$x_{max} = e_{max} \tag{2}$$

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

C.2 Reference Servo

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

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

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

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

$$\frac{e}{x} = \frac{1}{1 + H_s} \tag{4}$$

If the 0 dB frequency is specified as

$$\omega_0 = \sqrt{\frac{a_{max}c}{e_{max}}} \tag{5}$$

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

$$x_{max} = e_{max} \mid 1 + H_S \mid \tag{6}$$

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

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

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

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

Hence, it is permitted to use $a_{max}(\text{motor})$ as specified for low frequencies in 11.4.6 and 11.4.8 for the calculation of ω_0 of a reference servo.
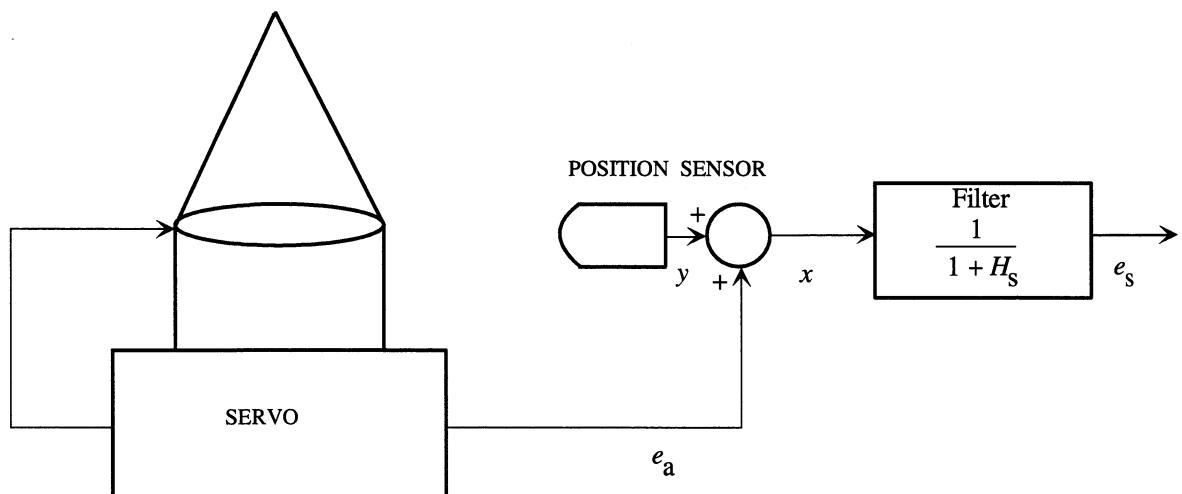
C.3 Requirement for track deviations

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

The open-loop transfer function of the Reference Servo for axial and radial tracking shall be given by equation (3) within an accuracy such that $\mid 1 + H \mid$ does not differ by more than ± 20 % from its nominal value in a bandwidth from 30 Hz to 100 kHz. The constant c shall be 3. The 0 dB frequency $\omega_0/_{(2\pi)}$ shall be given by equation (5), where a_{max} and e_{max} for axial and radial tracking are specified in 20.2.4, 11.4.6 and 11.4.8.
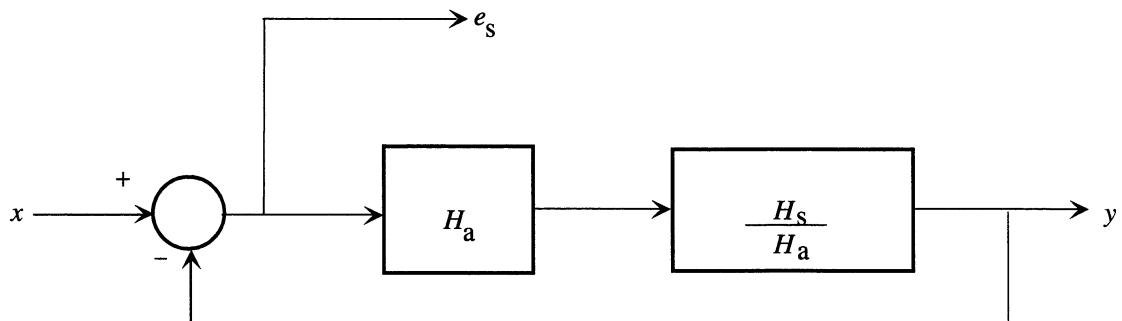
C.4 Measurement implementation

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.
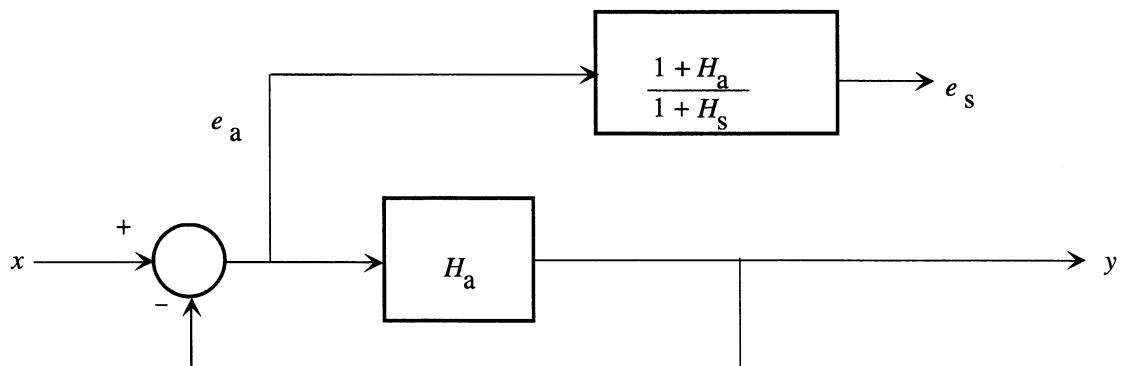
ECMA-94-0081-A

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

ECMA-94-0082-A

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

ECMA-94-0083-A

Figure C.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 C.2 is used in the low-frequency Channel, while that of figures C.3 or C.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 hysteresis. The current must be corrected for the transfer function of the motor and then be converted to a tracking error with a filter with a transfer function $e/a = e/(x\omega^2)$, derived from equation (4).

Annex D

(normative)

CRC for ID fields

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

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

The residual polynomial is defined by

$$R(x) = \left(\sum_{i=8}^{i=23} \bar{b}_i x^i + \sum_{i=0}^{i=7} b_i x^i \right) x^{16} \bmod G(x)$$

where b_i denotes a bit of the first three bytes and $\bar{b}_i$ an inverted bit. Bit b_{23} is the highest order bit of the first byte.

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

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

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

Annex E

(normative)

Format of the Data field of a sector

E.1 Contents of the Data field and Interleaving

The bytes in the Data field constitute an ordered sequence A_n. The elements of A_n for a 1 024 byte sector are, depending on the value of n:

$$1 \leq n \leq 1024: A_n = D_n \qquad \text{user data bytes}$$
$$1025 \leq n \leq 1036: A_n = F_m \qquad \text{bytes with non-specified content}$$
$$1077 \leq n \leq 1040: A_n = C_k \qquad \text{CRC check bytes}$$
$$1041 \leq n \leq 1200: A_n = E_{st} \qquad \text{ECC check bytes,}$$

where

$$h = \text{int}\left[n - \frac{1025}{4} \right] + 1$$

$$m = [(n - 1025) \bmod 4] + 1$$

$$k = n - 1036$$

$$s = [(n - 1041) \bmod 10] + 1$$

$$t = \text{int}\left(\frac{n - 1041}{10} \right) + 1$$

The notation int[x] denotes the largest integer not greater than x.

Before the ECC and CRC bytes are calculated, the bytes in the Data field are ten-way interleaved. For that purpose, the first three sub-groups of A_n are mapped onto a two dimensional matrix B_{ij} with 104 rows and 10 columns. Thus

for $\qquad 1 \leq n \leq 1\ 040: B_{i,j} = A_n$

where:

$$\iota = 103 - \text{int}\left[\frac{n-1}{10} \right]$$

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

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

The elements of A_n for a 512 byte sector are, depending on the value of n:

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

where

$$m = n - 512$$

$$k = n - 516$$

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

$$t = \mathrm{int}\left(\frac{n-521}{5}\right) + 1$$

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. The Resync bytes are not included in A_n.

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

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

where

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

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

E.2   CRC and ECC

E.2.1   General

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

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

E.2.2   CRC

The generator polynomial for the CRC bytes shall be

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

The four check bytes of the CRC shall be computed over the user data and the four F_m bytes. The information polynomial for a 1 024 byte sector shall be

$$I_c(x) = \left[\sum_{i=1}^{i=103}\sum_{j=0}^{j=9}(B_{ij})x^i\right] + \sum_{j=0}^{j=5}(B_{0,j})x^0$$

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

The information polynomial for a 512 byte sector shall be

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

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

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

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

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

E.2.3 ECC

The primitive polynomial and the elements shall be as specified in E.2.1. The generator polynomial for the check bytes of the ECC shall be

$$G_E(x) = \prod_{i=120}^{i=35} (x + \alpha^i)$$

This polynomial is self reciprocal. This property can be used to reduce the hardware size. The initial setting of the ECC register shall be all ZEROs. The bits of the computed check byte shall be inverted before they are encoded into Channel bits.

The 160 or 80 check bytes of the ECC shall be computed over the user data, the four F_m bytes and the four CRC bytes. The corresponding ten information polynomials shall be:

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

where $0 \leq j \leq 9$ for 1K sectors or where $0 \leq j \leq 4$ for 512-byte sectors.

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

$$R_{Ej}(x) = I_{Ej}(x)\, x^{16} \mod G_E(x)$$

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 E.1.

E.3 Resync

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

1000 1000 1 .

For 1 024-byte sectors, the Resync field RS_n shall be inserted between bytes A_{15n} and A_{15n+1}, where $1 \leq n \leq 59$.

For 512-byte sectors, the Resync field RS_n shall be inserted between bytes A_{20n} and A_{20n+1}, where $1 \leq n \leq 39$.

E.4 Recording Sequence

The bytes of the Data field shall be recorded on the disk immediately after the Sync field. Their order shall be according to the sequence A_n with the Resync bytes inserted as specified in E.3.

Table E.1 shows in matrix form the arrangement of the bytes. The sequence of recording is from left to right and top to bottom. The first three bytes SB_1, SB_2 and SB_3 form the Data Sync field, which precedes the Data field. The first 104 rows of the Data field contain 1024/512 bytes of user data, (D_n), 12 bytes with unspecified contents, (F_n) and 4 bytes of CRC data, (C_n). The last 16 rows contain the ECC check bytes.

Table E.1 - Data field configuration for 1024 byte Format. The indices i and j of bytes B_{ij} are given along the sides of the matrix

Column No. j →			0	1	2	3	4	5	6	7	8	9 Row No. I ↓	
SB1	SB2	SB3	D1	D2	D3	D4	D5	D6	D7	D8	D9	D10	103
			D11	D12	D13	D14	D15	D16	D17	D18	D19	D20	102
	RS1		D21	D22	D23	D24	D25	D26	D27	D28	D29	D30	101
			D31	D32	D33	D34	D35	D36	D37	D38	D39	D40	100
	RS2		D41	D42	D43	D44	D45	D46	D47	D48	D49	D50	99
			D51	D52	D53	D54	D55	D56	D57	D58	D59	D60	98
	RS3		D61	D62	D63	D64	D65	D66	D67	D68	D69	D70	97
104 Rows			⋮				⋮					⋮	
	RS49		D981	D982	D983	D984	D985	D986	D987	D988	D989	D990	5
			D991	D992	D993	D994	D995	D996	D997	D998	D999	D1000	4
	RS50		D1001	D1002	D103	D1004	D105	D1006	D1007	D1008	D1009	D1010	3
			D1011	D1012	D1013	D1014	D1015	D1016	D1017	D1018	D1019	D1020	2
	RS51		D1021	D1022	D1023	D1024	F1	F2	F3	F4	F5	F6	1
			F7	F8	F9	F10	F11	F12	C1	C2	C3	C4	0
	RS52		E1,1	E2,1	E3,1	E4,1	E5,1	E6,1	E7,1	E8,1	E9,1	E10,1	-1
			E1,2	E2,2	E3,2	E4,2	E5,2	E6,2	E7,2	E8,2	E9,2	E10,2	-2
	RS53		E1,3	E2,3	E3,3	E4,3	E5,3	E6,3	E7,3	E8,3	E9,3	E10,3	-3
16 Rows			⋮				⋮					⋮	
			E1,14	E2,14	E3,14	E4,14	E5,14	E6,14	E7,14	E8,14	E9,14	E10,14	-14
	RS59		E1,15	E2,15	E3,15	E4,15	E5,15	E6,15	E7,15	E8,15	E9,15	E10,15	-15
			E1,16	E2,16	E3,16	E4,16	E5,16	E6,16	E7,16	E8,16	E9,16	E10,16	-16

Table E.2 Data field Configuration for 512 byte format.
The indices i and j of bytes B_{ij} are given along the sides of the matrix.

Row No. I ↓

Column no. j →

			0	1	2	3	4	
SB1	SB2	SB3	D1	D2	D3	D4	D5	103
			D6	D7	D8	D9	D10	102
			D11	D12	D13	D14	D15	101
		RS1	D16	D17	D18	D19	D20	100
			D21	D22	D23	D24	D25	99
			D26	D27	D28	D29	D30	98
		RS2	D31	D32	D33	D34	D35	97
			⋮	⋮	⋮	⋮	⋮	
		RS33	D496	D497	D498	D499	D500	4
			D501	D502	D503	D504	D505	3
			D506	D507	D508	D509	D510	2
		RS34	D511	D512	F1	F2	F3	1
			F4	C1	C2	C3	C4	0
			E1,1	E2,1	E3,1	E4,1	E5,1	-1
		RS35	E1,2	E2,2	E3,2	E4,2	E5,2	-2
			E1,3	E2,3	E3,3	E4,3	E5,3	-3
			⋮				⋮	
		RS39	E1,14	E2,14	E3,14	E4,14	E5,14	-14
			E1,15	E2,15	E3,15	E4,15	E5,15	-15
			E1,16	E2,16	E3,16	E4,16	E5,16	-16

104 rows

16 rows

Annex F

(normative)

Contents of the Control Zones

Each sector in the two Control Zones shall be pre-recorded, (embossed) in the standard sector format specified by ECMA-201, (RLL 2,7 modulation). Each sector shall contain the same 512 bytes of Control data provided by the manufacturer of the media. The Control data is divided into four groups in the following way.

1) The media characterization data gives a general characterization of the disk. It specifies the type of disk, the ECC, the tracking method, etc. The data is recorded in bytes 0 to 17. Bytes 0 to 12 are mandatory.

2) The Recording Control data specifies the settings of the drive for reading, writing and erasing. Space is allocated for the following sets of data:

- three wavelengths L_1, L_2 and L_3,

- for each wavelength the reflectance R of the disk,

- for each wavelength four rotational frequencies N_1, N_2, N_3 and N_4,

- for each value of N:

    the maximum read power

    one set of erase conditions

    three sets of write conditions: viz. two sets for constant pulse width and one set for constant pulse power, (each set may contain three values for the inner, middle and outer radius of the Information Zone).

The Recording Control data can be divided into two sub-groups, one for the conformance tests described in clauses 18 to 27, and one for control of user drives.

a) The conformance test data specifies the settings for the Reference Drive. They can also be used as reference data for user drives. The conformance test data shall be recorded in bytes 18 to 34, 44 to 47, 132 to 148 and 158 to 161, and are mandatory for rewritable and partially embossed media.

b) The user reference test data contains the recommendation of the media manufacturer for the settings of a user drive for operating the disk in the test environment. This data is recorded in bytes 48 to 131, and 162 to 359 and is optional, except in those bytes listed in c) below.

c) The following bytes are reserved for future standardization and shall be set to (FF):

28 to 30	
35 to 43	198 to 200
56 to 58	226 to 228
84 to 86	256 to 258
112 to 114	263 to 271
142 to 144	284 to 286
149 to 157	312 to 314
170 to 172	340 to 342

3) Bytes 400 to 428 are mandatory.

4) The last group contains unspecified data, recorded in bytes 480 to 511.

Optional bytes shall either contain the prescribed data or shall be set to (FF).

F.1 Media characterization data

Byte 0: Format Descriptor 1

This byte shall be set to 01100001, indicating Continuous Composite Servo tracking, Constant Angular Velocity of the disk and GCR mark width modulation Recording code.

Byte 1: Format Descriptor 2

For the 1024 byte format, this byte shall be set to 00000010, indicating Reed-Solomon Long Distance Error Correction Code of degree 16 with a 10-way interleave, 1 024 bytes user data per sector. For the 512 byte format this byte will be set to 00010001 indicating Reed-Solomon Long Distance Code of degree 16 with 5-way interleave and 512 bytes per sector.

Byte 2: Sectors per logical track

This byte shall be set to 00011001 to indicate that the number of sectors per track is 25.

Byte 3: Reflectance

This byte shall specify the disk manufacturer's specification of the reflectance R of the disk, expressed as a fraction, when measured at a nominal wavelength of 780 nm. It is specified as a number n such that

$$n = 100\,R$$

Byte 4: On-land or in-groove recording

This byte shall be set to 00000000, indicating on-land recording.

Byte 5: Reserved

This byte shall be set to (FF).

Byte 6: Maximum read power

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

$$n = 20\,P_w$$

Byte 7: Media Type

The allowed setting of this byte shall be

0010 0000:   indicates fully rewritable MO media

Other settings of this byte are prohibited by this ECMA Standard, they are reserved for future standardization.

Bytes 8, 9: Last track in the Data Zone

These bytes shall be set to 00111010/01101101 and 10110110/01001010, respectively, indicating the MSB, LSB of the logical track number of the last track in the Data Zone, viz. 15 030/27 978.

Byte 10: Polarity of the figure of merit

This byte shall be set to 00000001, indicating that the polarity is negative.

Byte 11: Magnitude of the figure of merit

This byte shall indicate the magnitude of the figure of merit F, specified as a number n, such that

$$n = 10000\,F$$

Byte 12: Track Pitch

This byte shall indicate the track pitch in µm time 100. It shall be set to 10001011 representing a track pitch of 1,39 µm.

Byte 13: Reserved

This byte shall be set to (FF).

Bytes 14 to 17: Unspecified

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

F.2 Recording control data

Byte 18: Wavelength

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

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

This byte shall be set to $n = 156$.

Byte 19: Reflectance

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

$$n = 100\ R_1.$$

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

Byte 20: Rotational frequency

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

$$n = N_1.$$

This byte shall be set to $n = 30$.

Byte 21: Maximum read power

This byte shall specify the maximum read power P_1, in milliwatts, in the Information Zone under condition L_1 and N_1, expressed as a number n such that

$$n = 20\ P_1$$

where $24 \leq n \leq 26$

Bytes 22 to 27: Write power at constant pulse width

Bytes 22 to 27 shall specify the write powers P_w, in milliwatts, for two values of a pulse width T_p, under condition L_1 and N_1, where T is the period of one Channel bit. P_w is expressed as a number n such that

$$n = 5\ P_w.$$

Byte 22 Write power at $T_p = 1,00\ T$ ns and Band 1
Byte 23 Write power at $T_p = 1,00\ T$ ns and Band 16
Byte 24 Write power at $T_p = 1,00\ T$ ns and Band 31

Byte 25 Write power at $T_p = 0,50\ T$ ns and Band 1
Byte 26 Write power at $T_p = 0,50\ T$ ns and Band 16
Byte 27 Write power at $T_p = 0,50\ T$ ns and Band 31

Bytes 28-30 Reserved

These bytes shall be set to (FF).

Bytes 31 to 34: Write pulse width at constant write power

Bytes 31 to 34 shall specify the write pulse width T_p, in nanoseconds, at a write power P_w under condition L_1 and N_1. T_p is expressed as a number n such that

$$n = T_p$$

Byte 31 Write power

Byte 32 Write pulse width at Band 1
Byte 33 Write pulse width at Band 16
Byte 34 Write pulse width at Band 31

Bytes 35 to 43: Reserved

These bytes shall be set to (FF).

Bytes 44 to 47: D.C. erase power

Byte 44 shall be set to (00). Bytes 45 to 47 shall then specify erase powers P_e, in milliwatts, for a d.c. erase at three radii, under condition L_1 and N_1. P_e is expressed in the same way as P_w in bytes 22 to 30.

Byte 45 Erase power at Band 1

Byte 46 Erase power at Band 16

Byte 47 Erase power at Band 31

Byte 48: Rotational frequency

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

If this byte is not set to (FF), n shall be set to 50.

Bytes 49 to 75

These bytes shall specify the same parameters as in bytes 21 to 47, but under the condition L_1 and N_2, except bytes 56 to 58 which shall be set to (FF).

Byte 76: Rotational frequency

This byte shall specify the rotational frequency N_3, in hertz, of the disk, expressed in the same way as N_1 in byte 20.

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

Bytes 77 to 103

These bytes shall specify the same parameters as in bytes 21 to 47, but under the condition L_1 and N_3, except bytes 84 to 86 which shall be set to (FF).

Byte 104: Rotational frequency

This byte shall specify the rotational frequency N_4, in hertz, of the disk, expressed in the same way as N_1 in byte 20.

If this byte is not set to (FF), n shall have a value other than 40, 50 or 60.

Bytes 105 to 131

These bytes shall specify the same parameters as in bytes 21 to 47, but under the condition L_1 and N_4, except bytes 112 to 114 which shall be set to (FF).

Byte 132: Reserved

This byte shall specify the wavelength L_2 of the drive, in nanometers, as a number n such that

$$n = 1/5 \, L_2$$

Byte 133: Reflectance

This byte shall specify the reflectance R_2 of the disk measured at wavelength L_2 as a number n such that

$$n = 100 \, R_2$$

Byte 134: Rotational frequency

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

$$n = N_1$$

This byte shall be set to $n = 30$.

Byte 135: Maximum read power

This byte shall specify the maximum read power P_2 in the Information Zone, in milliwatts, under condition L_2 and N_1, expressed as a number n such that

$$n = 20\,P_2$$

where $24 \leq n \leq 26$

Bytes 136 to 141: Write power at constant pulse width

These bytes shall specify the write powers P_w in milliwatts for two values of a pulse width T_p, under condition L_2 and N_1 for three radii, where T is the period of one Channel bit. P_w is expressed as number n such that

$$n = 5\,P_w$$

Byte 136 Write power at $T_p = 1,00\ T$ ns and Band 1
Byte 137 Write power at $T_p = 1,00\ T$ ns and Band 16
Byte 138 Write power at $T_p = 1,00\ T$ ns and Band 31

Byte 139 Write power at $T_p = 0,50\ T$ ns and Band 1
Byte 140 Write power at $T_p = 0,50\ T$ ns and Band 16
Byte 141 Write power at $T_p = 0,50\ T$ ns and Band 31

Bytes 142-144 Reserved

These bytes shall be set to (FF).

Bytes 145 to 148: Write pulse width at constant write power

These bytes shall specify the write pulse width T_p, in nanoseconds, at a write power P_w under condition L_2 and N_1 for three radii. T_p is expressed as a number n such that

$$n = T_p$$

P_w is expressed in the same way as in bytes 136 to 144.

Byte 145 Write power

Byte 146 Write pulse width at Band 1

Byte 147 Write pulse width at Band 16

Byte 148 Write pulse width at Band 31

Bytes 149 to 157: Reserved

These bytes shall be set to (FF).

Bytes 158 to 161: D.C. erase power

Byte 158 shall be set to (00). Bytes 159 to 161 shall then specify erase powers P_e, in milliwatts, for a d.c. erase at three radii, under condition L_2 and N_1. P_e is expressed in the same way as P_w in bytes 136 to 144.

Byte 159 Erase power at Band 1
Byte 160 Erase power at Band 16
Byte 161 Erase power at Band 31

Byte 162: Rotational frequency

This byte shall specify the rotational frequency N_2 of the disk, in hertz , expressed in the same way as N_1 in byte 134.

If this byte is not set to (FF), n shall be set to 50.

Bytes 163 to 189

These bytes shall specify the same parameters as in bytes 135 to 161, but under the condition L_2 and N_2, except bytes 170 to 172 which shall be set to (FF).

Byte 190: Rotational frequency

This byte shall specify the rotational frequency N_3 of the disk, in hertz , expressed in the same way as N_1 in byte 134.

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

Bytes 191 to 217

These bytes shall specify the same parameters as in bytes 135 to 161, but under the condition L_2 and N_3, except bytes 198 to 200 which shall be set to (FF).

Byte 218: Rotational frequency

This byte shall specify the rotational frequency N_4 of the disk, in hertz , expressed in the same way as N_1 in byte 134.

If this byte is not set to (FF), n shall have a value other than 30, 50 or 60.

Bytes 219 to 245

These bytes shall specify the same parameters as in bytes 135 to 161, but under the condition L_2 and N_4, except bytes 226 to 228 which shall be set to (FF).

Byte 246: Wavelength

This byte shall specify the wavelength L_3 of the drive, in nanometers, expressed in the same way as L_2 in byte 132.

Bytes 247 to 359

These bytes shall specify the same parameters as in bytes 133 to 245, but under the condition L_3, except bytes 256 to 258, 263 to 271, 284 to 286, 312 to 314 and 340 to 342 which shall be set to (FF).

Bytes 360 to 379: Reserved

These bytes shall be set to (FF).

Summary of Recording Control data

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

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

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

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

F.3   System data

Bytes 380 to 387: Reserved

These bytes shall be set to (FF).

Bytes 388 and 389: Number of tracks in the first data Band

Byte 388 shall be set to 00000001/00000000 and byte 389 shall be set to 00101011/11101100 respectively, indicating the MSB and LSB of the number of logical tracks in the first data Band, viz. 299/236. The number includes DMA tracks.

Byte 390: Number of Bands

This byte shall be set to 00100101/00100001, indicating the number of Bands is 35/33

Byte 391: Banding constant for the media

This byte is not used and shall be set to (FF).

Bytes 392 to 393: Number of physical tracks per data Band

These bytes shall be set to the number of physical tracks per data Band except for the first and last data Bands on the disk. Byte 392 shall be set to 00000001/00000001 and byte 393 shall be set to 01110111/10010000.

Bytes 394 to 399: Reserved

These bytes shall be set to (FF).

Bytes 400 to 423: Control bytes for partially embossed disks

These bytes shall be set to (FF).

Bytes 424 to 479: Reserved.

These bytes shall be set to (FF).

F.4   Unspecified data

Bytes 480 to 511

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.

Table F.1 - Summary of recording control data

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

See F.1 for specification of the contents of each byte
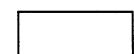
Legend for Table F.1

▓▓▓ Mandatory: Set bytes to (FF)   ▒▒▒ Mandatory: Set bytes as specified   ☐ Not Mandatory

Annex G

(informative)

Guidelines for sector replacement

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

a) a sector has two or three ID fields with each an error as detected by the CRC check;

b) the Sector Mark cannot be recognized;

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

Annex H

(normative)

Measurement of the figure of merit

H.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 not measure media properties only 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.

H.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 of the polarization between both opposite states of magnetization of the layer, and the Kerr ellipticity ß. The figure of merit of the media is then

$$F_{\mathrm{L}} = R \sin \theta \cos 2\text{ß} .$$

A low-frequency test pattern is written on the same disk. The written domains shall be substantially larger than the focal 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 rotating at 30 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.

H.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

$$F = F_{\mathrm{L}} \frac{V}{VL}$$

Annex J

(informative)

Read power, write power and erase power

J.1 Read power

The values of P_{max} for two further rotational frequencies are defined in table J.1. The value contained in the Control Zone may not exceed these values for a specific rotational frequency.

Table J.1 - Rotational frequency and maximum read power

Rotational Frequency	Maximum Read Power P_{max}
50 Hz	$1,6 \text{ mW} \leq P_{max} \leq 1,7 \text{ mW}$
60 Hz	$1,8 \text{ mW} \leq P_{max} \leq 2,0 \text{ mW}$

J.2 Write power and erase power

The values of write power and erase power contained in the Control Zones are described as the values at the temperature of 23 °C only and should not exceed the values for the following two rotational frequencies as follows:

Rotational Frequency	Maximum Write Power and Maximum Erase Power	
50 Hz	$P_{w,e} = 51\left(\dfrac{1}{T_p} + \dfrac{1}{\sqrt{T_p}}\right) \text{m W}$	$T_p \leq 33 \text{ ns}$
	$P_{w,e} = 10,4 \text{ mW}$	$T_p > 33 \text{ ns}$
60 Hz	$P_{w,e} = 51\left(\dfrac{1}{T_p} + \dfrac{1}{\sqrt{T_p}}\right) \text{m W}$	$T_p \leq 27 \text{ ns}$
	$P_{w,e} = 11,6 \text{ mW}$	$T_p > 27 \text{ ns}$

where $P_{w,e}$ is the write power (P_w) or erase power (P_e) and T_p is the numeric value in nanoseconds of the write pulse width.

The write power and erase power should be compensated for the temperature of the disk according to the formula:

$$P_t = P_{23} - [0,03 \ (T_{op} - 23)]$$

where

P_t is the compensated power,

P_{23} is the value described in the Control Zone, and

T_{op} is the numeric value in degree Centigrade (°C) of the temperature of the disk.

Annex K

(normative)

Test method for measuring the adsorbent force of the hub

K.1   The purpose of this test is to determine the magnetic characteristic of the magnetizable material of the hub.

K.2   The test device (see figure K.1) consists of a spacer, a magnet, a back yoke and a centre shaft. The dimensions of the test device are as follows:

D_d = 7,0 mm ± 0,1 mm

D_e = 14,0 mm ± 0,1 mm

D_f = 13,0 mm max.

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

H_c = 0,40 mm ± 0,01 mm

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

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

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

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

Number of poles	: 4
Maximum energy product (BH_{max})	: 175 kJ/m^3 ± 16 kJ/m^3 (typical)
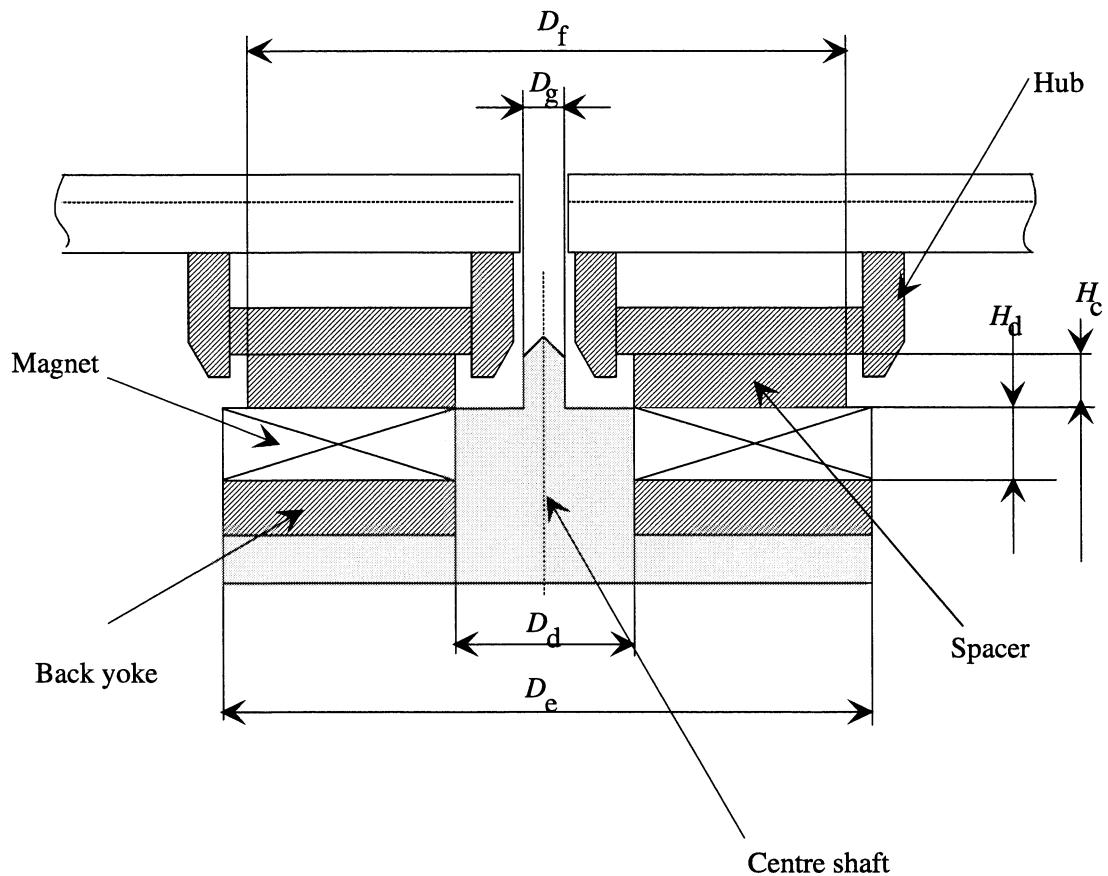
The characteristics of the magnet with back yoke shall be adjusted by the use of a pure nickel plate with the following dimensions (see figure K.2), and the adsorbent force of this plate at the point of H_c = 0,4 mm when spaced from the magnet surface shall be 3,3 N ± 0,2 N.

D_h = 6,0 mm ± 0,1 mm

D_i = 15,0 mm ± 0,1 mm
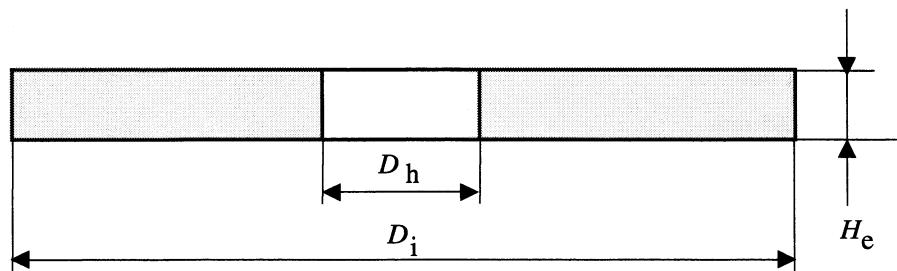
H_e = 1,00 mm ± 0,05 mm

K.5   The test condition for temperature shall be as specified in 8.1.1.

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

Figure K.2 - Calibration plate of the test device

Annex L

(informative)

Derivation of the operating climatic environment

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

L.1 Standard climatic environment classes

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

The IEC class 3K3 refers to climatic conditions which

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

L.2 Overtemperature considerations

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

L.3 Absolute humidity

The introduction of the parameter

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

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

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

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

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

L.4 Deviations from the IEC Standard environment class

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

---

[1] Classification of environmental conditions - Part3: Classification of groups of environmental parameters and their severities. Stationary use at weatherprotected locations.

- Atmospheric pressure

  The IEC 3K3 lower limit of 70 kPa has been extended to 60 kPa. ODCs 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 gradients) of temperature and relative humidity are not according to IEC 3K3.

L.5   Wet bulb temperature specifications

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

> wet bulb temperature [unit: °C]

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

In order to facilitate comparisons between different specifications, figure L.2 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.

Absolute air humidity (g/m^3)
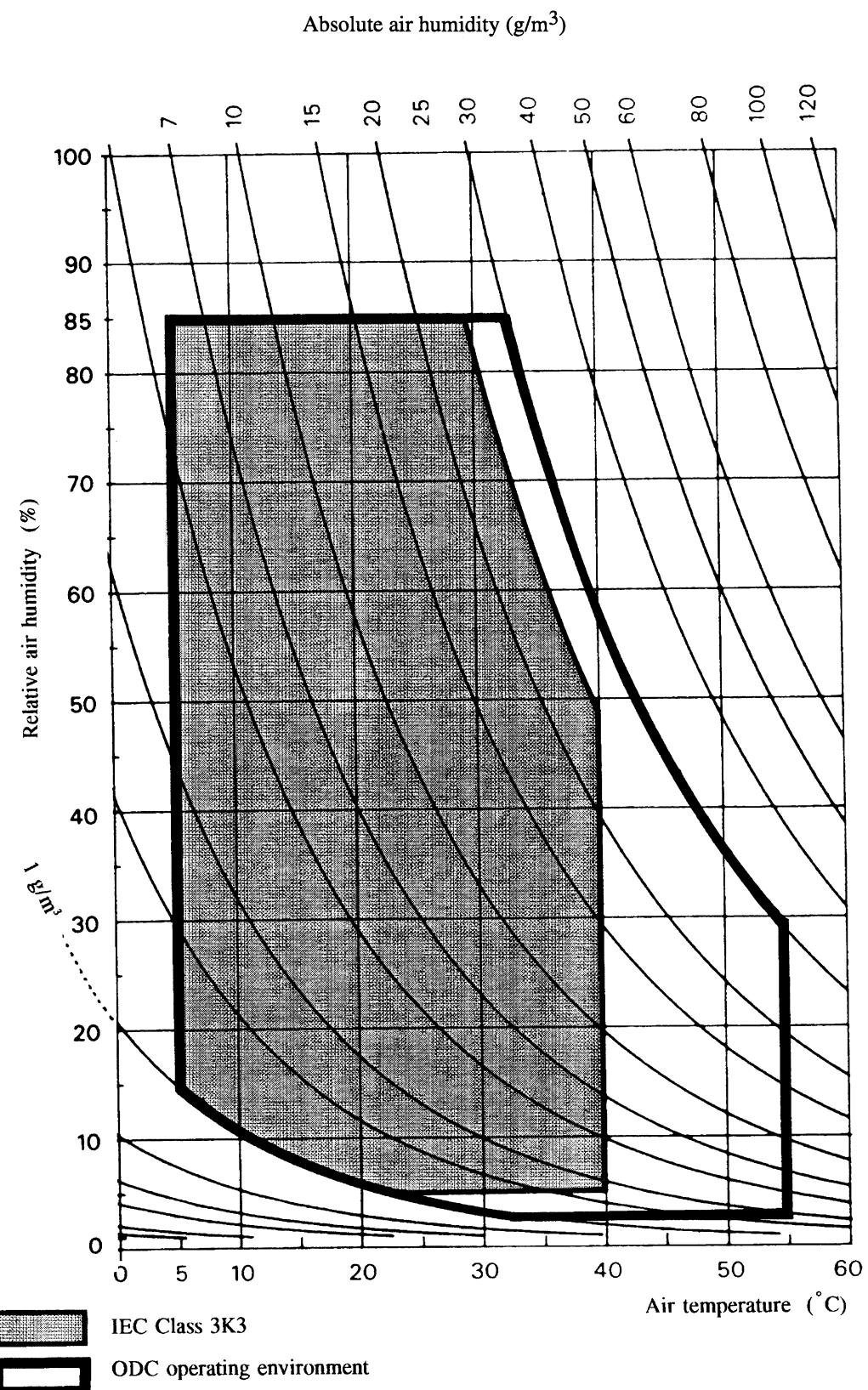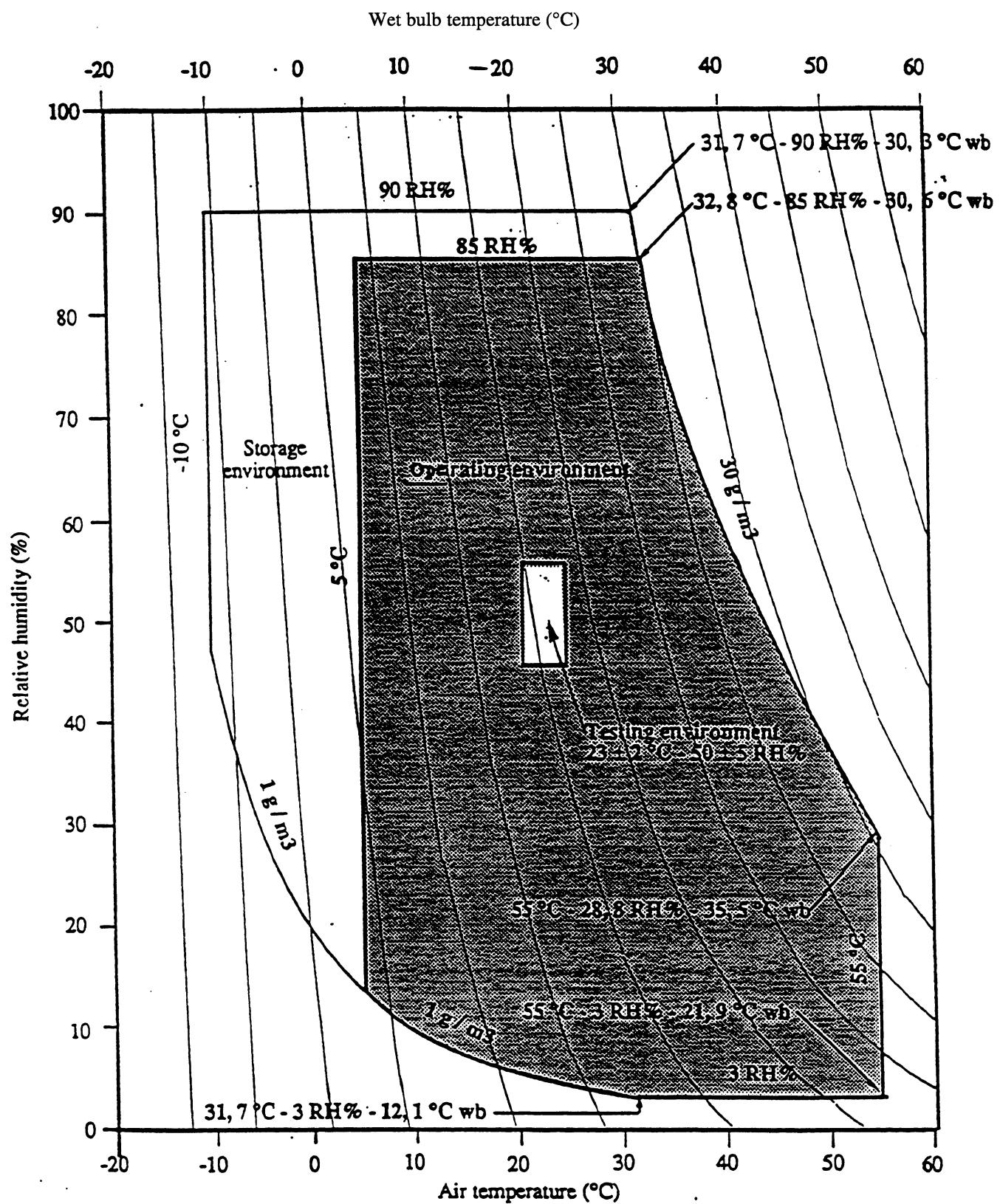
Figure L.1 - Climatogram of IEC Class 3K3 and the ODC operating environment

Wet bulb temperature (°C)

Note - Temperature(°C) - Relative humidity(RH%) - Wet bulb temperature(°C wb)

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

Annex M

(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.

M.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 M.1. Class 100 000 means that 3 500 000 particles per cubic metre of a size of 0,5 μm and larger are allowed, but only 25 000 particles per cubic metre of a size of 5,0 μm and larger.

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

M.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.


ECMA-94-0109-B
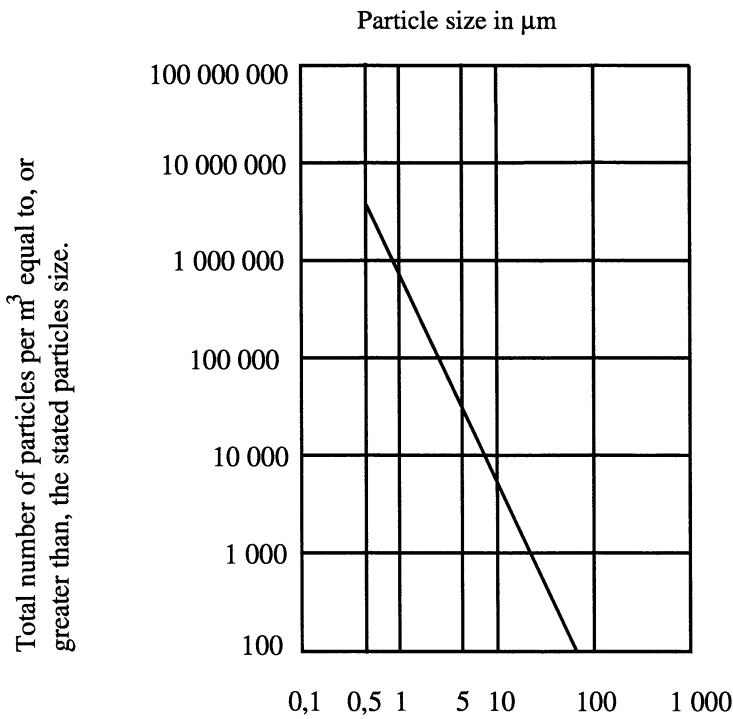
Figure M.1 - Particle size distribution curve

Annex N

(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.
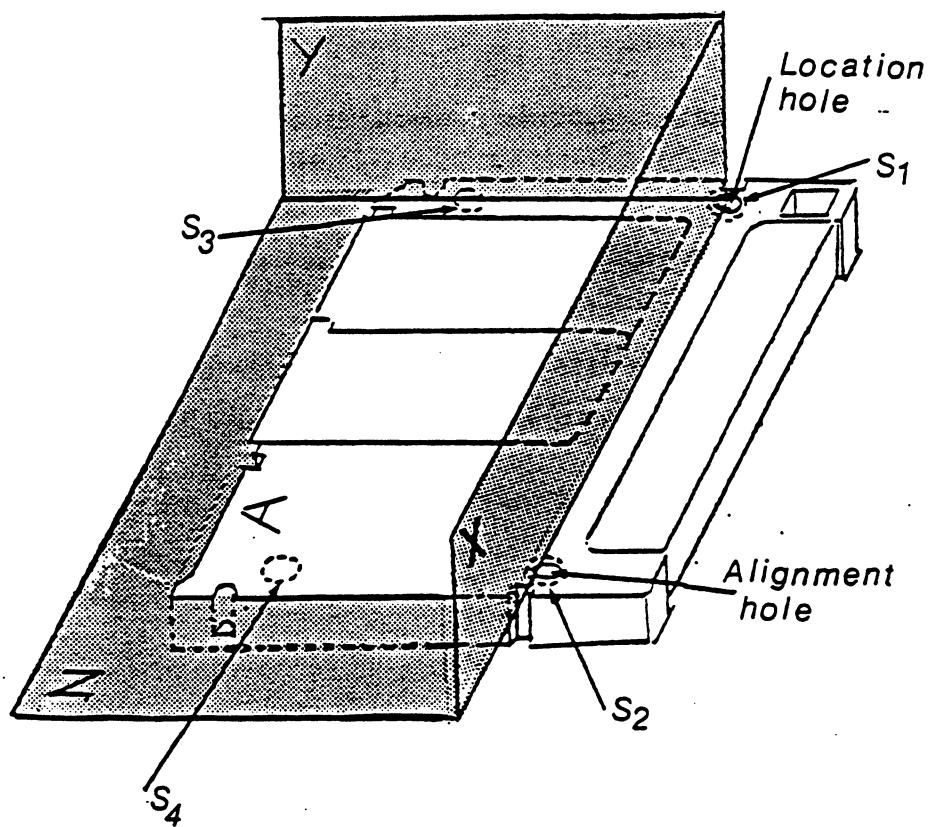
Figure N.1 - Position of the cartridge

Annex P

(informative)

Transportation

P.1 General

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

P.2 Packaging

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

P.2.1 Temperature and humidity

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

P.2.2 Impact loads and vibration

a) Avoid mechanical loads that would distort the shape of the cartridge.

b) Avoid dropping the cartridge.

c) Cartridges should be packed in a rigid box containing adequate shock-absorbent material.

d) The final box should have a clean interior and a construction that provides sealing to prevent the ingress of dirt and moisture.

Annex Q
(informative)

Office environment

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

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

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

Annex R

(normative)

Relaxation by zones of the requirements for signals

Table R.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 R.1 - Requirements for signals in each zone

CLAUSE	SIGNAL	ZONES										
		INITIAL	ACQUIRE		TEST		CONTROL	DATA	CONTROL	TEST		BUFFER
			LEAD	FOCUS	MFG.	DRIVE				DRIVE	MFG.	
11.5.4	Reflectance											
11.5.4	Uniformity											
21.1.a	Cross Track											
21.1.b	Cross Track											
21.2	Cross Track Min.											
21.3.a	PP											
21.3.b	PP											
21.4	DPP (first)											
21.4	DPP (second)											
21.5	On Track											
22.1	SM											
22.2	VFO$_1$, VFO$_2$											
22.3	AM, ID, PA											
23	Embossed Data											
24.3.2	Write Power											
24.4.1	Erase Power											
25.1	FOM											
25.2	Imbalance											
26.1	Resolution											
26.2	NBSN											
26.3	Cross Talk											
27	Erase Char.											

Annex S

(informative)

GCR Recording Codes

8 BIT BYTE HEX	8 BIT BYTE BINARY	9 BIT GCR ENCODE
00	00000000	011001011
01	00000001	011001001
02	00000010	001001101
03	00000011	101100011
04	00000100	011001010
05	00000101	101100101
06	00000110	101100110
07	00000111	101100111
08	00001000	011001111
09	00001001	101101001
0A	00001010	101101010
0B	00001011	101101011
0C	00001100	011001110
0D	00001101	101101101
0E	00001110	101101110
0F	00001111	101101111
10	00010000	001001011
11	00010001	001001001
12	00010010	011001101
13	00010011	100100011
14	00010100	001001010
15	00010101	100100101
16	00010110	100100110
17	00010111	100100111
18	00011000	001001111
19	00011001	100101001
1A	00011010	100101010
1B	00011011	100101011
1C	00011100	001001110
1D	00011101	100101101
1E	00011110	100101110
1F	00011111	100101111

8 BIT BYTE HEX	8 BIT BYTE BINARY	9 BIT GCR ENCODE
20	00100000	101001111
21	00100001	101001101
22	00100010	001010010
23	00100011	001010011
24	00100100	101001110
25	00100101	001010101
26	00100110	001010110
27	00100111	001010111
28	00101000	101001011
29	00101001	001011001
2A	00101010	001011010
2B	00101011	001011011
2C	00101100	101001010
2D	00101101	001011101
2E	00101110	001011110
2F	00101111	001011111
30	00110000	011100011
31	00110001	001100011
32	00110010	001110010
33	00110011	001110011
34	00110100	010100011
35	00110101	001110101
36	00110110	001110110
37	00110111	001110111
38	00111000	111100011
39	00111001	001111001
3A	00111010	001111010
3B	00111011	001111011
3C	00111100	110100011
3D	00111101	001111101
3E	00111110	001111110
3F	00111111	001111111

8 BIT BYTE HEX	8 BIT BYTE BINARY	9 BIT GCR ENCODE
40	01000000	010001011
41	01000001	100001001
42	01000010	010010010
43	01000011	010010011
44	01000100	010001010
45	01000101	010010101
46	01000110	010010110
47	01000111	010010111
48	01001000	010001111
49	01001001	010011001
4A	01001010	010011010
4B	01001011	010011011
4C	01001100	010001110
4D	01001101	010011101
4E	01001110	010011110
4F	01001111	010011111
50	01010000	011100101
51	01010001	001100101
52	01010010	010110010
53	01010011	010110011
54	01010100	010100101
55	01010101	010110101
56	01010110	010110110
57	01010111	010110111
58	01011000	111100101
59	01011001	010111001
5A	01011010	010111010
5B	01011011	010111011
5C	01011100	110100101
5D	01011101	010111101
5E	01011110	010111110
5F	01011111	010111111

8 BIT BYTE HEX	8 BIT BYTE BINARY	9 BIT GCR ENCODE
60	01100000	011100110
61	01100001	001100110
62	01100010	011010010
63	01100011	011010011
64	01100100	010100110
65	01100101	011010101
66	01100110	011010110
67	01100111	011010111
68	01101000	111100110
69	01101001	011011001
6A	01101010	011011010
6B	01101011	011011011
6C	01101100	110100110
6D	01101101	011011101
6E	01101110	011011110
6F	01101111	011011111
70	01110000	011100111
71	01110001	001100111
72	01110010	011110010
73	01110011	011110011
74	01110100	010100111
75	01110101	011110101
76	01110110	011110110
77	01110111	011110111
78	01111000	111100111
79	01111001	011111001
7A	01111010	011111010
7B	01111011	011111011
7C	01111100	110100111
7D	01111101	011111101
7E	01111110	011111110
7F	01111111	011111111

8 BIT BYTE HEX	8 BIT BYTE BINARY	9 BIT GCR ENCODE
80	10000000	111001011
81	10000001	111001001
82	10000010	100010010
83	10000011	100010011
84	10000100	111001010
85	10000101	100010101
86	10000110	100010110
87	10000111	100010111
88	10001000	111001111
89	10001001	100011001
8A	10001010	100011010
8B	10001011	100011011
8C	10001100	111001110
8D	10001101	100011101
8E	10001110	100011110
8F	10001111	100011111
90	10010000	011101001
91	10010001	001101001
92	10010010	100110010
93	10010011	100110011
94	10010100	010101001
95	10010101	100110101
96	10010110	100110110
97	10010111	100110111
98	10011000	111101001
99	10011001	100111001
9A	10011010	100111010
9B	10011011	100111011
9C	10011100	110101001
9D	10011101	100111101
9E	10011110	100111110
9F	10011111	100111111

8 BIT BYTE HEX	8 BIT BYTE BINARY	9 BIT GCR ENCODE
A0	10100000	011101010
A1	10100001	001101010
A2	10100010	101010010
A3	10100011	101010011
A4	10100100	010101010
A5	10100101	101010101
A6	10100110	101010110
A7	10100111	101010111
A8	10101000	111101010
A9	10101001	101011001
AA	10101010	101011010
AB	10101011	101011011
AC	10101100	110101010
AD	10101101	101011101
AE	10101110	101011110
AF	10101111	101011111
B0	10110000	011101011
B1	10110001	001101011
B2	10110010	101110010
B3	10110011	101110011
B4	10110100	010101011
B5	10110101	101110101
B6	10110110	101110110
B7	10110111	101110111
B8	10111000	111101011
B9	10111001	101111001
BA	10111010	101111010
BB	10111011	101111011
BC	10111100	110101011
BD	10111101	101111101
BE	10111110	101111110
BF	10111111	101111111

8 BIT BYTE HEX	8 BIT BYTE BINARY	9 BIT GCR ENCODE
C0	11000000	110001011
C1	11000001	110001001
C2	11000010	110010010
C3	11000011	110010011
C4	11000100	110001010
C5	11000101	110010101
C6	11000110	110010110
C7	11000111	110010111
C8	11001000	110001111
C9	11001001	110011001
CA	11001010	110011010
CB	11001011	110011011
CC	11001100	110001110
CD	11001101	110011101
CE	11001110	110011110
CF	11001111	110011111
D0	11010000	011101101
D1	11010001	001101101
D2	11010010	110110010
D3	11010011	110110011
D4	11010100	010101101
D5	11010101	110110101
D6	11010110	110110110
D7	11010111	110110111
D8	11011000	111101101
D9	11011001	110111001
DA	11011010	110111010
DB	11011011	110111011
DC	11011100	110101101
DD	11011101	110111101
DE	11011110	110111110
DF	11011111	110111111

8 BIT BYTE HEX	8 BIT BYTE BINARY	9 BIT GCR ENCODE
E0	11100000	011101110
E1	11100001	001101110
E2	11100010	111010010
E3	11100011	111010011
E4	11100100	010101110
E5	11100101	111010101
E6	11100110	111010110
E7	11100111	111010111
E8	11101000	111101110
E9	11101001	111011001
EA	11101010	111011010
EB	11101011	111011011
EC	11101100	110101110
ED	11101101	111011101
EE	11101110	111011110
EF	11101111	111011111
F0	11110000	011101111
F1	11110001	001101111
F2	11110010	111110010
F3	11110011	111110011
F4	11110100	010101111
F5	11110101	111110101
F6	11110110	111110110
F7	11110111	111110111
F8	11111000	111101111
F9	11111001	111111001
FA	11111010	111111010
FB	11111011	111111011
FC	11111100	110101111
FD	11111101	111111101
FE	11111110	111111110
FF	11111111	111111111

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