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ID format for 50 mm magneto-optical disc system

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CONTENTS

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ID FORMAT FOR 50 mm MAGNETO-OPTICAL DISC SYSTEM

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The text of this standard is based on the following documents:

FDIS	Report on voting
100/870/FDIS	100/912/RVD

Full information on the voting for the approval of this standard can be found in the report on voting indicated in the above table.

This publication has been drafted in accordance with the ISO/IEC Directives, Part 2.

The committee has decided that the contents of this publication will remain unchanged until the maintenance result date indicated on the IEC web site under "http://webstore.iec.ch" in the data related to the specific publication. At this date, the publication will be

- reconfirmed;
- withdrawn;
- replaced by a revised edition, or
- amended.

A bilingual version of this publication may be issued at a later date.

ID FORMAT FOR 50 mm MAGNETO-OPTICAL DISC SYSTEM

1 Scope

This International Standard specifies the characteristics of 50 mm Optical Disc Cartridges (ODC) with a capacity of 730 Mbytes per Cartridge. This regulation covers the logical format of removable 50 mm magneto-optical discs used on digital still cameras, digital movie cameras, electronic albums and similar devices and combinations of these devices that record, play or process the digital data of still pictures, motion pictures and audio. This standard specifies the recording and reproducing format and processing method of files of still pictures, motion pictures and audio on 50 mm magneto-optical discs so that the users can use these discs on various compatible devices.

2 Normative references

The following referenced documents are indispensable for the application of this document. For dated references, only the edition cited applies. For undated references, the latest edition of the referenced document (including any amendments) applies.

IEC 60950-1:2001, *Information technology equipment – Safety – Part 1: General requirements*

ISO/IEC 13346-1:1995, *Information technology – Volume and file structure of write-once and rewritable media using non-sequential recording for information interchange – Part 1: General*

3 Terms and definitions

For the purposes of this document, the following terms and definitions apply.

3.1
band
part of the Data Zone comprising a fixed number of consecutive physical tracks

3.2
base band wobble address
address information formed by wobbling with bi-phase modulation

3.3
case
housing for an optical disc, that protects the disc and facilitates disc interchange

3.4
channel bit
smallest element for the representation of data on a disc. It is recorded as either a space or a mark

3.5
clamping zone
annular part of the disc within which the clamping force is applied by the clamping device

3.6
control zone
zone containing the information on media parameters and format necessary for writing and reading the remaining tracks of the optical disc

3.7
Cyclic Redundancy Check
CRC
method for detecting errors in data

3.8
data clock
clock for data detection and data recording, generated by a PLL synchronized to fine clock marks

3.9
defect management
method for handling the defective areas on the disc

3.10
disc reference plane
plane defined by the perfectly flat annular surface of an ideal spindle onto which the clamping zone of the disc is clamped, and which is normal to the axis of rotation

3.11
ECC Block
group of frames to perform ECC 32 kB ECC Block execute Error Correction with a set of 16 frames

3.12
embossed information
information so formed as to be unalterable by magneto-optical means

3.13
entrance surface
surface of the disc onto which the optical beam first impinges

3.14
Error Correction Code
ECC
error-detecting code designed to correct certain kinds of errors in data

3.15
Fine Clock Mark
embossed mark on disc for generating a clock

3.16
format
arrangement of information on the disc

3.17
frame
least physical addressable unit, which holds 2 048 data bytes and ECC bytes, and is comprised numbers of segments

3.18
interleaving
process of allocating the physical sequence of units of data so as to render the data more immune to burst errors

3.19
land and groove
trench-like feature of the disc, 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

3.20
Logical Zone
user data area including spare sector for Defect Management

3.21
magnetic field modulation
technique for recording encoded information on the disc by switching a recording magnetic field between two opposite directions

3.22
optical disc
disc that will accept and retain information in the form of marks in a recording layer that can be read with an optical beam

3.23
optical disc cartridge
ODC
device consisting of a case containing an optical disc

3.24
polarization
direction of polarization of an optical beam is the direction of the electric vector of the beam

3.25
protective coating
layer coated on top of the recording layer to protect from environmental influences and emergency landing of magnetic head

3.26
read power
optical power, incident at the entrance surface of the disc, used when reading

3.27
recording magnetic field
magnetic field that switches between two opposite directions (both perpendicular to the disc surface) according to the encoded information. When the focus spot of a laser beam heats the disc sufficiently, this magnetic field causes a permanent magnetic domain in the magneto-optical layer on the disc

3.28
recording layer
layer of the disc on or in which data is written during manufacture and/or use

3.29
Reed-Solomon code
error detection and/or correction code which is particularly suited for the correction of errors which occur in bursts or are strongly correlated

3.30
sector
least logical addressable unit from host interface, which holds 2 048 user bytes with Defect Management process adopted

3.31
segment
subdivision of a Frame bounded by an interval of Fine Clock Mark. The first segment of a frame is used as an address segment

3.32
spindle
part of the disc drive which is in contact with the disc

3.33
substrate
transparent layer of the disc, provided for mechanical support of the recording layer, through which the optical beam accesses the recording layer

3.34
track
path which is followed by the focus of the optical beam during one revolution of the disc. A track consists of a groove or a land

3.35
track pitch
distance between adjacent track (a groove and a land) centre lines, measured in a radial direction

3.36
zone
annular area of the disc

4 Conventions and notations

4.1 Representation of numbers

A measured value is rounded off to the least significant digit of the corresponding specified value. It implies that a specified value of 1,26 with a positive tolerance of +0,01, and a negative tolerance of –0,02 allows a range of measured values from 1,235 to 1,275.

– Letters and digits in parentheses represent numbers in hexadecimal notation.
– The setting of a bit is denoted by ZERO or ONE.
– Numbers in binary notation and bit combinations are represented by strings of 0 and 1.
– Numbers in binary notation and bit combinations are shown with the most significant bit to the left.
– Negative values of numbers in binary notation are given in TWO's complement.
– In each field the data is recorded so that the most significant byte (byte 0) is recorded first.

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

4.2 Names

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

5 List of acronyms

ALPC	Auto Laser Power Control
ADB	Address Data Bit
CDS	Codeword Digital Sum
CRC	Cyclic Redundancy Check
DCB	Data Channel Bit
DDS	Disc Definition Structure
DMA	Defect Management Area
DSV	Digital Sum Value
ECC	Error Correction Code
EDC	Error Detection Code
FA1	Functional Area 1
FA2	Functional Area 2
FCM	Fine Clock Mark
ID	Identifier
IED	ID Error Detection code
LSB	Least Significant Byte
LZ	Logical Zone
MO	Magneto-Optical
MSB	Most Significant Byte
NRZI	Non Return to Zero Inverted
ODC	Optical Disc Cartridge
PDL	Primary Defect List
PI	Parity of Inner-code
PO	Parity of Outer-code
R/W	Rewritable
RS	Reed-Solomon
SDL	Secondary Defect List
ZCAV	Zoned Constant Angular Velocity
ZCLV	Zoned Constant Linear Velocity

6 General description of the optical disc cartridge

The optical disc cartridge which is the subject of this standard consists of a case containing an optical disc.

The case is a protective enclosure for the disc. 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 disc is recordable on one side. Data can be written onto the disc as marks in the form of magnetic domains in the recording layer and can be overwritten with new data with a focused optical beam, using the thermo-magnetic effect. The data can be read with a focused optical beam, using the magneto-optical effect. The beam accesses the recording layer through the transparent substrate of the disc.

7 General requirements

7.1 Environments

7.1.1 Testing environment

Temperature:	23 °C ± 2 °C
Relative humidity:	45 % to 55 %
Atmospheric pressure:	60 kPa to 106 kPa
Air cleanliness:	Class 100 000

7.1.2 Operating environment

Temperature:	0 °C to 60 °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 maximum
Relative humidity gradient:	10 %/h maximum
Air cleanliness:	office environment
Magnetic field strength at the recording layer for any condition under which a beam is in focus:	2 000 A/m maximum
Magnetic field strength at the recording layer during any other condition:	48 000 A/m maximum

7.1.3 Storage environment

Temperature:	–20 °C to 70 °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 maximum
Relative humidity gradient:	10 %/h maximum
Air cleanliness:	office environment
Magnetic field strength at the recording layer:	48 000 A/m maximum

7.1.4 Transportation

This standard does not specify requirements for transportation; guidance is given in Annex I.

7.2 Temperature shock

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

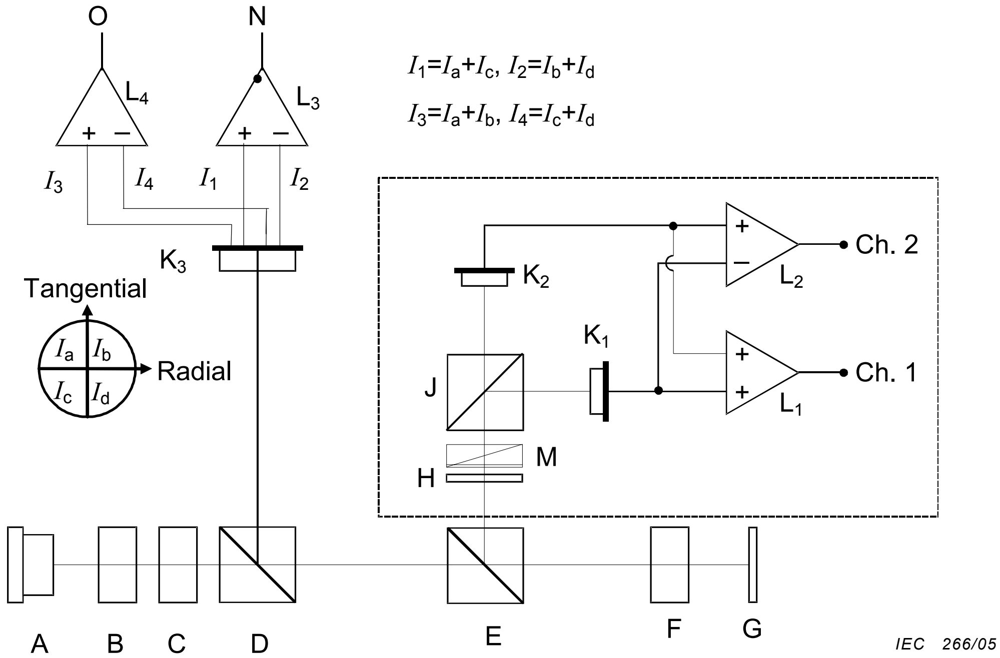
7.3 Safety requirements

The cartridge shall satisfy the safety requirements of IEC 60950, when used in the intended manner or in any foreseeable use in an information processing system.

8 Reference drive

8.1 Optical system

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



A	Laser diode	I_1, I_2	Push-pull channels
B	Collimator lens	I_3, I_4	Tangential push-pull channels
C	Optional shaping prism	J	Polarizing beam splitter
Ch.1	Channel 1	K_1, K_2	Photodiodes for Channels 1 and 2
Ch.2	Channel 2	K_3	Split photodiode
D	Beam splitter	L_1, L_2, L_3, L_4	DC-coupled amplifiers
E	Polarizing beam splitter	M	Phase retarder
F	Objective lens	N	Track- centre detection signal
G	Optical disc	O	Clock-mark detection signal
H	Optional half-wave plate		

Figure 1 – Optical system of the reference drive

In the absence of polarization changes in the disc, 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 M shall be adjusted in such a way 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 beam splitter J shall have a p-s intensity reflectance ratio of at least 100.

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

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

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

to make it correspond to the nominal beam splitter E.

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

8.2 Optical beam

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

a) Wavelength (λ): 650 nm ± 10 nm

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

λ/NA = 1,083 µm ± 0,017 µm

c) Filling D/W of the aperture of the objective lens:

Radial 0,85 ± 0,05; tangential 0,85 ± 0,05

d) Variance of the wavefront of the optical beam near the recording layer, after passing through an ideal substrate:

0 to λ^2/330

e) Polarization: Perpendicular to the track

f) Extinction ratio: 0,01 max.

g) The optical power for writing and reading and the magnetic field shall be as specified in Clause 12.

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°.

8.3 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 DC to 10 MHz for rotational frequencies of the disc as specified in 8.5.

8.4 Tracking

The Tracking Channel of the drive provides the tracking error signal to control the servo 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.

8.5 Rotation of the disc

The spindle shall position the disc as specified in 9.3. It shall rotate the disc at a linear speed of 4,8 m/s.

The direction of rotation shall be counter-clockwise when viewed from the objective lens.

9 Mechanical and physical characteristics

9.1 Dimensional and physical characteristics of the cartridge

9.1.1 Cartridge Outline (Figure 2)

The cartridge is a rectangular parallelepiped having a curvature on one side. It has the hole (centre hole) on the bottom side to accept a disc rotating axis from the drive. It has a top opening for the magnetic head on the top side, and a bottom opening for the optical head of the drive on the bottom side.

The shutter of the cartridge, when left as it is, always covers the access window (top opening, bottom opening) and the centre hole by the force from shutter spring and the shutter lock. When the cartridge is inserted into the drive, the shutter fully opens the access window and the centre hole, being ready for recording/reading operation. When it is pulled out of the drive, the shutter again closes the access window and centre hole by using the force from the shutter spring.

The cartridge can insert the drive when correctly directed to the drive. The cartridge is set to write enable or write protected.

(1)	Dimensions:	56,5 (D) mm × 59,5 (W) mm × 4,8 (H) mm
(2)	Top opening:	Magnetic head
(3)	Bottom opening and centre hole:	Optical head and disc rotating axis
(4)	Shutter:	Covers top and bottom opening and bottom centre hole
(5)	Loading direction:	An arrowhead indicating the loading direction is marked on the top side
(6)	Shutter-lock release lug:	For insertion depth into the cartridge (see Figure 2)
(7)	Shutter lock:	Shutter engages with shutter lock while the shutter is closed.
(8)	Reference planes:	Four, A to D, on the bottom side
(9)	Index hole 1:	–
(10)	Index hole 2:	–
(11)	Miss-insert protection	Allows the cartridge inserted to the bottom of the drive only when it is in the correct direction
(12)	Reference hole 1:	Circle
(13)	Reference hole 2:	U-shape
(14)	Loading ditch:	Two symmetrical ditches for power loading
(15)	Write protect valve:	Slides to open/close the write protect hole (16)

(16) Write protect hole:	Open when the write protect valve knob is at up position – write protect – depth 3 mm min. Closed when the write protect valve knob is at down position – write enable – depth $1^{+0,3}_{-0,1}$ mm
(17) User hole:	Open – depth 3 mm min. Closed – depth $1^{+0,3}_{-0,1}$ mm
(18) Holding area:	Cartridge holding force in the holding area 1,5 N to 4 N
(19) Shutter spring:	Applies force to the shutter in the direction to top/bottom opening (2), (3)
(20) Disc horizontal centring in the drive:	$((X – 18,8)^2 + (Y – 24,8)^2)$ mm $\leq (0,15)^2$ mm
(21) Disc horizontal pre-positioning in the cartridge:	$((X – 18,8)^2 + (Y – 24,8)^2)$ mm $\leq (0,8)^2$ mm
(22) Disc reference height:	1,15 mm ± 0,13 mm (from the cartridge reference plane)
(23) Turntable inclination:	0,3° max.
(24) Shutter locking force:	5 N min.
(25) Cartridge mass:	20 g maximum (including disc)
(26) Fixing by screw:	The cartridge can be screw-assembled. For location of screw, see Figure 9.
(27) Standard test tools:	See Annexes B, C and D.

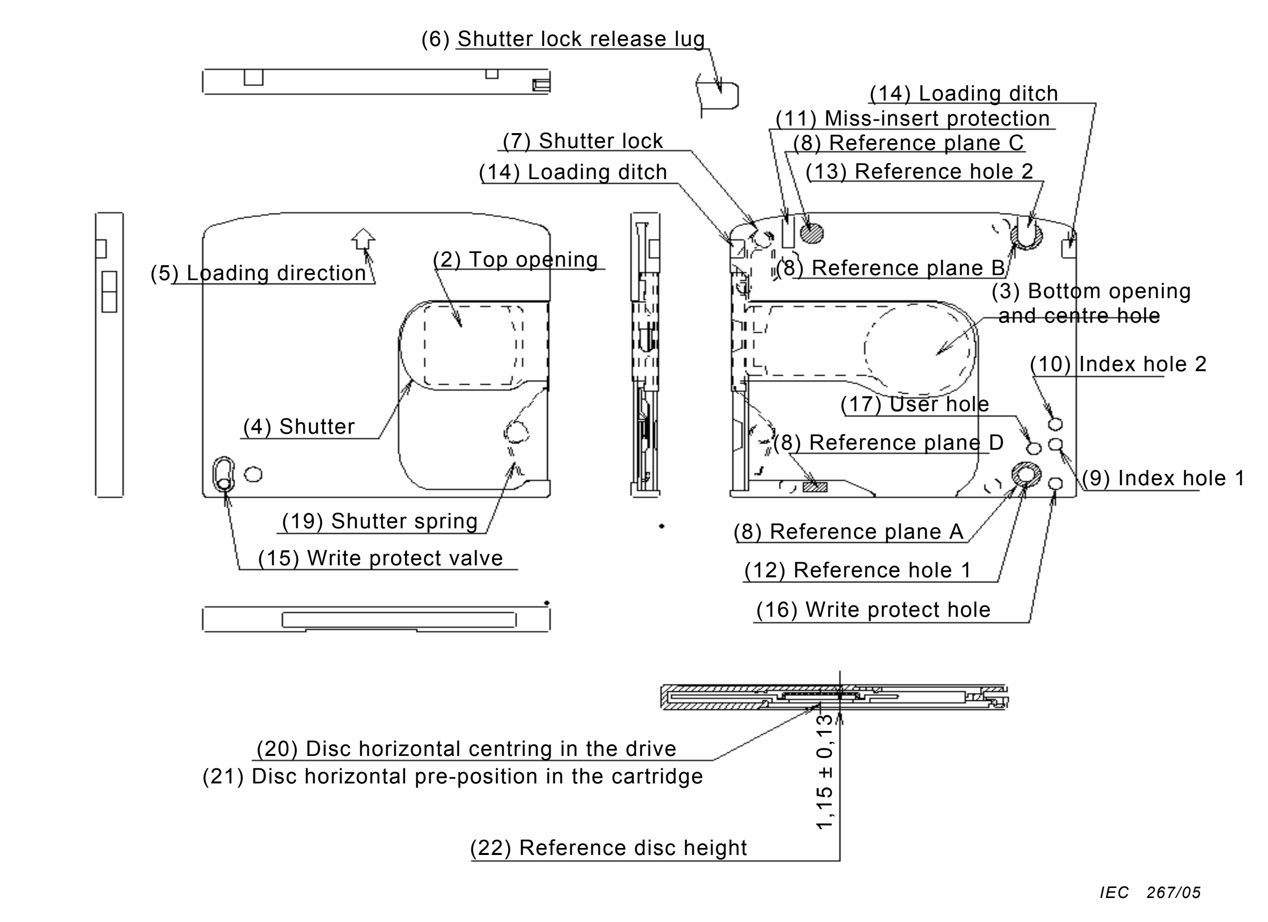


Figure 2 – Outline of cartridge

9.1.2 Cartridge reference line and reference plane (see Figure 3)

The plane defined with the reference planes A, B and C is the reference plane.

The cartridge reference lines: the line connecting the reference holes 1 and 2 together is the reference axis Y, the line normal to the reference axis Y and passing the centre of the reference hole 1 is the reference axis X.

Reference planes A, B, C and D and reference holes 1 and 2 are located at the position shown in Figure 3.

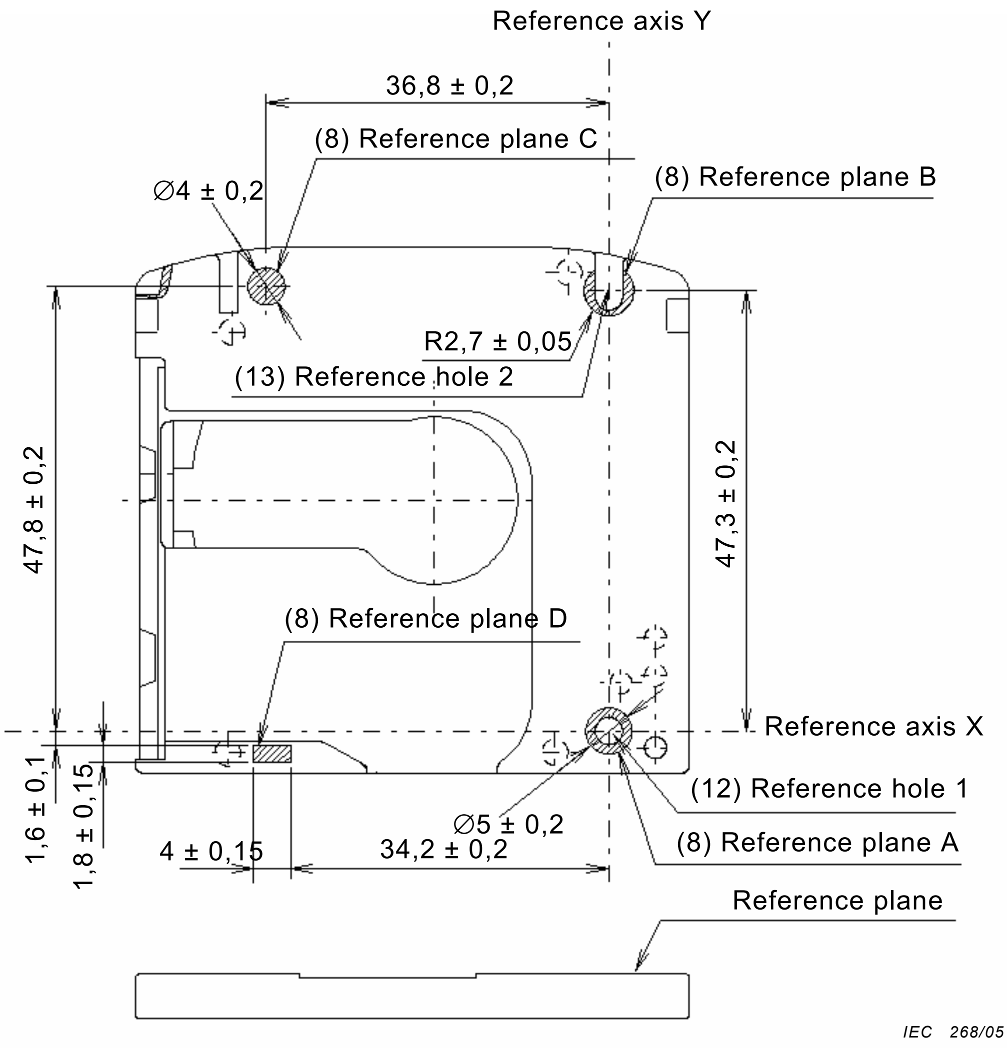


Figure 3 – Cartridge reference line and reference plane

9.1.3 Cartridge shape

Width (see Figures 4 and 5):	$59{,}5\ ^{0}_{-0{,}4}$ mm
Depth (see Figures 4 and 5):	$56{,}5\ ^{+0{,}6}_{0}$ mm
Thickness (see Figures 4 and 5):	4,8 mm ± 0,2 mm
Cartridge reference plane flatness (see Annex B):	0,1 mm max.
Cartridge flatness (see Annex C):	0,1 mm max.
Curvature (see Annex D):	The cartridge shall pass through the reference tool smoothly by its gravity
Screw (see Figure 9):	The cartridge can be screw-assembled. The screw location is shown in Figure 9

9.1.4 Mass

Maximum mass:	20 g max.(including disc)

9.1.5 Bottom centre hole

Diameter (see Figure 5):	Ø $18\ ^{+0{,}2}_{0}$ mm

9.1.6 Opening

Top opening (see Figure 4):	$15{,}5\ ^{+0{,}4}_{0}$ mm
Bottom opening (see Figure 5):	$13{,}7\ ^{+0{,}4}_{0}$ mm

9.1.7 Holding area and label area (see Figures 4 and 8)

Holding area: see Figure 8.

Label area is on the topside without the holding area.

No label area on the bottom side of the cartridge.

The cartridge may have a label area on the rear side.

The depth of the label area is 0,3 mm maximum. The label should be put within the label area.

9.1.8 Shutter

9.1.8.1 Function (see Figure 6)

The shutter shall be capable of covering the top opening, bottom opening and centre hole.

9.1.8.2 Shutter closing force

A force of 0,5 N to 0,7 N shall be enough to close the shutter fully. With the cartridge kept fixed, measure the closing force of the shutter on the spring scale when the shutter completely releases the centre hole located on the bottom side of the cartridge.

9.1.8.3 Shutter locking force

The shutter locking force shall be 5 N min.

9.1.8.4 Material

The material shall be metal

9.1.8.5 Play between the shutter and shutter lock at shutter full-closed position

The play shall be 0,6 mm max.

9.1.8.6 Shutter full-open position (see Figures 4, 5 and 6)

The engaged parts of the cartridge and the shutter are E and F, respectively.

9.1.9 Write protect hole (see Figures 2 and 5)

9.1.9.1 Diameter

The diameter shall be $2{,}4_{0}^{+0{,}1}$ mm.

9.1.9.2 Depth of hole

Write protect: 3 mm min.

Write enable: $1_{-0{,}1}^{+0{,}3}$ mm

9.1.9.3 Function

Table 1 – Write protection

Write protect hole	Function
CLOSE	Write enable
OPEN	Write protection

9.1.10 User hole (see Figures 2 and 5)

9.1.10.1 Diameter

The diameter shall be $2{,}4_{0}^{+0{,}1}$ mm.

9.1.10.2 Depth of hole

User hole open: 3 mm min.

User hole close: $1_{-0{,}1}^{+0{,}3}$ mm

9.1.10.3 Function

Table 2 – User hole

User hole	Function
CLOSE	-
OPEN	-

A cartridge conforming to this specification does not use a hole. The hole shall be closed

9.1.11 Index hole (see Figures 2 and 5)

9.1.11.1 Diameter of index hole

The diameter shall be $2{,}4^{+0{,}1}_{0}$ mm.

9.1.11.2 Depth of hole

OPEN: 2,4 mm min.

CLOSE: 0,1 mm max.

9.1.11.3 Function

Table 3 – Index hole

Index hole 1	Index hole 2	Function
CLOSE	CLOSE	-
CLOSE	OPEN	-
OPEN	CLOSE	-
OPEN	OPEN	-

A cartridge conforming to this specification does not use holes. The holes shall be closed.

9.1.12 Cartridge holding force

9.1.12.1 Holding force per point

The holding force shall be 1 N max.

9.1.12.2 Total holding force

The total holding force shall be 1,5 N to 4 N.

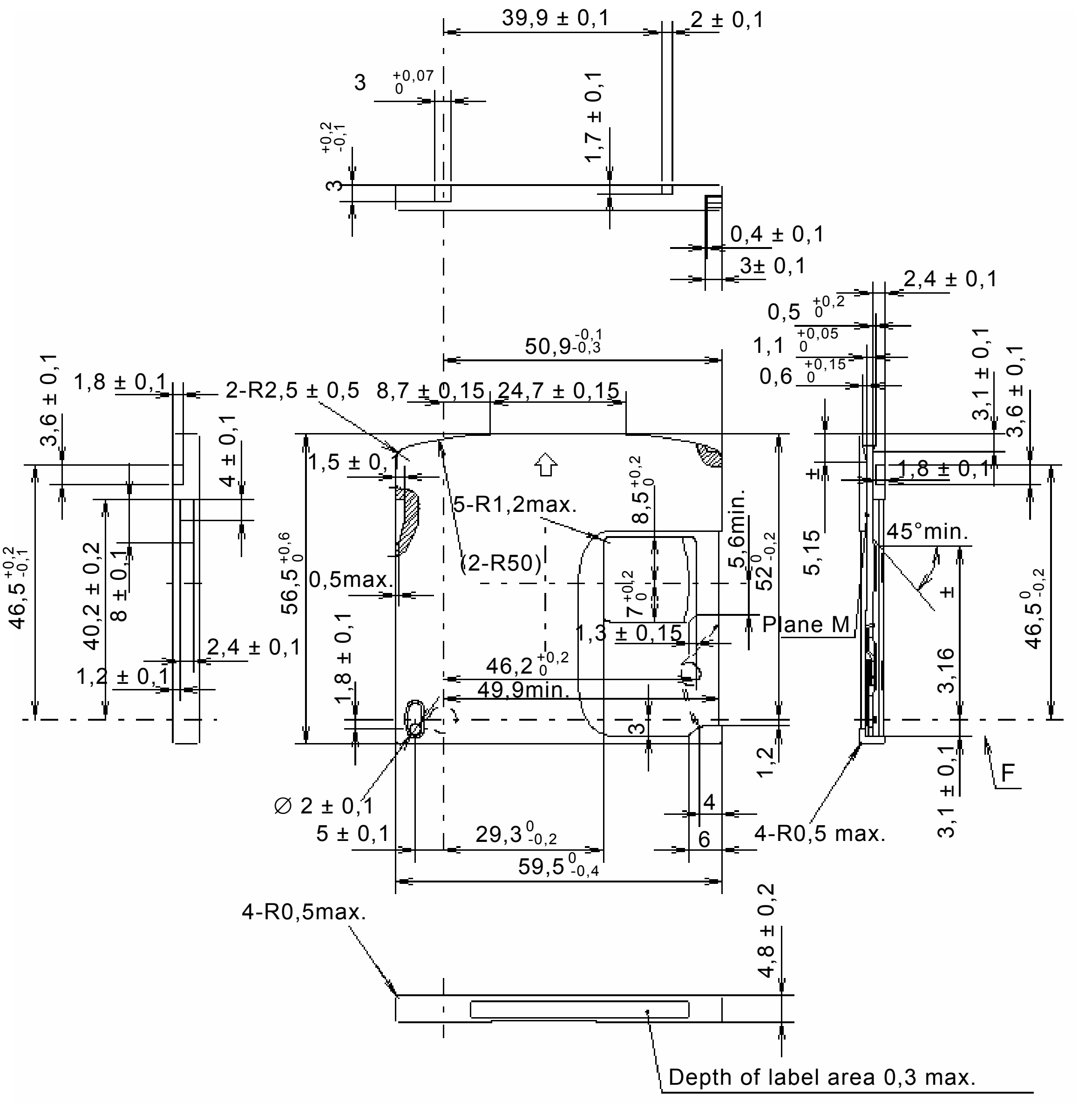


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Figure 4 – Cartridge Top and Side View

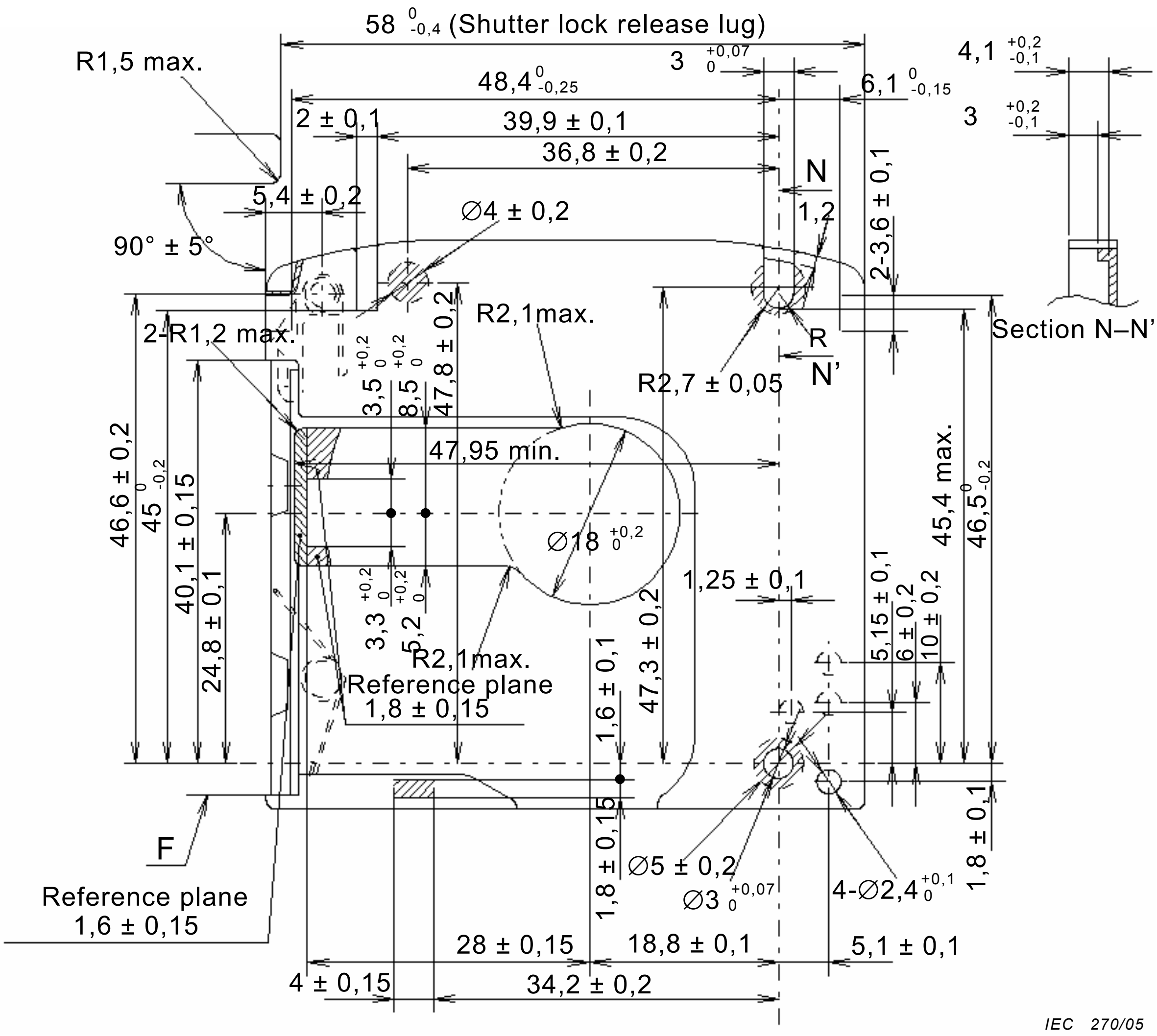


Figure 5 – Cartridge Bottom View

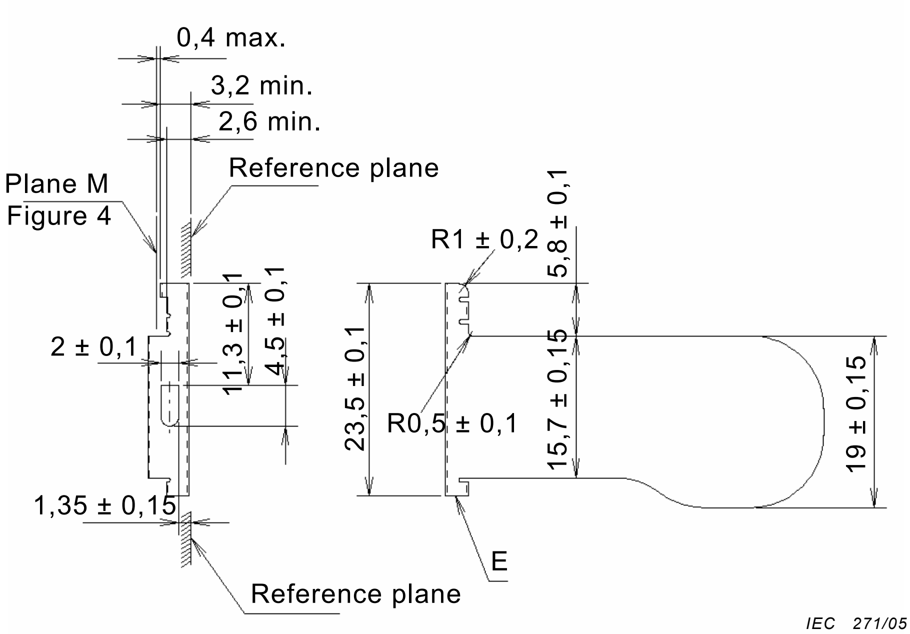


Figure 6 – Shutter

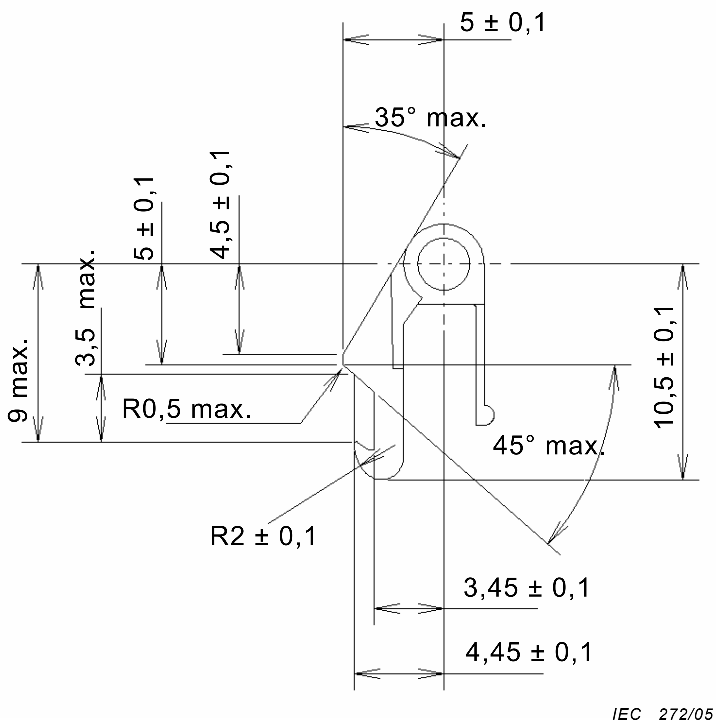


Figure 7 – Shutter lock

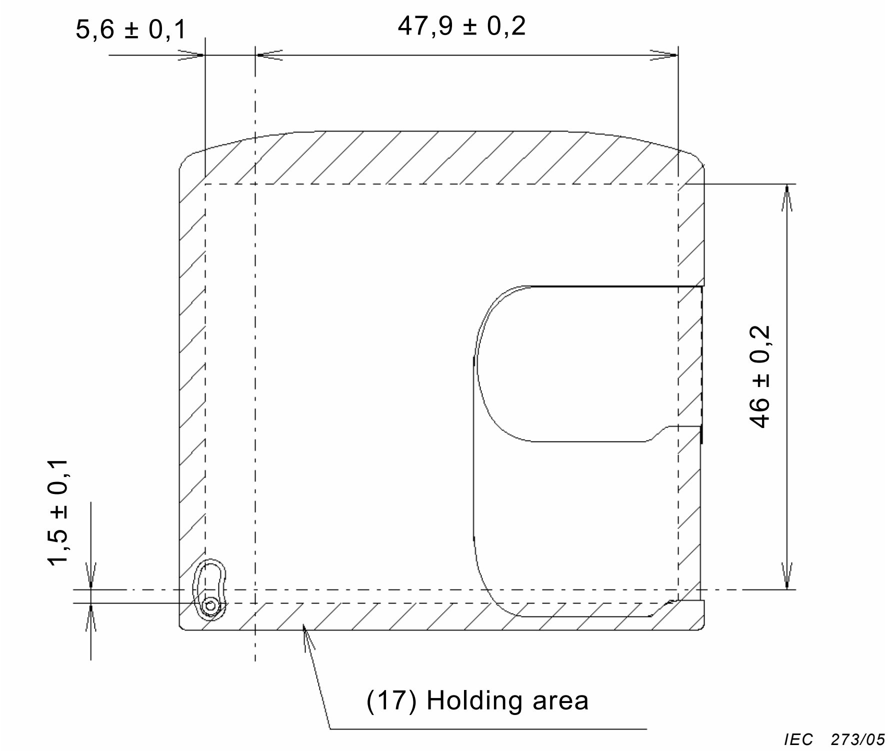


Figure 8 – Holding area

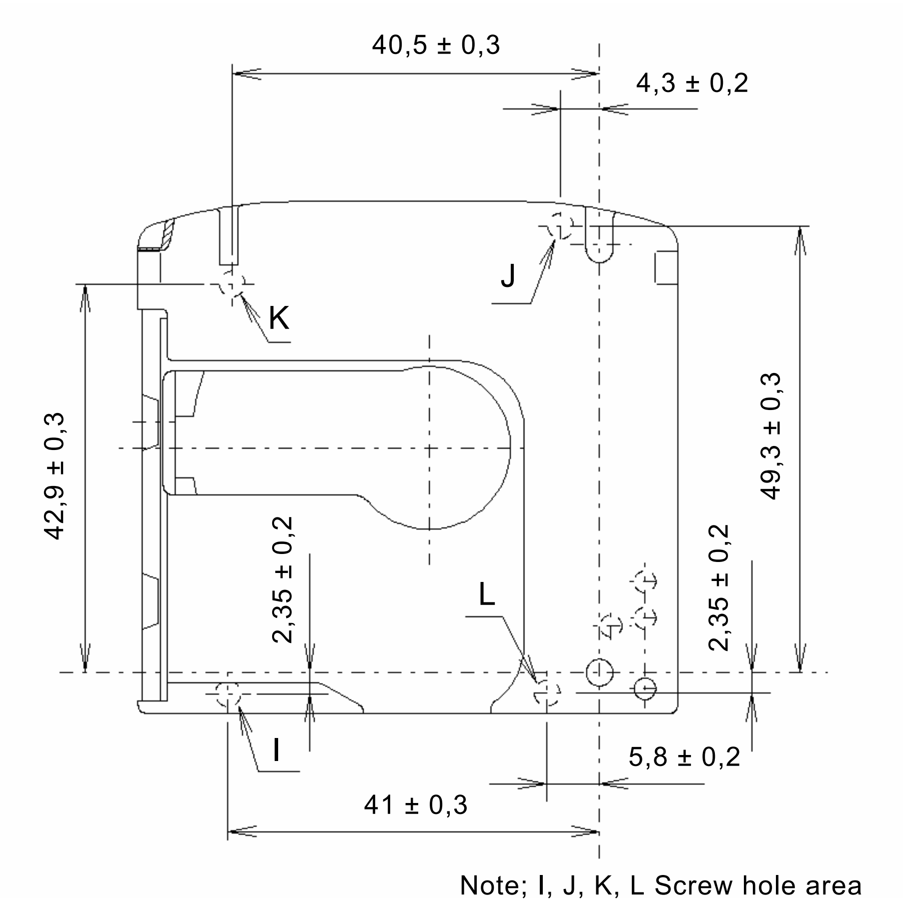


Figure 9 – Screw location

9.2 Dimensional, mechanical and physical characteristics of the disc

9.2.1 General description of the disc

The disc shall consist of a circular substrate with a recording layer that 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 disc substrate has a centre hole for providing the radial centring of the disc.

9.2.2 Reference axis and plane of the disc

The disc reference plane P is defined by the perfectly flat annular surface of an ideal spindle onto which the clamping zone of the disc is clamped, and which is normal to the axis of rotation of this spindle. This axis H passes through the centre of the centre hole of the disc and is normal to plane P.

9.2.3 Dimensions of the disc (see Figure 10)

9.2.3.1 Disc

The dimensions of the disc shall be measured in the testing environment. The dimensions of the disc in an operating environment can be estimated from the dimensions specified below.

Outer diameter = 50,8 mm ± 0,2 mm

Excluding axial deflection (see 9.2.4.5), the total thickness of the disc shall not exceed 0,7 mm in the range from

Ø 23,0 mm max.

to outer diameter – 1,0 mm.

Diameter of the centre hole = $11{,}0^{+0{,}05}_{0{,}0}$ mm

The eccentricity between the outline circle and the centre hole shall not exceed 0,1 mm.

The normal position of the recording layer = 1,6 mm ± 0,05 mm from the reference plane P in a direction normal to plane P.

Outer diameter of the clamping block = 16,8 mm ± 0,01 mm

9.2.3.2 Clamping zone

Outer diameter of the clamping zone = 16,4 mm min.

Inner diameter of the clamping zone = 11,4 mm max.

Thickness of the clamping zone = 0,7 mm ± 0,05 mm

Thickness of the clamping plate = 0,4 mm ± 0,04 mm

Height of the clamping plate = 1,7 mm ± 0,1 mm

from the reference plane, in the range of < Ø 9,0 mm.

Flat area diameter of the clamping plate = 9,85 mm min.

The disc clamping force shall be less than 5 N.

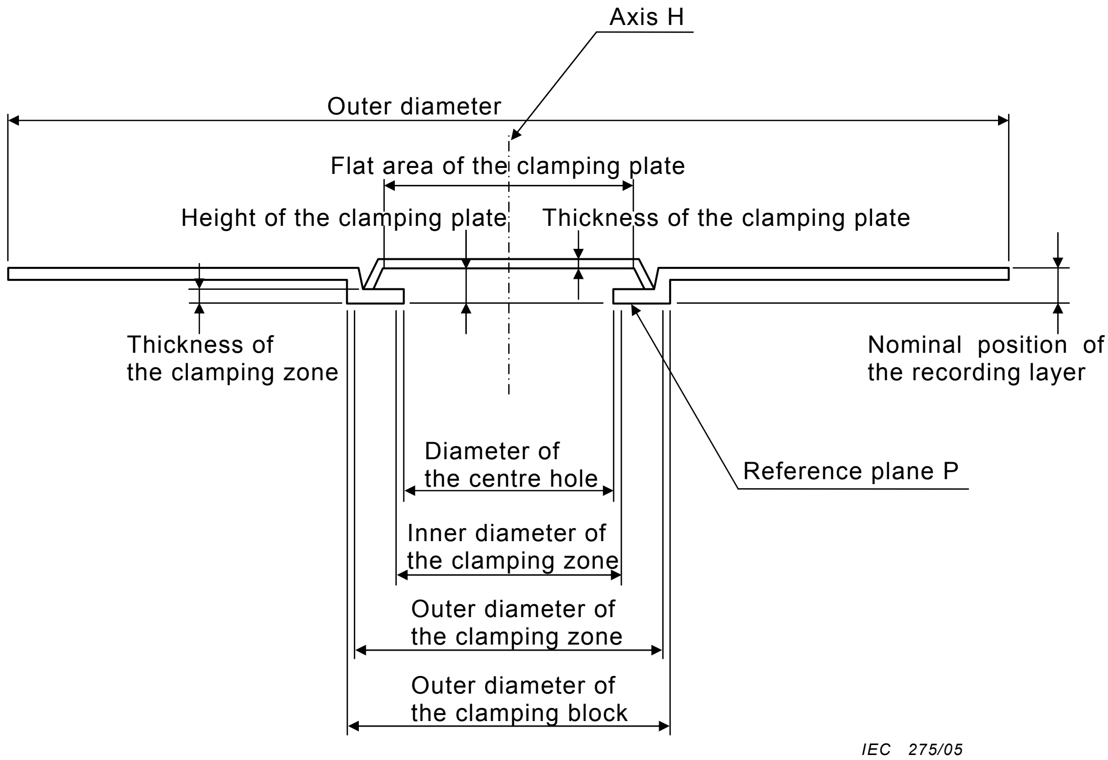


Figure 10 – Disc dimensions

9.2.4 Mechanical characteristics

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

9.2.4.1 Material

The disc shall be made from any suitable materials in such a way that it meets the requirements of this standard.

9.2.4.2 Mass

The mass of the disc shall not exceed 3 g.

9.2.4.3 Moment of inertia

The moment of inertia of the disc relative to axis H shall not exceed 0,001 g/m^2.

9.2.4.4 Imbalance

The imbalance of the disc relative to axis H shall not exceed 0,001 g/m.

9.2.4.5 Axial deflection

The axial deflection of the disc is measured as the axial deviation of the recording layer. Thus, it comprises the tolerances on the thickness of the substrate, on its index of refraction and the deviation of the entrance surface from plane P. The nominal position of the recording layer with respect to reference plane P is determined by the nominal thickness of the substrate.

The deflection of any point of the recording layer in the Information Zone from its nominal position, in a direction normal to plane P, shall not exceed ±0,10 mm for rotational frequencies of the disc as specified in 8.5.

9.2.4.6 Axial acceleration

The maximum allowed axial error e_{max} shall be specified in 11.1.3.4. The rotational frequency of the disc shall be 50 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

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

where

$$\omega = 2\pi f$$
$$\omega_0/2\pi = 2\,125\ \text{Hz}$$
$$i = \sqrt{-1}$$

or any other servo with |1+H| within 20 % of $|1+\mathrm{H_s}|$ in the bandwidth of 50 Hz to 100 kHz. Thus, the disc shall not require an axial acceleration of more than 35,0 m/s^2 at low frequencies from the servo motor of the Reference Servo.

9.2.4.7 Radial run-out

The radial run-out 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 H, the tolerances on the dimensions between axis H and the location of the track, and effects of non-uniformities in the index of refraction.

The run-out, defined as the difference between the maximum and the minimum distance of the centre of any track from the axis of rotation, measured along a fixed radial line over the one revolution of the disc, shall not exceed 50 µm at a rotation frequency of 50 Hz.

9.2.4.8 Radial acceleration

The maximum allowed tracking error e_{max} shall be as specified in 11.1.3.4. The rotational frequency of the disc shall be 50 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.

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

where

$$\omega = 2\pi f$$
$$\omega_0/2\pi = 2\,125\ \text{Hz}$$
$$i = \sqrt{-1}$$

or any other servo with |1+H| within 20 % of $|1+H_s|$ in the bandwidth of 50 Hz to 100 kHz. Thus, the disc shall not require a radial acceleration of more than 7,5 m/s^2 at low frequencies from the servo motor of the Reference Servo.

9.2.4.9 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

6,0 mrad (radial)

5,0 mrad (tangential)

6,0 mrad (all over)

in the Information Zone.

9.2.5 Optical characteristics

9.2.5.1 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.

9.2.5.2 Thickness of the substrate

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

$$0{,}9 \leq n \times d \leq 1{,}0$$

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

9.2.5.3 Reflectance

The reflectance R is the value of the reflectance on-land and in-groove of the Data Zone of the disc measured through the substrate and does not include the reflectance of the entrance surface.

The value of R at the standard wavelength specified in 8.2 shall lie within the range from 0,12 to 0,25.

At any point of the Data Zone, the value R shall meet the requirement

$$(R_{\text{max}} - R_{\text{min}})/(R_{\text{max}} + R_{\text{min}}) \leq 0{,}3$$

where

R_{max} is the maximum value of measured reflectance in the Data Zone;

R_{min} is the minimum value of measured reflectance in the Data Zone.

9.2.5.4 Birefringence

The birefringence of the transparent substrate in the Information Zone shall be less than 100 nm (double pass).

9.2.6 Protective coating

9.2.6.1 General description of protective coating

The protective coating shall cover the recording layer to protect from environmental influences and to fly the slider with a magnetic head.

The slider with magnetic head usually does not touch the protective coating at under the operating condition of over 4,5 m/s linear velocity.

The protective coating shall not disturb recording magnetic field.

9.2.6.2 General description of the operating zone

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

9.2.6.3 Characteristics of the protective coating in the operating zone (Figure 11)

The dimensions and physical characteristics of the protective coating in the operating zone shall meet the requirements specified in 9.2.6.4 to 9.2.6.7.

9.2.6.4 Dimensions of the protective coating in the operating zone

Inner diameter of the operating zone = 24,6 mm max.

Outer diameter of the operating zone = 48,8 mm min.

The thickness of the protective coating in the operating zone shall not exceed 20 µm (see Figure 11).

9.2.6.5 Surface roughness

The surface roughness of the protective coating in the operating zone is determined by the value of R_y.

R_y shall not exceed 1,6 µm at any point of the operating zone.

9.2.6.6 Surface irregularity

Surface irregularity of the protective coating in the operating zone shall not exceed 10 µm at any point of the operating zone.

9.2.6.7 Friction force and wear in thickness test (see Annex E)

The friction force should not exceed 50 mN after 100 times Contact Start-Stop wear test.

9.2.6.8 Dimensions of the protective coating outside the operating zone

The thickness of the protective coating in the zone outside the operating zone shall not exceed 100 µm from the recording layer (see Figure 11).

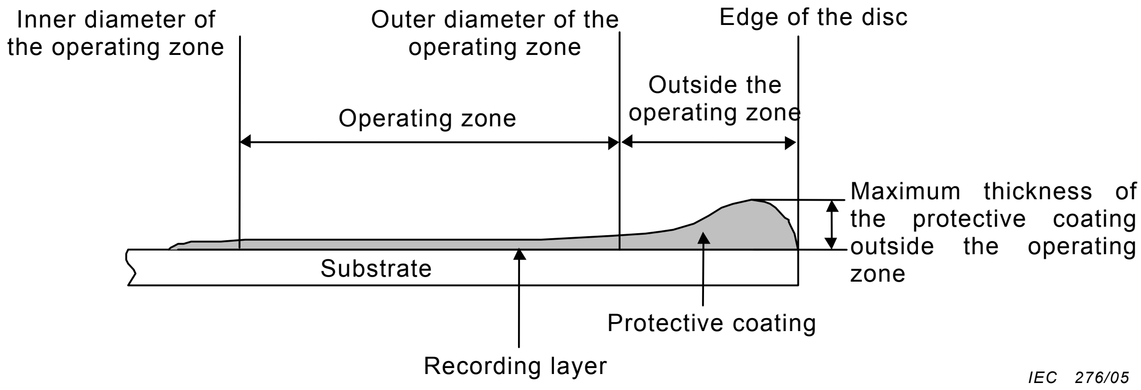


Figure 11 – Thickness of the protective coating

9.3 Interface between cartridge and drive

9.3.1 Disc Horizontal Centring in the Drive

Disc horizontal centring tolerance from the centre of the reference hole:

$((X - 18{,}8)^2 + (Y - 24{,}8)^2)$ mm $\leq (0{,}15)^2$ mm

9.3.2 Disc Horizontal Pre-positioning tolerance in the Cartridge

$((X - 18{,}8)^2 + (Y - 24{,}8)^2)$ mm $\leq (0{,}8)^2$ mm

The clamping block shall be inside of the centre hole of the cartridge.

9.3.3 Disc Reference Height (see Figure 2)

Disc reference height from the cartridge reference plane while drive is running:

1,15 mm ± 0,13 mm

9.3.4 Gap between the Disc and Cartridge Internal Wall (see Figure 12)

When set to the disc reference height of 1,15 mm, the disc can move up and down by the distance shown below without touching the internal wall of the cartridge.

(Turntable tilt angle: 0,3° max.; disc height: 1,15 mm ± 0,13 mm; drive reference plane flatness: 0,1 mm max.)

Ø 23,0 mm max.:	+0,25 mm from the top surface of the disc
	–0,25 mm from the bottom surface of the disc
Ø 29,0 mm min.:	+0,60 mm from the top surface of the disc
	–0,70 mm from the bottom surface of the disc

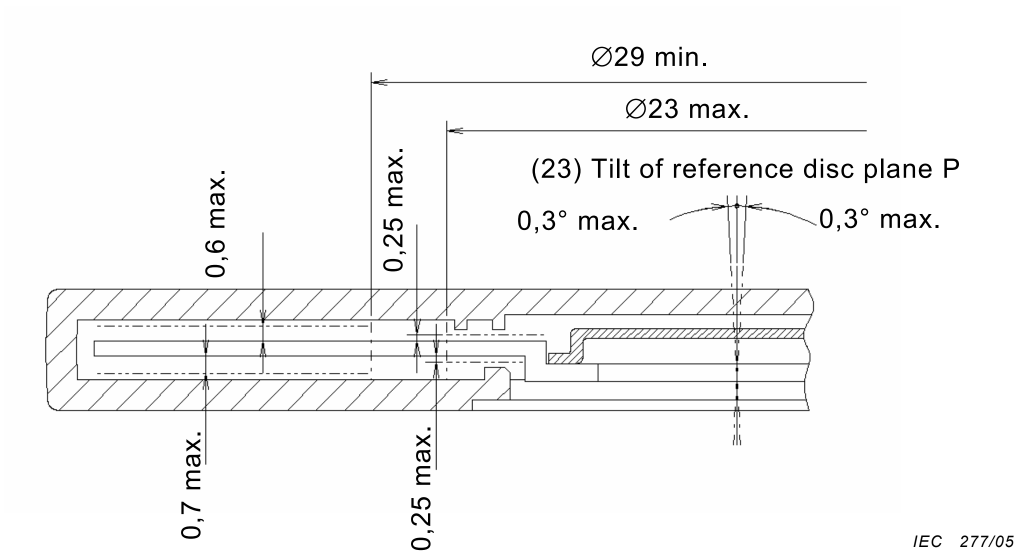


Figure 12 – Gap between the disc and the internal wall of the cartridge

10 Format of information

10.1 Track geometry

10.1.1 Track shape

The Information Zone shall contain tracks intended for the Continuous Servo tracking method. In certain areas of the discs, a track shall be composed on a groove or a land, where each groove has the straight groove, Fine Clock Mark fields, frame mark fields for addressing and Address fields by staggered one-side wobble. A groove is a wide trench-like feature, and the width of the groove is almost equal to that of the land, the bottom of which is located nearer the entrance surface than the land. The centre of a track is the centre of the land or groove. Each track shall form a 360° turn of a continuous spiral.

10.1.2 Direction of track spiral

Land and groove form a double spiral. The track shall spiral inward from the outer diameter to the inner diameter when the disc rotates counter-clockwise as viewed from the optical head.

10.1.3 Track pitch

The track pitch is the distance between centrelines of land and groove, measured in a radial direction. It is around 0,6 µm. The track pitch is precisely defined in terms of a groove pitch for convenience of measurement. The groove pitch shall be 1,20 µm ± 0,03 µm.

10.1.4 Position of Control track

The start position of inner Control tracks shall be 14,67 mm ± 0,10 mm.

The start position of outer Control tracks shall be 23,92 mm ± 0,10 mm.

10.2 Track format

10.2.1 General description of track format

Each track shall have *n* frames, and each frame has an address which is expressed by a combination of Band Number, Track Number and Frame Number described below (see 10.3.2.5)

10.2.2 Band Number

Band 1 shall be the first band of the Data Zone. The Band Number shall be increased by 1 for each band. Their located radii shall be as specified in Table 5.

The Band Number is given in the Address field of the Address Segment (see 10.3.2.5.3).

10.2.3 Track Number

Track 0 shall be the first track of each data band, Lead-in and Lead-out zone. Their located radii shall be as specified in Table 5. The track number located at radii smaller than that of track 0 should be increased by 1 for each Land and Groove track (see 10.3.2.5.4 and 10.3.2.5.8).

10.2.4 Frame Number

Frame 0 shall be the first frame of each track.

The Frame Number shall be increased by 1 for each frame.

The Frame Number is given in the address field of the Address Segment (see 10.3.2.5.2).

10.2.5 Track layout

On each track there shall be *n* frames (*n* is described in 10.6.2). A frame shall have a length of 20 748 Data Channel bits.

The layout of the track shall be as specified in Figure 13.

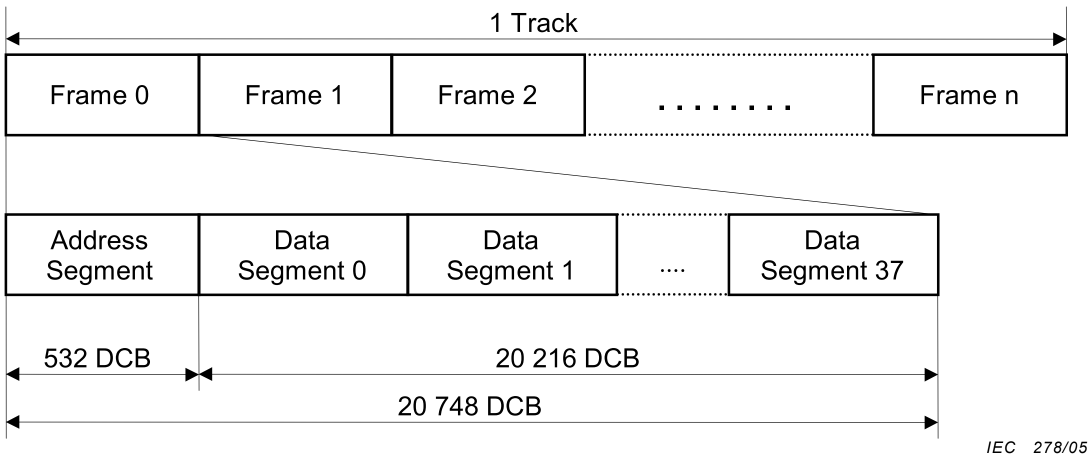


Figure 13 – Track layout

10.3 Frame format

10.3.1 General description of frame format

Each frame in ECC Block shall comprise an Address Segment and 38 Data Segments. The Address Segment shall have a length of 532 Data Channel bits.

10.3.2 Address Segment

Each Address Segment shall comprise a Fine Clock Mark field, a Pre-buffer field, preamble 1, a Synchronization field, an Address field and a Post-buffer field. The Address field data shall be modulated by Biphase-Mark code except for a Preamble 2 and a Resync field. In this Biphase-Mark code, 0 means 10 patterns at a double ADB rate, in the same way, 1 means 01 pattern at a double ADB rate. 1 Address Data bit equals to 6 Data Channel bits. The layout of the Address Segment shall be as specified in Figure 14. Wobble patterns of the Address Segment are shown in Figure 15.

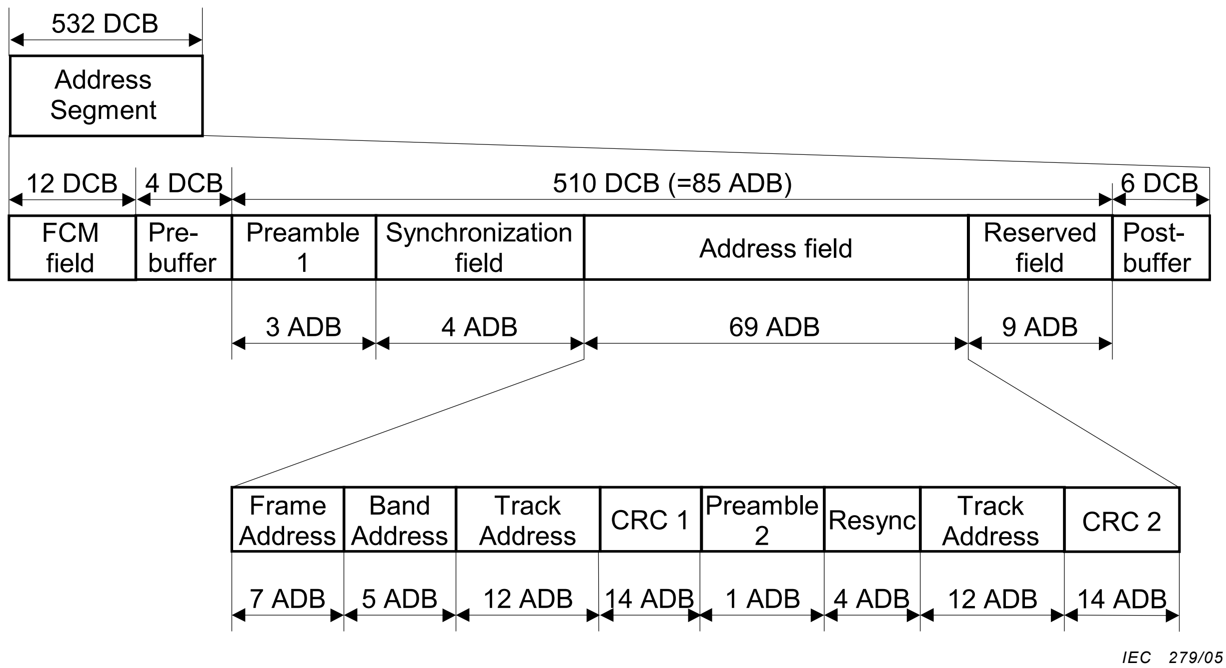
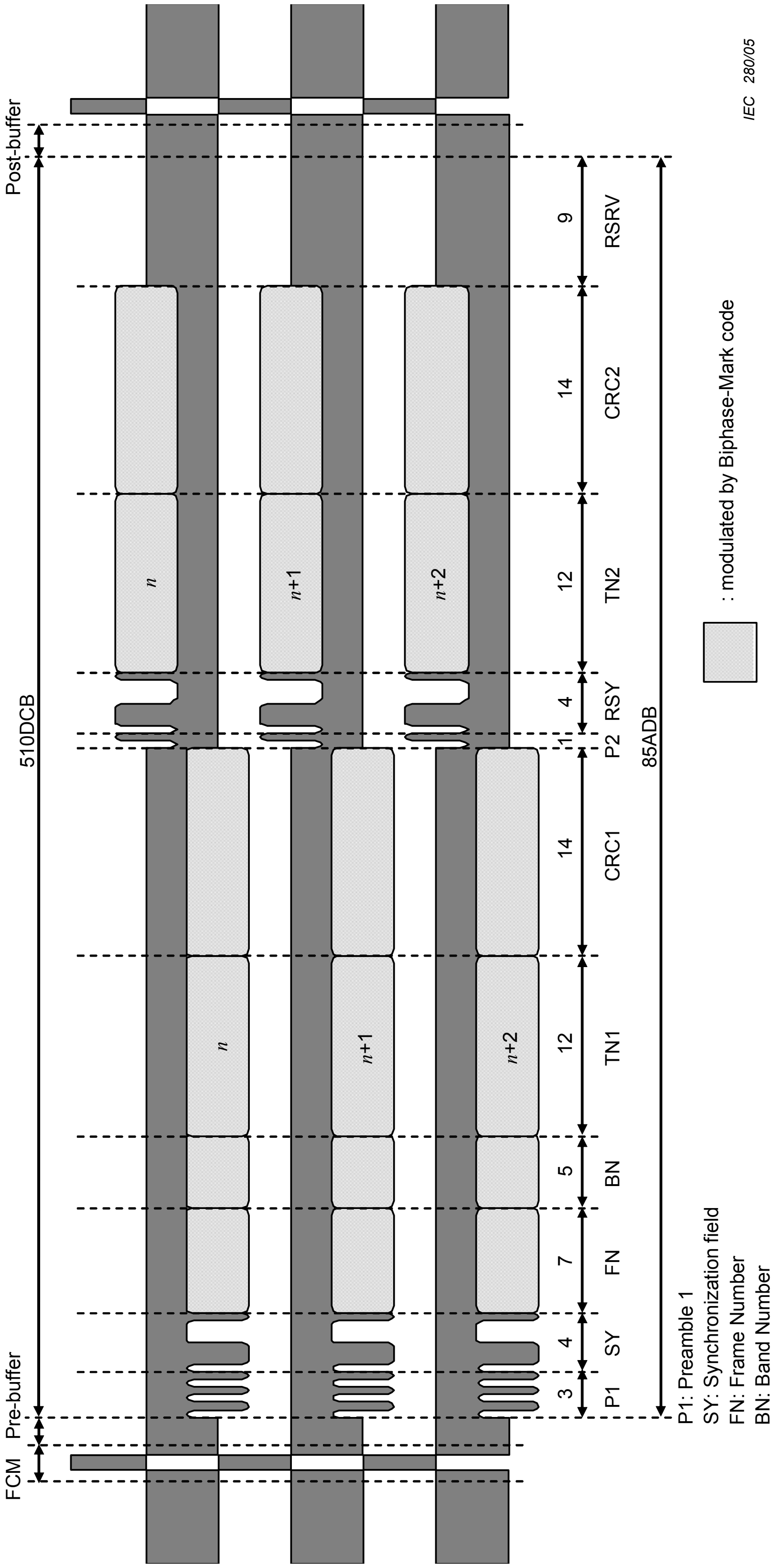


Figure 14 – Layout of the Address Segment



P1: Preamble 1
SY: Synchronization field
FN: Frame Number
BN: Band Number
TN1: Track Number 1
CRC1: Cyclic Redundancy Check 1 (for FN/BN/TN1)
P2: Preamble 2
RSY: Resync
TN2: Track Number 2
CRC2: Cyclic Redundancy Check 2 (for FN/BN/TN2)
RSRV: Reserved field

Figure 15 - Wobble Pattern of the Address Segment

10.3.2.1 Fine Clock Mark field

See 10.3.3.2.

10.3.2.2 Pre-buffer field

The Pre-buffer field shall have a length of 4 Data Channel bits with straight groove.

10.3.2.3 Preamble 1 field

The Preamble 1 field shall have a length of 3 Address Data bits set to 000. The Preamble 1 pattern is 101010 which pattern is expressed at a double ADB rate.

10.3.2.4 Synchronization field

For Synchronization with the address data, the Biphase-Mark code rule is violated.

The Synchronization field shall have a length of 4 Address Data bits. The Synchronization pattern is 10001110 which pattern is expressed at a double ADB rate.

10.3.2.5 Address field

10.3.2.5.1 General description of the Address field

The Address Segment shall have 1 Address field which has a length of 69 Address Data bits. The Address field shall comprise a Frame Number field, a Band Number field, a Track Number – 1 field, a CRC 1 field, a Preamble 2 field, a Resync field, a Track Number – 2 field and a CRC 2 field.

10.3.2.5.2 Frame Number field

The Frame Number field shall have a length of 7 Address Data bits.

The Frame Number format is according to the Frame Number in 10.2.5. The Frame Number shall be converted into Gray Code with the most significant bit first as follows:

Frame Number: 7-bit Gray Code, MSB in bit-1 of the Address field.

10.3.2.5.3 Band Number field

The Band Number field shall have a length of 5 Address Data bits.

The Band Number format is according to the Band Number in 10.2.2. The Band Number shall be converted into Gray Code with the most significant bit first as follows:

Band Number: 5-bit Gray Code, MSB in bit-8 of the Address field.

10.3.2.5.4 Track Number 1 field

The Track Number 1 field shall have a length of 12 Address Data bits.

The Track Number 1 format is according to the Track Number in 10.2.3. The Track Number 1 shall be converted into Gray Code with the most significant bit first as follows:

Track Number 1: 12-bit Gray Code, MSB in bit-13 of the Address field .

10.3.2.5.5 CRC 1 field

The CRC 1 field shall have a length of 14 Address Data bits.

For error detection of the Frame Number, the Band Number and the Track Number – 1, the CRC 1 field shall have 14-bit CRC and shall be calculated according to the Gray Code . The CRC codeword must be divisible by the check polynomial.

The most significant bit of the CRC 1 codeword is bit-1; the least significant bit is bit-38 of the Address field. The CRC parity bits (bit-25...38) are inverted on the disc.

The check polynomial is:

$$P(X) = X^{14} + X^{12} + X^{10} + X^{7} + X^{4} + X^{2} + 1$$

10.3.2.5.6 Preamble 2 field

The Preamble 2 field shall comprise 1 Address Data bit. The Preamble 2 pattern is 01 which pattern is expressed at a double ADB rate.

10.3.2.5.7 Resync field

For re-synchronization with the address data, the Biphase-Mark code rule is violated.

The Resync field shall have a length of 4 Address Data bits. The resync pattern is 01110001 which pattern is expressed at a double ADB rate.

10.3.2.5.8 Track Number 2 field

The Track Number 2 field shall have a length of 12 Address Data bits.

The Track Number 2 format in groove is according to the Track Number in 10.2.3. The Track Number 2 format on land is according to the Track Number plus 1 in 10.2.3. The Track Number 2 shall be converted into Gray Code with the most significant bit first as follows:

Track Number 2: 12-bit Gray Code, MSB in bit-44 of the Address field .

10.3.2.5.9 CRC 2 field

The CRC 2 field shall have a length of 14 Address Data bits.

For error detection of the Frame Number, the Band Number and the Track Number 2, the CRC 2 field shall have 14-bit CRC and shall be calculated after Gray coding. The CRC codeword must be divisible by the check polynomial.

The most significant bit of the CRC 2 codeword is bit-1, the least significant bit is bit-69 of the Address field (skipping from bit-13 to bit-43). The CRC 2 parity bits (bit-56...69) are inverted on the disc.

The check polynomial is:

$$P(X) = X^{14} + X^{12} + X^{10} + X^{7} + X^{4} + X^{2} + 1$$

10.3.2.6 Post-buffer field

The post-buffer field shall have a length of 6 Data Channel bits with straight groove.

10.3.3 Data Segments

10.3.3.1 General description of the Data Segments

Each Data Segment shall consist of a Fine Clock Mark field, a Pre-write field, a Data field and a Post-write field. The layout of the Data Segments shall be as specified in Figure 16.

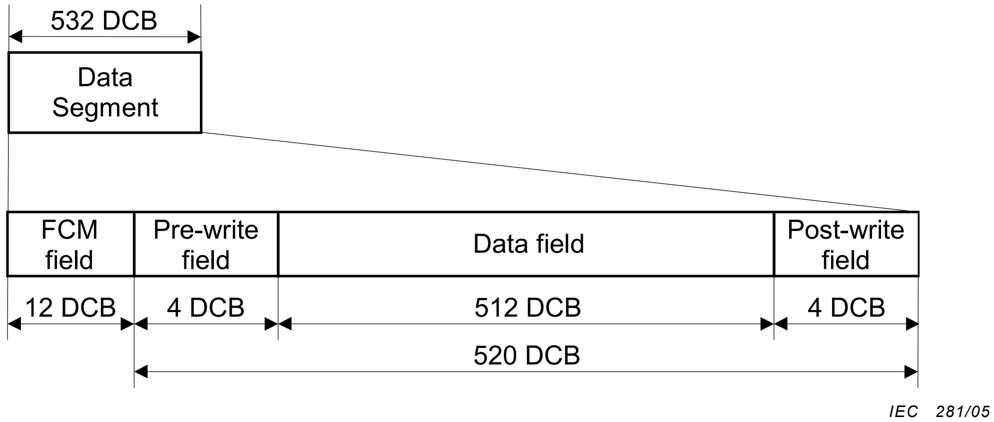


Figure 16 – Layout of the Data Segment

10.3.3.2 Fine Clock Mark field

The Fine Clock Mark field shall have a length of 12 Data Channel bits, and contain a Fine Clock Mark.

The Fine Clock Mark is used for generating the Data Channel clock. Patterns of this mark are shown in Figure 15.

10.3.3.3 Pre-write field and Post-write field

The Pre-write field and the Post-write field shall comprise 4 Data Channel bits respectively. The fields are used for suppressing interference from the residual signals that may remain after overwriting.

The Pre-write field bits of the first Data Segment shall be set to 1100. If the last bit of the Data field is 0, the Post-write filed bits of the current Data Segment and the Pre-write filed bits of the next Data Segment shall be set to 0011 and 1100 respectively. If the last bit of the Data field is 1, the Post-write filed bits of the current Data Segment and the Pre-write filed bits of the next Data Segment shall be set to 1100 and 0011 respectively.

The patterns of these bits are shown in Figure 17.

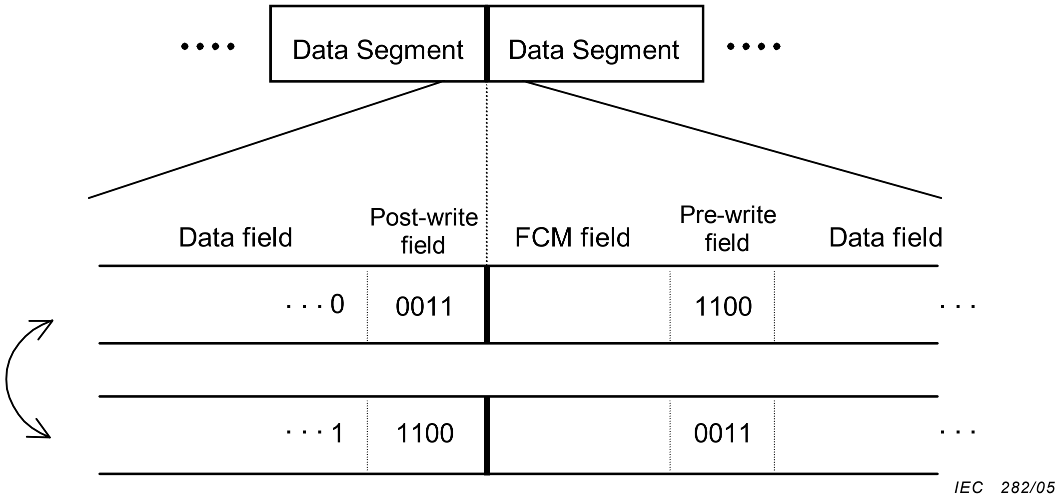


Figure 17 – The patterns of the Pre-write field and the Post-write field

10.3.3.4 Data field

The Data field shall have a length of 512 Data Channel bits. It may contain user written data. Data shall be written in this field using the Data clock frequency specified in table 4 for each data band.

10.3.3.5 Address Data clock frequency

The Address Data clock frequency is specified in Table 4.

The Address Data clock frequency shall be constant within the whole band irrespective of the radial position.

The length of one period of the Address Data clock is called an Address Data bit.

Table 4 – Nominal Address Data clock frequencies when the disc rotates at 50 Hz

Zone	f_{Ad} kHz
Lead-in Zone	
Outer Buffer Zone	5 532,80
Outer Control Zone	
Boundary tracks	5 532,80
Control tracks	5 532,80
Boundary tracks	5 532,80
Outer Test Zone	
for drives	5 532,80
for manufacturers	5 532,80
Data Zone	
Band 1	5 532,80
Band 2	5 359,90
Band 3	5 187,00
Band 4	5 014,10
Band 5	4 841,20
Band 6	4 668,30
Band 7	4 495,40
Band 8	4 322,50
Band 9	4 149,60
Band 10	3 976,70
Band 11	3 803,80
Band 12	3 630,90
Lead-out Zone	
Inner Test Zone	
for manufacturers	3 630,90
for drives	3 630,90
Inner Control Zone	
Boundary tracks	3 630,90
Control tracks	3 630,90
Boundary tracks	3 630,90
Inner Buffer Zone	3 630,90

10.4 ECC Block format

10.4.1 ECC Block layout

An ECC Block shall comprise 16 frames. Each block shall have a total length of 38 912 bytes and shall comprise several fields as shown in Figure 18.

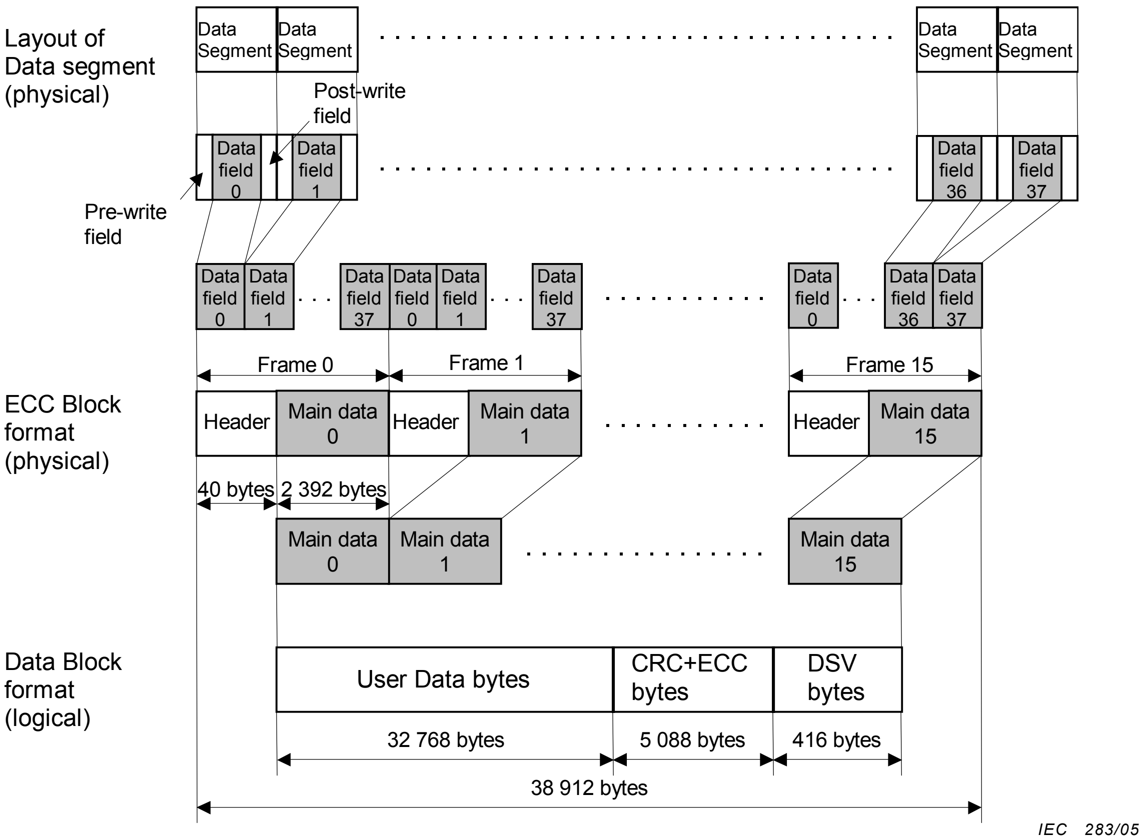


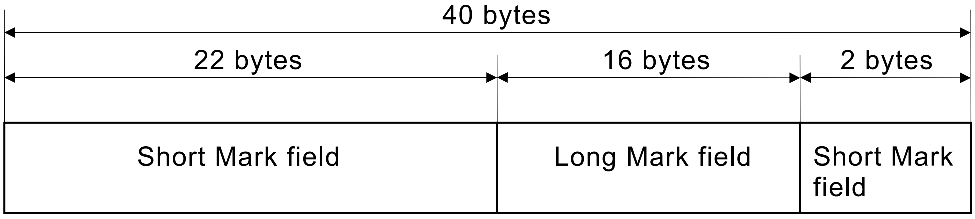
Figure 18 – ECC Block layout

10.4.2 Header

The Header shall start at the beginning of each frame. The length of each Header shall be equal to 40 bytes and it shall comprise three fields as shown in Figure 19.

The first 22 bytes and the last 2 bytes in the Header are the Short Mark fields. The Short Mark fields are used for phase compensation of the read data clock that is applied for data detection and optimising the read power level of the optical beam. Each field shall consist of 2T repeated data (11001100...).

The Long Mark field is used for the adjustment of reproduced signal gain and for optimising the read power level of the optical beam. The length of the field shall be equal to 16 bytes. The field shall consist of 8T repeated data (1111111100000000....).



IEC 284/05

Figure 19 – Header

10.4.3 User data bytes

The User data bytes are 32 768 bytes for recording user data.

10.4.4 CRC+ECC bytes

The Cyclic Redundancy Check and Error Correction Code bytes are used by the error detection and correction system to rectify erroneous data. The bytes shall be as specified in Annex F.

10.4.5 DSV bytes

See 10.5.

10.4.6 Sector number

Each 32kB ECC Block, which comprises 16 frames, shall be assigned 16 logical Sector numbers respectively. The first Sector number and last one on each band is shown in Table 8. The sectors shall be numbered consecutively onto whole groove track first in a Logical Zone.

Sector 0 shall be the 6th frame of track 49 on Band 1.

10.5 Recording code

The NRZI coding itself has no DC component suppressing capability. The NRZI Plus coding can suppress the low-frequency components of the channel bit stream by the DC component suppressing method which adds several redundant bits to the data stream and convolute them before NRZI modulating. These redundant bits shall be called DSV bytes.

The NRZI Plus coding is a method of converting n data words into n + 1 channel codewords. In this standard, the word size and data block size shall be decided as follows.

	4 bits (MSB first)
Data block size:	91 (words)
Kind of redundant bit:	0000 to 1111 (pure binary)

The NRZI Plus coding firstly converts a data block of 91 words into 16 types of a data block of 92 words.

Secondly, the converted 16 type data blocks are coded by the NRZI coding.

Finally one data block having peak DSV (Digital Sum Variation) at the last word of the data block as close to 0 as possible is selected from NRZI-coded 16 type data blocks. This conversion shall be as specified in Figure 20 and 21.

Coding:

$$C_i = \begin{cases} D_i \oplus T & (i=0) \\ D_i \oplus C_{i-1} & (i=1,...,90) \end{cases}$$

Decoding:

$$D_i = \begin{cases} C_i \oplus T & (i=0) \\ C_i \oplus C_{i-1} & (i=1,...,90) \end{cases}$$

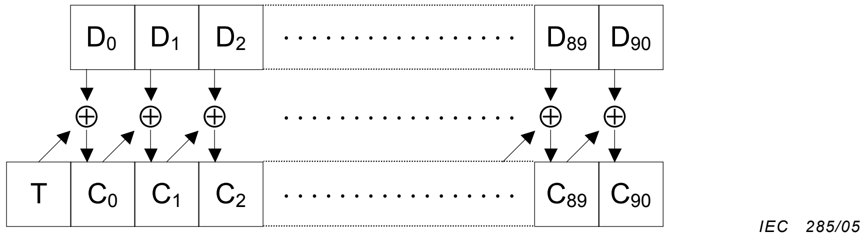


Figure 20 – NRZI Plus convolution method

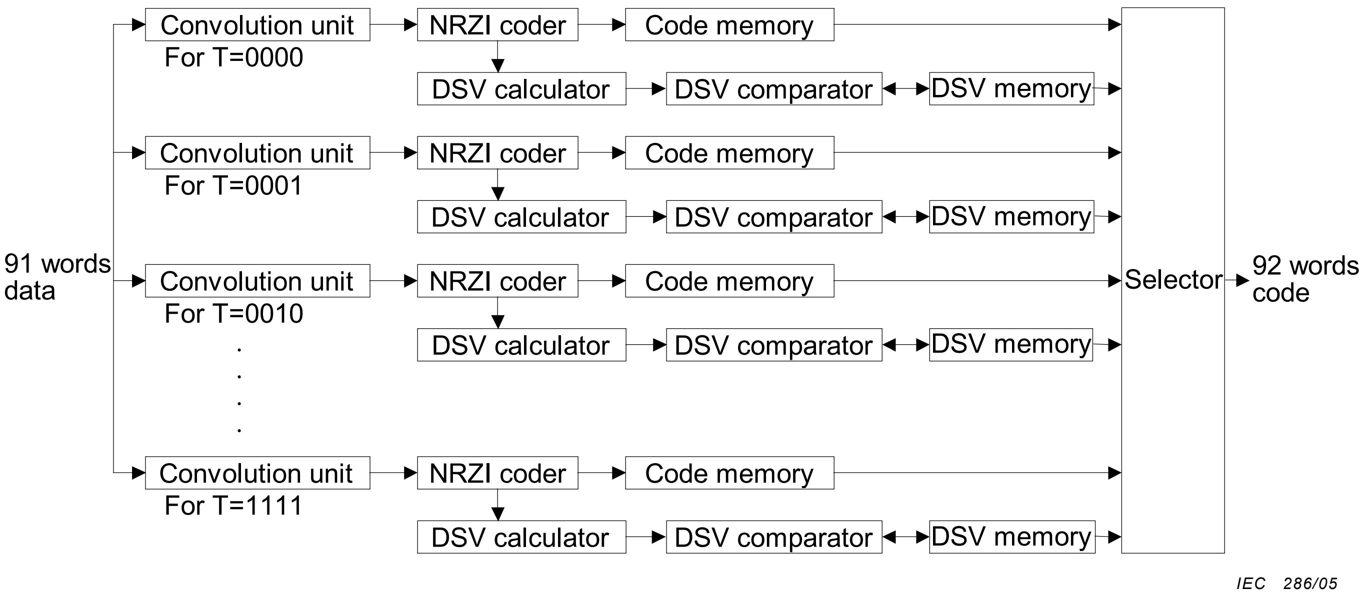


Figure 21 – NRZI Plus convolution method

In this conversion, an initial value of memorized DSV shall be set to 0. If an absolute value of DSV, which is calculated by CDS whenever the convolution of data word and NRZI coding of convoluted data are performed on each type data block, is greater than the absolute value of the memorized DSV, the calculated DSV shall be memorized as the peak DSV of the data block.

NOTE CDS is a value summed from the beginning of the codeword to the end of the codeword. A bit "1" and "0" within a codeword is translated into 1 and –1 respectively.

At the convolution and NRZI coding of the last word data of 16 type data blocks, one data block which has minimum absolute value of the memorized DSV shall be chosen. The DSV at the end of the chosen data block shall be set the initial memorized DSV of the next data block conversion.

The bit sequence of 37 856 bytes data of the User data bytes, CRC bytes, and ECC bytes shall be recorded in NRZI Plus code. The data sequence is recorded in MSB first.

45,5 bytes data block:	832 times
Total length of DSV bytes:	416 bytes

In Figure 21, the NRZI coder shall be reset before each Main data is input to the NRZI Plus code, i.e. the NRZI pre-state for coding of Main data shall be set to 0.

10.6 Format of the Information Zone

10.6.1 General description of the Information Zone

The Information Zone contains all information on the disc relevant for data interchange. The information comprises wobbled data and, possibly, user-written data. This clause defines the layout of the information; the characteristics of the signals obtained from this information are specified in Clause 11.

10.6.2 Division of the Information Zone

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

The division of the Information zone shall be as given in Table 5. The dimensions given in Table 5 are for reference only and are nominal locations. The tolerances are determined by the tolerance on the position of Control track as specified in 10.1.4.

Table 5 – Layout of the Information Zone

Zone	Nominal Radius Start-End (mm)	Band Number	Number of Tracks	Number of Frames	Track Number Start-End
Lead-in Zone					
Outer Buffer Zone	24,500 0 to 23,928 2	0	954	30	0 to 476
Outer Control Zone					
Boundary tracks	23,927 6 to 23,927 0	0	2	30	477 to 477
Control tracks	23,926 4 to 23,921 0	0	10	30	478 to 482
Boundary tracks	23,920 4 to 23,919 8	0	2	30	483 to 483
Outer Test Zone					
for drives	23,919 2 to 23,910 2	0	16	30	484 to 491
for manufacturers	23,909 6 to 23,900 6	0	16	30	492 to 499
Data Zone					
Band 1	23,900 0 to 23,591 0	1	516	30	0 to 257
Band 2	23,590 4 to 22,779 8	2	1 352	29	0 to 675
Band 3	22,779 2 to 21,983 0	3	1 328	28	0 to 663
Band 4	21,982 4 to 21,157 4	4	1 376	27	0 to 687
Band 5	21,156 8 to 20,347 4	5	1 350	26	0 to 674
Band 6	20,346 8 to 19,554 2	6	1 322	25	0 to 660
Band 7	19,553 6 to 18,728 6	7	1 376	24	0 to 687
Band 8	18,728 0 to 17,921 0	8	1 346	23	0 to 672
Band 9	17,920 4 to 17,132 6	9	1 314	22	0 to 656
Band 10	17,132 0 to 16,307 0	10	1 376	21	0 to 687
Band 11	16,306 4 to 15,501 8	11	1 342	20	0 to 670
Band 12	15,501 2 to 14,694 2	12	1 346	19	0 to 672

Table 5 *(continued)*

Zone	Nominal Radius Start-End (mm)	Band Number	Number of Tracks	Number of Frames	Track Number Start-End
Lead-out Zone					
Inner Test Zone					
for manufacturers	14,693 6 to 14,684 6	13	16	19	0 to 7
for drives	14,684 0 to 14,675 0	13	16	19	8 to 15
Inner Control Zone					
Boundary tracks	14,674 4 to 14,673 8	13	2	19	16 to 16
Control tracks	14,673 2 to 14,667 8	13	10	19	17 to 21
Boundary tracks	14,667 2 to 14,666 6	13	2	19	22 to 22
Inner Buffer Zone	14,666 0 to 14,000 6	13	1 110	19	23 to 577
NOTE The radii of a Zone given in the table refer to the nominal positions of the centres of the first and the last tracks of the Zone.					

10.6.3 Control Zones

There shall be an Outer Control Zone and an Inner Control Zone. They shall contain control information in the reserve area of frame information as specified in Annex G.

10.6.4 Test Zone

There shall be an Outer Test Zone and an Inner Test Zone. Each Test Zone shall comprise 32 tracks.

The Test Zone for drives are intended for tests to check write and read operations.

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

10.6.5 Data Zone

The Recording fields of the Data Zone may be user-written in the format specified in 10.3. The layout of the Data Zone is specified in 10.7.

The Data Zone shall be divided into 12 Bands numbered from 1 to 12. Each Band shall consist of the number of tracks specified in Table 5.

In addition, the Data Zone shall be partitioned into 177 groups as specified in 10.7.5.

10.7 Format of the Data Zone

10.7.1 General description of the Data Zone

The Data Zone shall contain four Defect Management Areas (DMAs) and two security areas. Two DMAs and a security area exist at the beginning of the Zone and another half exists at the end of the Zone. The area between these areas is called the User Area (see Figure 22).

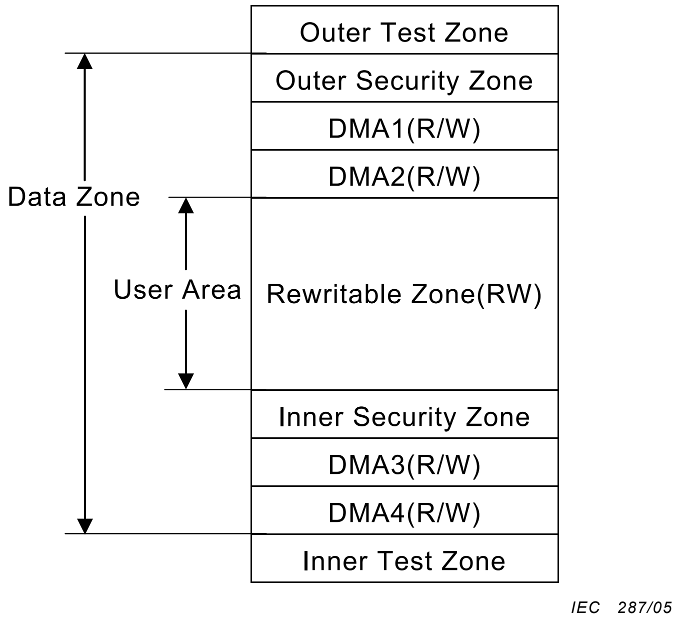


Figure 22 – Layout of the Data Zone and Test Zones

10.7.2 Security Zones

The two Security Zones comprise Security Area I and Security Area II. This zone is available when bit 2 of Byte 4 in the Control Zone is set to 1 as described in Annex G.

10.7.3 Defect Management Areas (DMAs)

The four Defect Management Areas contain information on the structure of the Data Zone and on defect management. The length of each DMA shall be 4 ECC Blocks. Two of the DMAs, DMA1 and DMA2, shall be located near the outer diameter of the disc; two others, DMA3 and DMA4, shall be located near the inner diameter of the disc. Table 6 indicates the boundaries of the DMAs as one of the examples.

Table 6 – Locations of the DMAs

	Band	**Start Address**		**End Address**		**Number of ECC Blocks**	**Number of Frames**
		Track	Frame	Track	Frame		
DMA1	1	45Groove	24	47Groove	27	4	64
DMA2		45Land	24	47Land	27	4	64
DMA3	12	664Groove	14	668Groove	1	4	64
DMA4		664Land	14	668Land	1	4	64

(Each DMA shall contain a Disc 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.

After initialization of the disc, each DMA shall have the following content.

The first DMA frame shall contain DDS.

The second DMA frame shall be the first frame of the PDL.

The SDL shall be located in the second ECC block of the DMA.

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 contents of the DDS are specified in 10.7.4; those of the PDL and SDL are specified in 10.8.6 and 10.8.7.

10.7.4 Disc Definition Structure (DDS)

The DDS shall consist of a table with a length of one sector. It specifies the condition of certification, number of bands and so on. The DDS shall be recorded in the first sector of each DMA at the end of initialization of the disc.

The information given in Table 7 on the disc structure shall be recorded in each of the four DDSs.

Table 7 – Byte assignment of the Disc Definition Structure (DDS)

BP	Description	Content
0	DDS Identifier	0x0A
1	DDS Identifier	0x0A
2-3	Reserved	0x00
4	Number of Band (MSB)	0x00
5	Number of Band (LSB)	0x0C
6	Number of Logical Zone (MSB)	0x00
7	Number of Logical Zone (LSB)	0xB1
8-31	Reserved	0x00
32	Certification condition of Band 1	–
33	Certification condition of Band 2	–
34	Certification condition of Band 3	–
35	Certification condition of Band 4	–
36	Certification condition of Band 5	–
37	Certification condition of Band 6	–
38	Certification condition of Band 7	–
39	Certification condition of Band 8	–
40	Certification condition of Band 9	–
41	Certification condition of Band10	–
42	Certification condition of Band11	–
43	Certification condition of Band12	–
44-255	Reserved	0x00
256	Certification condition of LZ0	–
:	Certification condition of LZ1	–
:	Certification condition of LZ175	–
432	Certification condition of LZ176	–
433-2047	Reserved	0x00
2048-32767	PDL	–
32768-131072	SDL	–

In the above table, the symbol "–" means that the appropriate value is to be entered in the DDS.

Certification condition of Band XX bit assignment:

Bit 7(MSB) to 6	00:	This band is not certified.
	01:	This band is certified by the media manufacturer.
	10:	This band is certified by the user.
	11:	This band is certified partially.
Bits 5 to 0(LSB)		Reserved

Certification condition of LZ XX:

Bit 7(MSB) to 6	00:	This LZ is not certified.
	01:	This LZ is certified by the media manufacturer.
	10:	This LZ is certified by the user.
	11:	Reserved
Bits 5 to 0(LSB)		Reserved

Table 8 - Assign of Logical Zone

Band No.	Number of Groove /Zone	Number of Groove Frame /Rev	Number of Groove Frame /Zone	Number of Logical Zone	Residual Groove Frames including Test track	Start of Security Area I		End of Security Area I		Start of Security Area II		End of Security Area II		Start of DMA		End of DMA		Logical Zone No
						1	0	11	19	11	20	45	23	45	24	47	27	
						Start of Band		Start of Data		End of Data		Start of Test track		End of Test track		End of Band		
1	258	30	7 740	6	1 596	0	0	49	6	253	29	254	0	256	29	257	29	0 - 5
2	676	29	19 604	19	148	0	0	1	0	671	25	672	0	674	28	675	28	6 - 24
3	664	28	18 592	18	160	0	0	1	0	659	7	660	0	662	27	663	27	25 - 42
4	688	27	18 576	18	144	0	0	1	0	683	17	684	0	686	26	687	26	43 - 60
5	675	26	17 550	17	142	0	0	1	0	670	13	671	0	673	25	674	25	61 - 77
6	661	25	16 525	16	141	0	0	1	0	656	8	657	0	659	24	660	24	78 - 93
7	688	24	16 512	16	128	0	0	1	0	683	15	684	0	686	23	687	23	94 - 109
8	673	23	15 479	15	119	0	0	1	0	668	18	669	0	671	22	672	22	110 - 124
9	657	22	14 454	14	118	0	0	1	0	652	13	653	0	655	21	656	21	125 - 138
10	688	21	14 448	14	112	0	0	1	0	683	13	684	0	686	20	687	20	139 - 152
11	671	20	13 420	13	108	0	0	1	0	666	11	667	0	669	19	670	19	153 - 165
12	673	19	12 787	11	1 523	0	0	1	0	593	15	669	0	671	18	672	18	166 - 176
						Start of Security Area I		End of Security Area I		Start of Security Area II		End of Security Area II		Start of DMA		End of DMA		
						594	0	610	15	610	16	664	13	664	14	668	1	

Track No.

Frame No.

10.7.5 Partitioning

During initialization of the disc, the Rewritable Zone shall be partitioned into 177 consecutive Logical Zones. If one Logical Zone is used, it shall span the entire User Area. Each Logical Zone shall comprise 126 sectors and 2 spare sectors. The detailed structure is shown in Figure 23.

Each Logical Zone is comprised of Groove and Land. The Groove is used initially and is then changed to Land at the end of each Logical Zone.

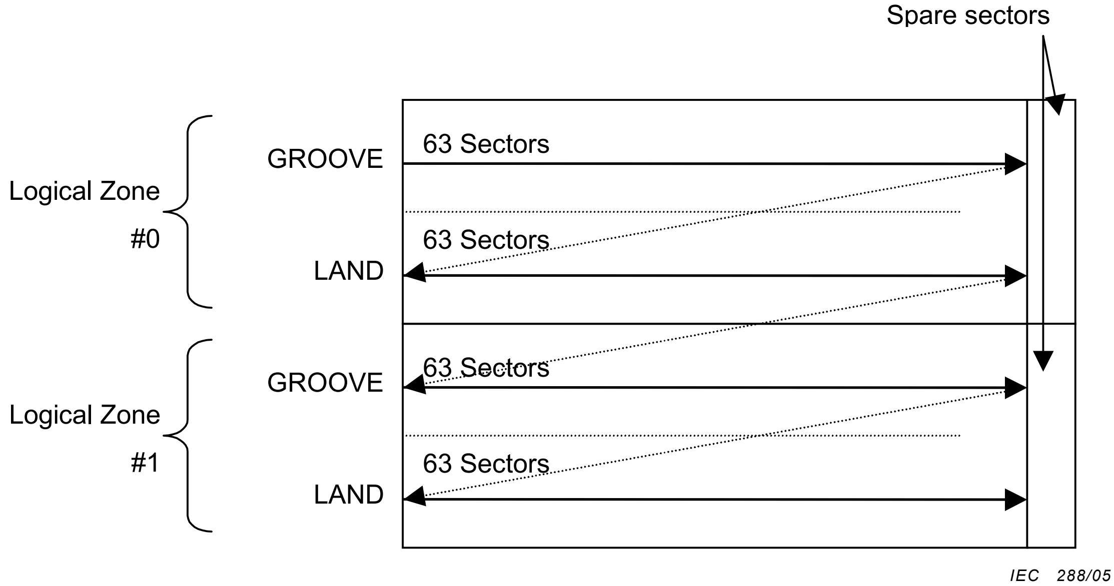


Figure 23 – Structure of Logical Zone

10.8 Defect Management

10.8.1 General description of the Defect Management

Defective sectors in the Rewritable Zone shall be replaced by good sectors according to the defect management method described below. The disc shall be initialized before use. This standard allows initialization with or without certification. Defective sectors are handled by a Linear Replacement Algorithm and a Sector Slipping Algorithm. The 2 sectors are distributed to each Logical Zone as shown in Figure 23.

10.8.2 Initialization of the Disc

During initialization of the disc, the 4 DMAs are recorded prior to the first use of the disc. The Rewritable Zone shall be partitioned into 179 groups. Each rewritable group shall contain a number of data sectors followed by spare sectors. The spare sectors can be used as replacements for defective data sectors. Initialization can include a certification of the rewritable groups whereby defective sectors are identified and skipped.

All DDS parameters shall be recorded in the four DDS sectors. The PDL and SDL shall be recorded in the 4 DMAs. The requirements for the recording of the PDLs and SDLs are stated in Tables 9 and 10.

10.8.3 Certification

If the disc is certified, the certification shall be applied to the data sectors and to the spare sectors in the groups. The method of certification is not stated by this standard. It may involve writing and reading the sectors in the groups. Defective sectors found during certification shall be handled by the Slipping Algorithm or, where applicable, by the Linear Replacement Algorithm. Defective sectors shall not be used for reading or writing.

10.8.3.1 Slipping Algorithm

The Slipping Algorithm shall be applied individually to each and every group in the Rewritable Zone in the case where certification is performed. The Slipping is performed independently on each Land or Groove.

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

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

If the spare sector area of a group becomes exhausted during certification, the defective sector shall be handled by the Linear Replacement Algorithm using the spare sector of another group.

10.8.3.2 Linear Replacement Algorithm

The Linear Replacement Algorithm is used to handle defective sectors found after certification. It is also used during certification in the event of the spare area of a group becoming exhausted. The Linear Replacement is performed in common on both Land and Groove.

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

This replacement shall be performed with all 16 sectors and the preceding and adjacent Logical Zone must be used as another group.

The addresses of the defective sector and of the replacement sector shall be recorded in the SDL. The addresses of sectors already recorded in the PDL shall not be recorded in the SDL.

If a replacement sector listed in the SDL is later found to be defective, it shall be dealt with by making a new entry in the SDL indicating a replacement sector for that defective sector.

10.8.4 Discs not certified

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

A defective sector shall be replaced by the first available good spare sector of the group. If there are no spare sectors left in the group, the defective sector shall be replaced by the first good spare sector of another group. The preceding and adjacent Logical Zone shall be used as another group. The addresses of the defective sector and of the replacement sector shall be recorded in the SDL.

If there exists a list of the defective sectors in the PDL, these sectors shall be skipped for use even if the disc is not certified. This is the same as the process specified in 10.8.3.2 for the certified discs.

10.8.5 Write procedure

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

10.8.6 Primary Defect List (PDL)

The Primary Defect List (PDL) is established upon certification of the media. The PDL shall be recorded when the disc is certified. The PDL shall not be recorded when the disc is not certified.

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

The PDL shall contain the address of all defective sectors identified at initialization. The addresses shall be listed in ascending order. All unused bytes in the PDL shall be set to (FF). The information described in Table 9 shall be recorded in each of four PDLs.

In an empty PDL, the number of entries in the PDL (BP2 and BP3) shall be set to (00) and the rest of the PDL shall be set to (FF), viz. BP4 to BP32 767 shall be set to (FF).

Table 9 – Content of the PDL

RBP	Description	Content
0	PDL Identifier	0x00
1	PDL Identifier	0x01
2	Number of entries in PDL (MSB)	
3	Number of entries in PDL (LSB)	
4-7	First PDL entry	
8-11	Second PDL entry	
:	:	
	Unused area	0xff
NOTE RBP is the Relative Byte Position within the list, starting with 0.		

10.8.6.1 PDL Identifier

(0001): PDL identifier

10.8.6.2 Number of entries in the PDL

This field shall specify the number of entries in the PDL.

10.8.6.3 PDL entry

b31 b30 b29 b25 b24 b23 b17 b16 b12 b11 b0

Entry Type	Reserved	L/G	Frame Number	Band Number	Track Number

Entry Type	00:	A defective sector defined by the disc manufacturer
	01:	Reserved
	10:	A defective sector found during a certification process
	11:	A defective sector which is transferred from the SDL without a certification process
L/G	0:	A defective sector on groove
	1:	A defective sector on land

IEC 289/05

Figure 24 – Structure of PDL entry

10.8.7 Secondary Defect List (SDL)

The Secondary Defect List (SDL) is created when defective ECC Blocks or defective sectors which cannot be registered in the PDL during certification are found.

Each entry in the SDL contains 8 bytes, viz. The first 4 bytes are assigned for MarkP and the address of the defective ECC Block; the last 4 bytes are assigned for the address of its replacement ECC Block. The address of the SDL is represented by the first frame address of the ECC Block.

The addresses of the defective ECC Block shall be listed in ascending order.

All unused bytes in the SDL shall be set to (FF). The information described in Table 10 shall be recorded in each of 4 SDLs.

Sectors listed in the PDL shall not be recorded in the SDL.

Table 10 – Content of the SDL

RBP	Description	Content
0	SDL Identifier	0x00
1	SDL Identifier	0x02
2	Number of entries in SDL (MSB)	
3	Number of entries in SDL (LSB)	
4-11	First SDL entry	
12-19	Second SDL entry	
:	:	
	Unused area	0xff
NOTE RBP is the Relative Byte Position within the list, starting with 0.		

10.8.7.1 SDL Identifier

(0002): SDL identifier

10.8.7.2 Number of entries in the SDL

This field shall specify the number of entries in the SDL.

10.8.7.3 SDL entry

b63 b62 b57 b56 b55 b49 b48 b44 b43 b32 b31 b25 b24 b23 b17 b16 b12 b11 b0

MarkP	Reserved	L/G	Frame Number	Band Number	Track Number	Reserved	L/G	Frame Number	Band Number	Track Number

First frame address in the defective ECC Block

First frame address in the replacement ECC Block

MarkP 0: Replacement ECC Block is assigned and not defective

1: Replacement ECC Block is not assigned ECC Block is defective or certain situations

IEC 290/05

Figure 25 – Structure of SDL entry

11 Characteristics of embossed information

11.1 Method of testing

11.1.1 General description of the testing method

The format of the embossed information on the disc is defined in Clause 10 which specifies the requirements for the signals from grooves as obtained when using the Reference Drive defined in Clause 8.

11.1.2 Environment

All signals in 11.2 to 11.4 shall be within their specified with the cartridge in any environment in the Testing environment defined in 7.1.1.

11.1.3 Reference Drive

11.1.3.1 Optics and mechanics

The focused optical beam shall have the properties defined in 8.2 a) to f). The disc shall rotate as specified in 8.5.

11.1.3.2 Read power

For the testing specified in this subclause, the optical power incident on the entrance surface of the disc (used for reading the information) shall be in the range from 1,0 mW to $P_{\text{r max}}$. $P_{\text{r max}}$ shall be in the range

$$1{,}0 \text{ mW} \le P_{\text{r max}} \le 3{,}0 \text{ mW}.$$

11.1.3.3 Read channels

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 I_1, I_2, I_3, I_4, in 8.1.

11.1.3.4 Focusing and Tracking

During the measurement of the signals, the focus of the optical beam shall have an axial deviation of not more than

e_{max}(axial) = 0,6 µm

from the recording layer, and it shall have a radial deviation of not more than

e_{max}(radial) = 0,06 µm

from the centre of a track.

11.1.4 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.

I_1 I_2 and I_3 I_4 are the sum outputs of the two halves of the split photo-diode detector in the tracking channel.

11.2 Signals from grooves (see Figure 26)

11.2.1 Measurement condition

I_T and I_{PP} are the filtered signals of (I_1 + I_2) and (I_1 – I_2), respectively, in order that frequencies above 1 MHz are attenuated by at least 40 dB, thereby eliminating the effect of modulation due to wobbled grooves and due to fine clock marks.

11.2.2 Cross-track signal

The cross-track signal is the sinusoidal signal of I_T, when the focus of the optical beam crosses the tracks. The peak-to-peak value of the cross-track signal shall meet the following requirements.

$(I_{Tmax} - I_{Tmin})/(I_{Tmax} + I_{Tmin}) \leq 0,1$

11.2.3 Divided push-pull signal

The divided push-pull signal is the sinusoidal signal of I_{PP}/I_T, when the focus of the optical beam crosses the tracks.

$0,5 \leq I_{PP}/I_T = 1,5$

11.2.4 Phase depth

The phase depth of the grooves equals

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

where

n is the index of refraction of the substrate;

d is the groove depth

λ is the wavelength

The phase depth shall be less than 180°.

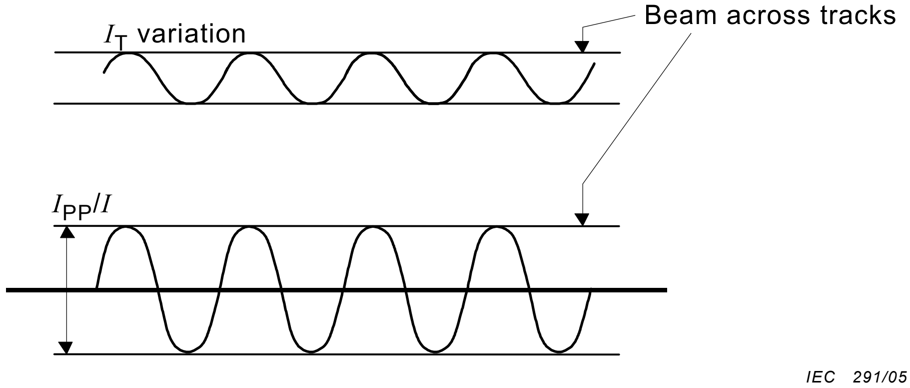


Figure 26 – Signals from grooves

11.3 Signals from wobble groove (see Figure 27)

11.3.1 Wobble signal

The wobble signal I_W in address segments shall meet the following requirements:

$$0,10 \le I_W \le 0,35$$

where I_W is $(I_1 - I_2)/(I_1 + I_2)$.

The value of the wobble signal in each address segment shall meet the following requirements.

$$(I_{Wmax} - I_{Wmin})/(I_{Wmax} + I_{Wmin}) \le 0,35$$

where I_{Wmax} is the maximum value of measured I_W and I_{Wmin} is the minimum value of I_W

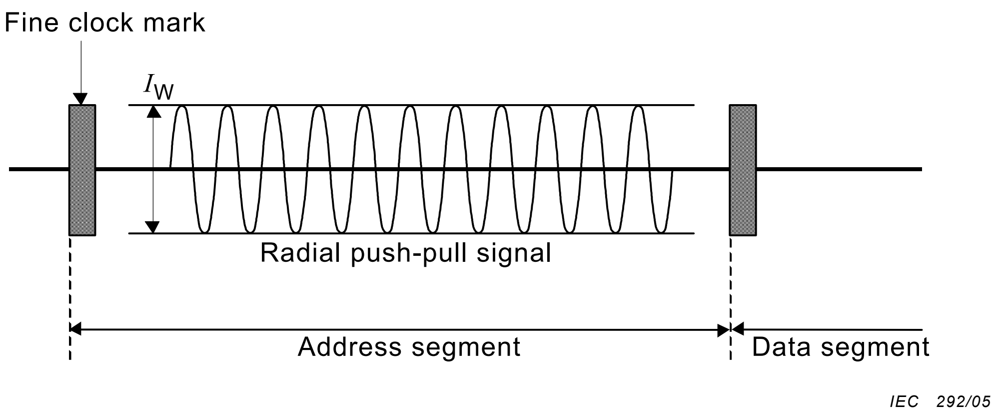


Figure 27 – Signals from wobbled groove

11.4 Signal from fine clock marks (see Figure 28)

11.4.1 Fine clock mark

The signal from the fine clock marks shall meet the following requirements:

$0,5 \leq (I_3 - I_4)/(I_3 + I_4) \leq 1,5$

11.4.2 Timing jitter

The jitter shall be defined as the standard deviation of the signal from fine clock marks and signal clock generated by a PLL circuit.

$Jt(H) \leq 0,07$ T

where T is the Channel clock period, $Jt(H)$ is the standard deviation (sigma) of the difference between the marks and the mean value of n T, where n is greater than 1 000.

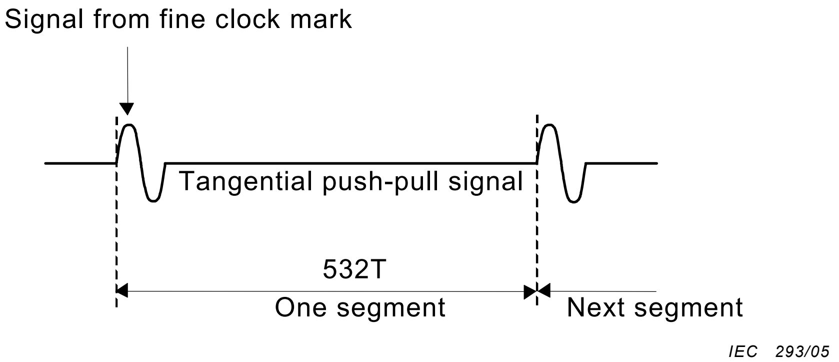


Figure 28 – Signals from fine clock marks

11.4.3 Radial push-pull on fine clock mark

The signal of radial push-pull on fine clock marks (I_{PPF}) shall meet the following requirement:

$0,7 \leq I_{PPF}/I_{PP} \leq 1,1$

The deference of the centre level between push-pull signal and envelope of fine clock marks shall meet the following requirement:

$-0,1 \leq (((I_{PPFh} - I_{PPFl})/2) - ((I_{PPh} + I_{PPl})/2))/I_{PP} \leq 0,1$

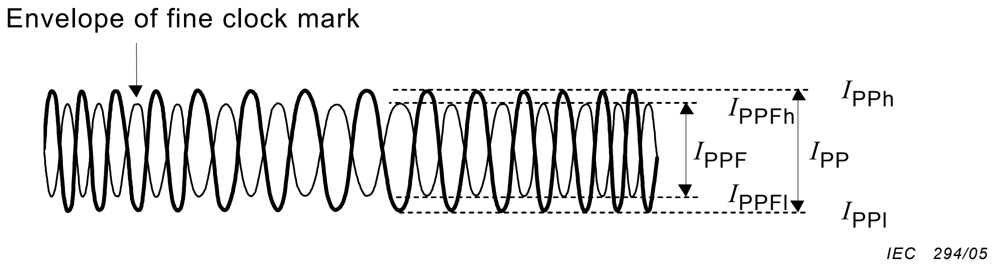


Figure 29 – Radial push-pull signal and envelope of fine clock mark

12 Characteristics of the recording layer

12.1 Method of testing

12.1.1 General description of the testing method

Clause 12 describes a series of tests to assess the magneto-optical properties of the recording layer, as used for writing data. The tests shall be performed only in the Data Zone. The write and read operations necessary for the tests shall be made on the same Reference Drive.

Clause 12 specifies only the average quality of the recording layer and does not specify local deviation from the specified values, called defects that can cause write problems.

12.1.2 Environments

All signals in Clause 12 shall be within their specified ranges with the cartridge in any environment in the range of allowed operating environments defined in 7.1.2.

12.1.3 Reference Drive

12.1.3.1 Optics and mechanics

The focused optical beam shall have the properties defined in 8.2 a) to f). The disc shall rotate as specified in 8.5.

12.1.3.2 Read power

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

12.1.3.3 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 8.3.

12.1.3.4 Tracking

During the measurement of the signals, the focus of the optical beam shall follow the tracks as specified in 11.1.3.4.

12.1.4 Overwrite conditions

12.1.4.1 Write pulse

Peak write power P_{W}, bias power P_{b}, pulse width T_{W}, rise time T_{r} and fall time T_{f} are defined in Figure 30. The value of P_{b} shall be less than 0,2 mW. T_{W} shall be 0,5 T. T_{r} and T_{f} shall be less than 3 ns. The P_{W} shall not exceed 10,5 mW.

12.1.4.2 Write magnetic field

The requirements of all tests shall be met for the recording magnetic field H_{ext} (see Figure 30) of applied magnetic field intensities at the recording layer during writing in 12 kA/m.

The magnetic field shall be normal to the recording surface. The shape of the magnetic field on the recording layer is described in Figure 30.

T_h is the time for which the absolute value of the magnetic field is more than H_0 (=0,9 × H_{ext}).

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

The phase difference T_{M-P} is defined as the time span between the moment the recording magnetic field rises to H_0 and the moment the laser power falls to a half of P_W, as shown in Figure 30.

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

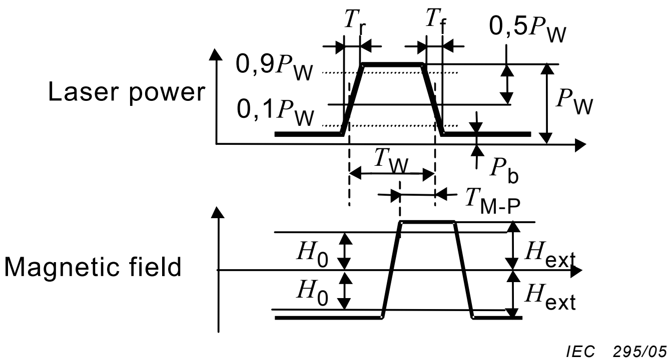


Figure 30 – Recording magnetic field shape and Write pulse

12.1.5 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.

12.2 Magneto-optical characteristics

12.2.1 Imbalance of the magneto-optical signal

The imbalance of the magneto-optical signal is the DC 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 disc in the low-frequency region where the modulation transfer function of the optical system is one. 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 Data Zone. The imbalance shall be measured in a bandwidth from DC to 40 kHz. The imbalance is specified for a Reference Drive with a beam splitter E with nominal values for the reflectance; the phase retarder shall be in neutral position.

12.2.2 Resolution

I_{8T} is the peak-to-peak value of the signal obtained in Channel 2 (see 8.3) from 8T marks written under the conditions given in 12.1.4, and read under the conditions specified in 12.1.3.

I_{2T} is the peak-to-peak value of the signal obtained in Channel 2 (see 8.3) from 2T marks written under the conditions given in 12.1.4 and read under the conditions specified in 12.1.3.

The resolution I_{2T}/I_{8T} shall meet the following requirements:

$I_{2T}/I_{8T} \geq 0{,}30$

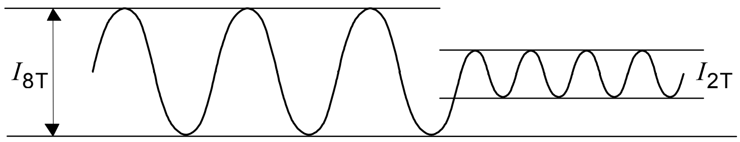


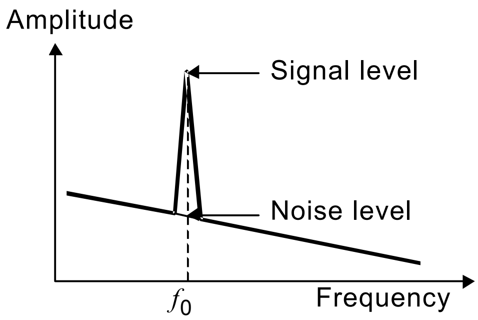
Figure 31 – Resolution

12.2.3 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 2T marks in the Recording field of a series of sectors at a frequency f_0. The write conditions shall be as specified in 12.1.4.

Read the Recording fields in Channel 2 under the conditions specified in 12.1.3, using a spectrum analyser with a bandwidth of 30 kHz. Measure the amplitudes of the signal and the noise at the frequency f_0 as indicated in Figure 32.



The narrow-band signal-to-noise ratio is

$20 \times \log_{10}$ (signal level/noise level)

The narrow-band signal-to-noise ratio shall be greater than 43 dB in the Data Zone for all allowed values of the write magnetic field.

Figure 32 – Spectrum analyser display

12.2.4 Crosstalk ratio

The test on crosstalk shall be carried out on seven adjacent data tracks, designated (n–1/land), (n–1/groove), (n/land), (n/groove), (n+1/land), (n+1/groove), (n+2/land), (n+2/groove) in the Data Zone.

The procedure shall be

a) erase each of the tracks;

b) write a series of 2T marks in track (n/land) and (n+1/groove);

c) read the signal level in tracks of (n–1/groove), (n/land), (n/groove), (n+1/land), (n+1/groove) and (n+2/land).

The crosstalk from track (n/land) to track (n–1/groove) and to track (n/groove) shall be lower than –23 dB.

The crosstalk from track (n+1/groove) to track (n+1/land) and to track (n+2/land) shall be lower than –23 dB.

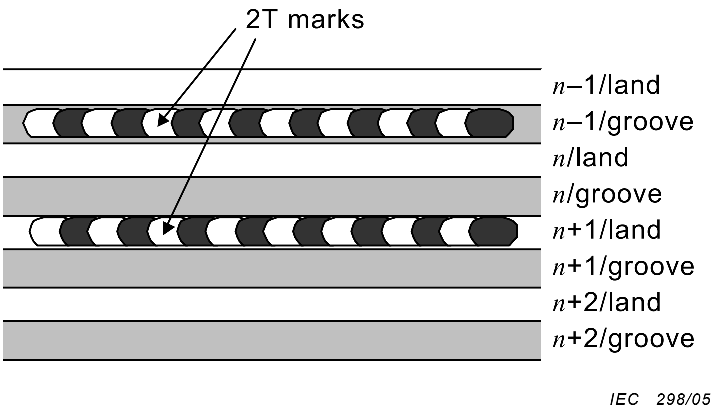


Figure 33 – Crosstalk test pattern

12.2.5 Overwrite

The test on cross-erase shall be carried out on three adjacent data tracks in the Data Zone.

The procedure shall be

a) erase each of the tracks;

b) write a series of 2T marks at a frequency f_0 in a track with 1,1 × P_w;

c) read the signal level 1 in the track;

d) write a series of 3T marks in the track with 0,9 × P_w;

e) read the signal level 2 at the frequency f_0 in the track.

The difference between signal level 1 and signal level 2 shall be greater than 20 dB.

12.2.6 Cross-erase

The test on cross-erase shall be carried out on 4 adjacent data tracks, designated (n–1/land), (n/groove), (n/land), (n+1/groove) in the Data Zone.

The procedure shall be

a) erase each of the tracks;

b) write a series of 2T marks in track (n/land) with P_w;

c) read the signal level 1 of 2T marks in track (n/land);

d) write a series of 3T marks in track (n/groove) and in track (n+1/groove) with 1,1 × P_w;

e) read the signal level 2 of 2T marks in track (n/land);

f) write a series of 2T marks in track (n/groove) with P_w;

g) read the signal level 3 of 2T marks in track (n/groove);

h) write a series of 3T marks in track (n–1/land) and (n/land) wit 1,1 × P_w;

i) read the signal level 4 of 2T marks in track (n/groove).

The difference between signal level 1 and signal level 2 shall be lower than 2 dB.

The difference between signal level 3 and signal level 4 shall be lower than 2 dB.

13 File system

The file system specification is ISO/IEC13346-1. The specification is based on the OSTA Universal Disc Format Specification (UDF) Revision 1.50, and has restrictions as shown below.

The file system specification has the following restrictions:

– logical sector length is 2 048 byte (fixed);
– single volume. Multi-volume is not supported;
– single partition. Multi-partition is not supported;
– for blank space management, Unallocated Space Bitmap can be made;
– partition map type is 1;
– allocation descriptor is Short allocation descriptor only;
– strategy type of ICB tag: 4 only;
– CD-ROM Volume Descriptor Set is not generated (no UDF bridge format);
– all numerical data of more than one byte are set in little-endian format.

13.1 Volume

13.1.1 General

13.1.1.1 OSTA CS0 Charspec

The OSTA CS0 Charspec is according to Table 11.

Table 11 – OSTA CS0 Charspec

RBP	Length	Name: Type	Contents
0	1	Character Set Type: Uint8	0
1	63	Character Set Info: bytes	“OSTA Compressed Unicode” Remainders: all 0

13.1.1.2 Time stamp

The time stamp is according to Table 12.

Table 12 – Time stamp

RBP	Length	Name: Type	Contents
0	2	Type and Timezone: Uint16	#121c type = 1 Time difference = 540 min
2	5	Year: Uint16	
4	1	Month: Uint8	
5	1	Day: Uint8	
6	1	Hour: Uint8	
7	1	Minutes: Uint8	
8	1	Second: Uint8	
9	1	Centiseconds: Uint8	0
10	1	100s of micro seconds: Uint8	0
11	1	Microseconds: Uint8	0

13.1.1.3 Entity Identifier

Three entity identifiers are defined: Domain, UDF, and Implementation.

13.1.1.3.1 Domain Entity Identifier

The Domain Entity Identifier is according to Table 13.

Table 13 – Domain Entity Identifier

RBP	Length	Name: Type	Contents
0	1	Flags: Uint8	0
1	23	Identifier: bytes	"*OSTA UDF Compliant" Remainders: all 0
24	8	Identifier Suffix: bytes	(Refer to Table 14)

13.1.1.3.2 Domain Identifier Suffix

The Domain Identifier Suffix is according to Table 14.

Table 14 – Domain Identifier Suffix

RBP	Length	Name: Type	Contents
0	2	UDF Revision: Uint16	#0150
1	1	Domain Flags: Uint8	0
2	5	Reserved: bytes	All 0

13.1.1.3.3 UDF Entity Identifier

The UDF Entity Identifier is according to Table 15.

Table 15 – UDF Entity Identifier

RBP	Length	Name: Type	Contents
0	1	Flags: Uint8	0
1	23	Identifier: bytes	"*UDF LV Info" Remainders: all 0
24	8	Identifier Suffix: bytes	(Refer to Table 16)

13.1.1.3.4 UDF Identifier Suffix

The UDF Identifier Suffix is according to Table 16.

Table 16 – UDF Identifier Suffix

RBP	Length	Name: Type	Contents
0	2	UDF Revision: Uint16	#0150
2	1	OS class: Uint8	0
3	1	OS Identifier: Uint8	0
4	4	Reserved: bytes	All 0

13.1.1.3.5 Implementation Entity Identifier

The Implementation Entity Identifier is according to Table 17.

Table 17 – Implementation Entity Identifier

RBP	Length	Name: Type	Contents
0	1	Flags: Uint8	0
1	23	Identifier: bytes	
24	8	Identifier Suffix: bytes	(Refer to Table 18.)

13.1.1.3.6 Implementation Identifier Suffix

The Implementation Identifier Suffix is according to Table 18.

Table 18 – Implementation Identifier Suffix

RBP	Length	Name: Type	Contents
0	1	OS class: Uint8	0
1	1	OS Identifier: Uint8	0
2	6	Implementation Use Area: bytes	All 0

13.1.2 Volume Recognition Structures

Restrictions on Volume Recognition Structures:

– a Boot Descriptor that makes media as a boot device is not generated;
– only the following descriptors are generated: Beginning Extended Area Descriptor, NSR
– Descriptor and Terminating Extended Area Descriptor.

13.1.2.1 Beginning Extended Area Descriptor

The Beginning Extended Area Descriptor is according to Table 19.

Table 19 – Beginning Extended Area Descriptor

RBP	Length	Name: Type	Contents
0	1	Structure Type: Uint8	0
1	5	Standard Identifier: bytes	“BEA01”
6	1	Structure Version: Uint8	1
7	2 041	Structure Data: bytes	All 0

13.1.2.2 NSR Descriptor

The NSR Descriptor is according to Table 20.

Table 20 – NSR Descriptor

RBP	Length	Name: Type	Contents
0	1	Structure Type: Uint8	0
1	5	Standard Identifier: bytes	“NSR02”
6	1	Structure Version: Uint8	1
7	1	Reserved: byte	0
8	2 040	Structure Version: Uint8	All 0

13.1.2.3 Terminating Extended Area Descriptor

The Terminating Extended Area Descriptor is according to Table 21.

Table 21 – Terminating Extended Area Descriptor

RBP	Length	Name: Type	Contents
0	1	Structure Type: Uint8	0
1	5	Standard Identifier: bytes	"TEA01"
6	1	Structure Version: Uint8	1
7	2 041	Structure Data: bytes	All 0

13.1.3 Volume Structure

13.1.3.1 Descriptor Tag

The Descriptor Tag is according to Table 22.

Table 22 – Descriptor Tag

RBP	Length	Name: Type	Contents
0	2	Tag Identifier: Uint16	
2	2	Descriptor Version: Uint16	2
4	1	Tag Checksum: Uint8	
5	1	Reserved: byte	0
6	2	Tag Serial Number: Uint16	0
8	2	Descriptor CRC: Uint16	
10	2	Descriptor CRC Length: Uint16	
12	4	Tag Location: Uint32	
NOTE The Tag Serial Number is not changed even if the system is reinitialized.			

13.1.3.2 Anchor Volume Descriptor Pointer

The Anchor Volume Descriptor Pointer is according to Table 23.

Table 23 – Anchor Volume Descriptor Pointer

RBP	Length	Name: Type	Contents
0	16	Descriptor Tag: tag	Tag Identifier = 2
16	8	Main Volume Descriptor Sequence Extent: extent_ad	
24	8	Reserve Volume Descriptor Sequence Extent: extent_ad	
32	480	Reserved: bytes	All 0

13.1.3.3 Primary Volume Descriptor

The Primary Volume Descriptor is according to Table 24.

Table 24 – Primary Volume Descriptor

RBP	Length	Name: Type	Contents
0	16	Descriptor Tag: tag	Tag Identifier=1
16	4	Volume Descriptor Sequence Number: Uint32	
20	4	Primary Volume Descriptor Number: Uint32	0
24	32	Volume Identifier: dstring	
56	2	Volume Sequence Number: Uint16	1
58	2	Maximum Volume Sequence Number: Uint16	1
60	2	Interchange Level: Uint16	2
62	2	Maximum Interchange Level: Uint16	2
64	4	Character Set List: Uint32	1
68	4	Maximum Character Set List: Uint32	1

Table 24 *(continued)*

RBP	Length	Name: Type	Contents
72	128	Volume Set Identifier: dstring	
200	64	Descriptor Character Set: charspec	OSTA CS0 Charspec (Refer to Table 11)
264	64	Explanatory Character Set: charspec	OSTA CS0 Charspec (Refer to Table 11)
328	8	Volume Abstract: extent_ad	All 0
336	8	Volume Copyright Notice: extent_ad	All 0
344	32	Application Identifier: regid	All 0
376	12	Recording Date and Time: timestamp	(see Table 12)
388	32	Implementation Identifier: regid	Implementation Entity Identifier (Refer to Table 11)
420	64	Implementation Use: bytes	All 0
484	4	Predecessor Volume Descriptor Sequence Location: Uint32	All 0
488	2	Flags: Uint16	#0
490	22	Reserved: Byte	All 0

13.1.3.4 Implementation Use Volume Descriptor

13.1.3.4.1 Format of the Implementation Use Volume Descriptor

The Implementation Use Volume Descriptor is according to Table 25

Table 25 – Implementation Use Volume Descriptor

RBP	Length	Name: Type	Contents
0	16	Descriptor Tag: tag	Tag Identifier=4
16	4	Volume Descriptor Sequence Number: Uint32	
20	32	Implementation Identifier: regid	UDF Entity Identifier (Refer to Table 15)
52	460	Implementation Use: bytes	(Refer to Table 26)

13.1.3.4.2 Implementation Use of Implementation Use Volume Descriptor

The Implementation Use of Implementation Use Volume Descriptor is according to Table 26.

Table 26 – Implementation Use of Implementation Use Volume Descriptor

RBP	Length	Name: Type	Contents
0	64	LVI Charset: charspec	OSTA CS0 Charspec (Refer to Table 11)
64	128	Logical Volume Identifier	
192	36	Logical Volume Info1	All 0
228	36	Logical Volume Info2	All 0
264	36	Logical Volume Info3	All 0
300	36	Implementation ID: regid	Implementation Entity Identifier (Refer to Table 17)
332	128	Implementation Use	All 0

13.1.3.5 Partition Descriptor

13.1.3.5.1 Format of the Partition Descriptor

The Partition Descriptor is according to Table 27

Table 27 – Partition Descriptor

RBP	Length	Name: Type	Contents
0	16	Descriptor Tag: tag	Tag Identifier=5
16	4	Volume Descriptor Sequence Number: Uint32	
20	2	Partition Flags: Uint16	1
22	2	Partition Number: Uint16	0
24	32	Partition Contents: regid	Partition identification information (see Table 28)
56	128	Partition Contents Use: bytes	Partition Header Descriptor (see Table 29)
184	4	Access Type: Uint32	4
188	4	Partition Starting Location: Uint32	
192	4	Partition Length: Uint32	
196	32	Implementation Identifier: regid	Implementation Entity Identifier (see Table 17)
228	128	Implementation Use: bytes	All 0
356	156	Reserved: bytes	All 0
NOTE Partition Contents Use is always recorded as Partition Header Descriptor.			

13.1.3.5.2 Partition Contents

Partition identification information consists of the fields given in Table 28.

Table 28 – Partition Contents

RBP	Length	Name: Type	Contents
0	1	Flags: Uint8	0
1	23	Identifier: bytes	"+NSR02"
24	8	Identifier Suffix: bytes	All 0

13.1.3.5.3 Partition Header Descriptor

The Partition Header Descriptor consists of the fields given in Table 29.

Table 29 – Partition Header Descriptor

RBP	Length	Name: Type	Setting
0	8	Unallocated space table: short_ad	All 0
8	8	Unallocated space bitmap: short_ad	(see Table 40)
16	8	Partition Integrity table:short_ad	All 0
24	8	Freed space table: short_ad	All 0
32	8	Freed space bitmap: short_ad	All 0
40	88	Reserved: bytes	All 0
NOTE Only Unallocated Space Bitmap is used.			

13.1.3.6 Logical Volume Descriptor

13.1.3.6.1 Format of the Logical Volume Descriptor

The Logical Volume Descriptor consists of the fields given in Table 30.

Table 30 – Logical Volume Descriptor

RBP	Length	Name: Type	Contents
0	16	Descriptor Tag: tag	Tag Identifier=6
16	4	Volume Descriptor Sequence Number: Uint32	
20	64	Descriptor Character Set: charspec	OSTA CS0 Charspec (see Table 11)
84	128	Logical Volume Identifier: dstring	
212	4	Logical Block Size: Uint32	#800=2048
216	32	Domain Identifier: regid	Domain Entity Identifier (see Table 13)
248	16	Logical Volume Contents Use: bytes	File Set Descriptor Extent Information (see Table 31)
264	4	Map Table Length: Uint32	6
268	4	Number of Partition Maps: Uint32	1
272	32	Implementation Identifier: regid	Implementation Entity Identifier (see Table 17)
304	128	Implementation Use: bytes	All 0
432	8	Integrity Sequence Extent: extent_ad	Integrity Sequence Extent Information (see Table 32)
440	6	Partition Maps: bytes	Partition Maps (type1) (see Table 33)

The Logical Volume Contents Use must always be bytes to set File Set Descriptor Extent information.

The number of Partition Maps is always 1. Combined use of Read Only and (Over) Rewritable is not allowed.

13.1.3.6.2 File Set Descriptor Extent Information

The File Set Descriptor Extent Information consists of the fields given in Table 31.

Table 31 – File Set Descriptor Extent Information

RBP	Length	Name: Type	Contents
0	4	Extent Length: Uint32	#800=2048
4	6	Identifier: lb_addr	(see table 39)
10	6	Implementation Use: bytes	All 0

13.1.3.6.3 Integrity Sequence Extent Information

The Integrity Sequence Extent Information consists of the fields given in Table 32.

Table 32 – Integrity Sequence Extent Information

RBP	Length	Name: Type	Contents
0	4	Extent Length: Uint32	
4	8	Extent Location: Uint32	

13.1.3.6.4 Partition Maps

The Partition Maps consist of the fields given in Table 33.

Table 33 – Partition Maps

RBP	Length	Name: Type	Contents
0	1	Partition Map Type: Uint8	1
1	1	Partition Map Length: Uint8	6
2	2	Volume Sequence Number: Uint16	1
4	2	Partition Number: Uint16	0

13.1.3.7 Unallocated Space Descriptor

The Unallocated Space Descriptor consists of the fields given in Table 34.

Table 34 – Unallocated Space Descriptor

RBP	Length	Name: Type	Contents
0	16	Descriptor Tag: tag	Tag Identifier=7
16	4	Volume Descriptor Sequence Number: Uint32	
20	4	Number of Allocation Descriptors: Uint32	0
24	0	Allocation Descriptors: extent_ad	None

13.1.3.8 Terminating Descriptor

The Terminating Descriptor consists of the fields given in Table 35.

Table 35 – Terminating Descriptor

RBP	Length	Name: Type	Contents
0	16	Descriptor Tag: tag	Tag Identifier=8
16	496	Reserved: bytes	All 0

13.1.3.9 Logical Volume Integrity Descriptor

13.1.3.9.1 Format of the Logical Volume Integrity Descriptor

The Logical Volume Integrity Descriptor consists of the fields given in Table 36.

Table 36 – Logical Volume Integrity Descriptor

RBP	Length	Name: Type	Contents
0	16	Descriptor Tag: tag	Tag Identifier=9
16	12	Recording Date and Time: timestamp	(see Table 12)
28	4	Integrity Type: Uint32	
32	8	Next Integrity Extent: extent_ad	All 0
40	32	Logical Volume Contents Use: bytes	Information for Logical Volume Header Descriptor (see Table 37)
72	4	Number of Partitions: Uint32	1
76	4	Length of Implementation Use=L_IU: Uint32	#2e=46
80	4	Free Space Table: Uint32	
84	4	Size Table: Uint32	
88	L_IU=46	Implementation Use: bytes	Implementation Use Information (see Table 38)
NOTE The Logical Volume Contents Use must always be set in the Logical Volume Header Descriptor format.			

13.1.3.9.2 Logical Volume Contents Use

The Logical Volume Contents Use consists of the fields given in Table 37.

Table 37 – Logical Volume Contents Use

RBP	Length	Name: Type	Contents
0	8	Unique ID: Uint64	
8	24	Reserved: bytes	All 0

13.1.3.9.3 Implementation Use

The Implementation Use consists of the given in Table 38.

Table 38 – Implementation

RBP	Length	Name: Type	Contents
0	32	Implementation Identifier: regid	Implementation Entity Identifier (see Table 17)
32	4	Number of Files: Uint32	
36	4	Number of Directories: Uint32	
40	2	Minimum number of UDF read versions: Uint16	#0102
42	2	Minimum number of UDF write versions: Uint16	#0102
44	2	Maximum number of UDF write versions: Uint16	#0150
46	0	Implementation Use: bytes	None

13.2 File

13.2.1 File Structure

13.2.1.1 lb_addr (Logical Block Address)

The lb_addr (Logical Block Address) consists of the fields given in Table 39.

Table 39 – lb_addr (Logical Block Address)

RBP	Length	Name: Type	Contents
0	4	Logical Block Number: Uint32	
4	2	Partition Reference Number: Uint16	0

13.2.1.2 short_ad (Short Allocation Descriptor)

The short_ad (Short Allocation Descriptor) consists of the fields given in Table 40.

Table 40 – short_ad (Short Allocation Descriptor)

RBP	Length	Name: Type	Contents
0	4	Extent Length: Uint32	
4	4	Extent Location: Uint32	

13.2.1.3 long_ad (Long Allocation Descriptor)

The long_ad (Long Allocation Descriptor) consists of the fields given in Table 41.

Table 41 – long_ad (Long Allocation Descriptor)

RBP	Length	Name: Type	Contents
0	4	Extent Length: Uint32	
4	6	Extent Location: lb_addr	(see Table 39)
10	6	Implementation Use: bytes	All 0

13.2.1.4 File Set Descriptor

The File Set Descriptor consists of the fields given in Table 42.

Table 42 – File Set Descriptor

RBP	Length	Name: Type	Contents
0	16	Descriptor Tag: tag	Tag Identifier=256
16	12	Recording Date and Time: timestamp	(see Table 12)
28	2	Interchange Level: Uint16	3
30	2	Maximum Interchange Level: Uint16	3
32	4	Character Set List: Uint32	1
36	4	Maximum Character Set List: Uint32	1
40	4	File Set Number: Uint32	0
44	4	File Set Descriptor Number: Uint32	0

Table 42 *(continued)*

RBP	Length	Name: Type	Contents
48	64	Logical Volume Identifier Character Set: charspec	OSTA CS0 Charspec (see Table 11)
112	128	Logical Volume Identifier: dstring	
240	64	File Set Character Set: charspec	OSTA CS0 Charspec (see Table 11)
304	32	File Set Identifier: dstring	
336	32	Copyright File Identifier: dstring	All 0
368	32	AbstractFile Identifier: dstring	All 0
400	16	Root Directory ICB: long_ad	(see Table 41)
416	32	Domain Identifier: regid	Domain EntityIdentifier (see Table 13)
448	16	Next Extent: long_ad	All 0
464	48	Reserved: bytes	All 0

13.2.1.5 File Identifier Descriptor (40-52 byte)

The File Identifier Descriptor consists of the fields given in Table 43.

Table 43 – File Identifier Descriptor

RBP	Length	Name: Type	Contents
0	16	Descriptor Tag: tag	Tag Identifier=257
16	2	File version Number: Uint16	1
18	1	File Characteristics: Uint8	
19	1	Length of File Identifier (=L_FI): Uint8	Maximum13
20	16	ICB: long_ad	(see Table 41)
36	2	Length of Implementation Use: Uint16 (=L_IU)	
38	L_IU	Implementation Use: bytes	
38+L_IU	L_FI	File Identifier: d-characters	(see Table 44)
38+L_IU+L_FI	0 – 3	Padding: bytes	All 0

d-characters consist of the fields given in Table 44.

Table 44 – d-characters

RBP	Length	Name: Type	Contents
0	1	Compression identifier: Uint8	8
1	L_FI-1 (Length of file name)	Compression bit string: bytes	File name: 8.3 format
NOTE The File name cannot contain "#".			

13.2.1.6 File Entry

13.2.1.6.1 Format of the File Entry

The File Entry consists of the fields given in Table 45.

Table 45 – File Entry

RBP	Length	Name: Type	Contents
0	16	Descriptor Tag: tag	Tag Identifier=261
16	20	ICB Tag: icbtag	(see Table 46)
36	4	User ID: Uint32	0xffffffff
40	4	Group ID: Uint32	0xffffffff
44	4	Permissions: Uint32	
48	2	File Link Count: Uint16	
50	1	Record Format: Uint8	0
51	1	Record Display Attribute: Uint8	0
52	4	Record Length: Uint32	0
56	8	Information Length: Uint64	
64	8	Logical Blocks Recorded: Uint64	
72	12	Access Date and Time: timestamp	(see Table 12)
84	12	Modification Date and Time: timestamp	(see Table 12)
96	12	Attribute Date and Time: timestamp	(see Table 12)
108	4	Check Point: Uint32	1
112	16	Extended Attribute ICB: long_ad	(see Table 41)
128	32	Implementation Identifier: regid	Implementation Entity Identifier (see Table 17)
160	8	Unique Id: Uint64	
168	4	Length of Extended Attributes: Uint32 (=L_EA)	#38=56
172	4	Length of Allocation Descriptors: Uint32 (=L_AD)	
176	L_EA =56	Extended Attributes: bytes	(see Table 47)
176 +L_EA	L_AD	Allocation Descriptors: bytes	
NOTE Extended Attributes: Only File Times Extended Attribute is generated.			

13.2.1.6.2 ICB Tag

The ICB Tag consists of the given in Table 46.

Table 46 – ICB Tag

RBP	Length	Name: Type	Contents
0	4	Prior Recorded Number of Direct Entries: Uint32	0
4	2	Strategy Type: Uint16	4
6	2	Strategy Parameter: Uint16	0
8	2	Maximum Number of Entries: Uint16	1
10	1	Reserved: bytes	0
11	1	File Type: Uint8	
12	6	Parent ICB Location: lb_addr	(see Table 39)
18	2	Flags: Uint16	(see Table 50)

13.2.1.6.3 Extended Attributes

13.2.1.6.3.1 Format of the Extended Attributes

The Extended Attributes consists of the given in Table 47.

Table 47 – Extended Attributes

RBP	Length	Name: Type	Contents
0	24	Extended Attribute Header Descriptor	(see Table 48)
24	A_L=32	Extended Attribute =File Times Extended Attribute	(see Table 49)

13.2.1.6.3.2 Extended Attribute Header Descriptor

The Extended Attribute Header Descriptor consists of the fields given in Table 48.

Table 48 – Extended Attributes Header Descriptor

RBP	Length	Name: Type	Contents
0	16	Descriptor Tag: tag	Tag Identifier=262
16	4	Implementation Attributes Location: Uint32	#38=56
20	4	Application Attributes Location: Uint32	#38=56

13.2.1.6.3.3 File Times Extended Attribute

The File Times Extended Attribute consists of the fields given in Table 49.

Table 49 – File Times Extended Attribute

RBP	Length	Name: Type	Contents
0	4	Attribute Type: Uint32	5
4	1	Attribute Subtype: Uint8	1
5	3	Reserved: bytes	All 0
8	4	Attribute Length: Uint32	#20=32
12	4	Data Length: Uint32 (=D_L)	#c=12
16	4	File Time Existence: Uint32	1
20	D_L=12	File Times: timestamp	(see Table 12)

13.2.1.6.3.4 Flags in ICB Tag

The Flags in ICB Tag consists of the fields given in Table 50.

Table 50 – Flags in ICB Tag

Bit	Interpretation	Contents
0 – 2	Type of Allocation Descriptor	0
3	Directory Sort	0
4	Non-relocatable	0
5	Archive	
6	Setuid	0
7	Setgid	0
8	Stricky	0
9	Contiguous	
10	System	
11	Transformed	0
12	Multi-versions	0
13-15	Reserved	0
NOTE Allocation Descriptor in File Entry is Short Allocation Descriptor only. Unallocated Space Entry is not used.		

13.2.1.7 Space Bitmap Descriptor

The Space Bitmap Descriptor consists of the fields given in Table 51.

Table 51 – Space Bitmap Descriptor

RBP	Length	Name: Type	Contents
0	16	Descriptor Tag: tag	Tag Identifier=264
16	4	Number of Bits: Uint32	
20	4	Number of Bytes: Uint32 (=N_B)	
24	N_B	Bitmap: bytes	

13.2.1.8 Allocation Extent Descriptor

The Allocation Extent Descriptor consists of the fields given in Table 52.

Table 52 – Allocation Extent Descriptor

RBP	Length	Name: Type	Contents
0	16	Descriptor Tag: tag	Tag Identifier=258
16	4	Previous Allocation Extent Location: Uint32	
20	4	Length of Allocation Descriptors: Uint32	
NOTE Previous Allocation Extent Location may be other than 0.			

14 File format of Sound and Images

14.1 General

As digital still cameras become widely available, the image file format standard "Exif", which covers the image files and related audio files to be used among different digital still cameras and related devices, has been established. The purpose of this standard is to offer common specifications that are convenient for digital camera users to handle such files on different cameras. The Design rule for Camera File system (DCF) specifies the recording, playing, formatting and directory of photographed digital still image files so that these images can be directly played on a different digital camera or to be output to a printer. This DCF standard appreciates the concept of Exif and DCF standards and basically follows these standards for processing of still picture and audio. For management of motion picture file formatting that is not covered by these existing standards, the camera DCF standard uses the QuickTime file format established by Apple Computer, Inc.

Relationship between DCF Standard Compatible Equipment

The current DCF standard that specifies digital camera file system covers removable memory formatted with DOS FAT file system and does not cover 50 mm magneto-optical discs covered by this standard. The purpose of the DCF standard is to enable the users to use the same file on different devices. Appreciating this concept and taking into account the possibility of unification of both formats, provisions of the DCF standard are to be left undisturbed as long as possible. Therefore, with a few exceptions, DCF media standard, writer specification and reader specification of the DCF standard are made effective in the new standard as long as still pictures are concerned. These few exceptions are defined in the subclauses described below. The processing of audio and motion picture is not exactly specified in the DCF standard and will be defined in the new standard based on the DCF standard.

14.2 Directory Structure

The structure of directory on the media storing still picture file is compatible with the DCF media standard defined in the DCF standard. That is, the DCF image root directory DCIM is located directly under the media root and the DCF directory is located under DCIM. Each directory is named according to the DCF directory names. The directory to store motion picture file is located in the DCF directory. This new directory is called VCLIP.

The motion picture file is recorded directly under the VCLIP directory.

To protect the directory from accidental deletion, the UDF file system directory permission setting has a delete flag bit. When this bit is off, the directory is delete-protected. No other permission settings are defined. The directory is handled according to the DCF standard.

Handling of a directory in the DCF directory: when a file has been recorded into a directory located directly under the DCF directory, such as the VCLIP directory for motion pictures file, and the file is to be reproduced on a different reproducer, its directory number and file number should be specifically displayed so that the user can recognize that the file is not a DCF basic file.

As for the data which was not described in this standard, keeping it outside the DCF directory is recommended.

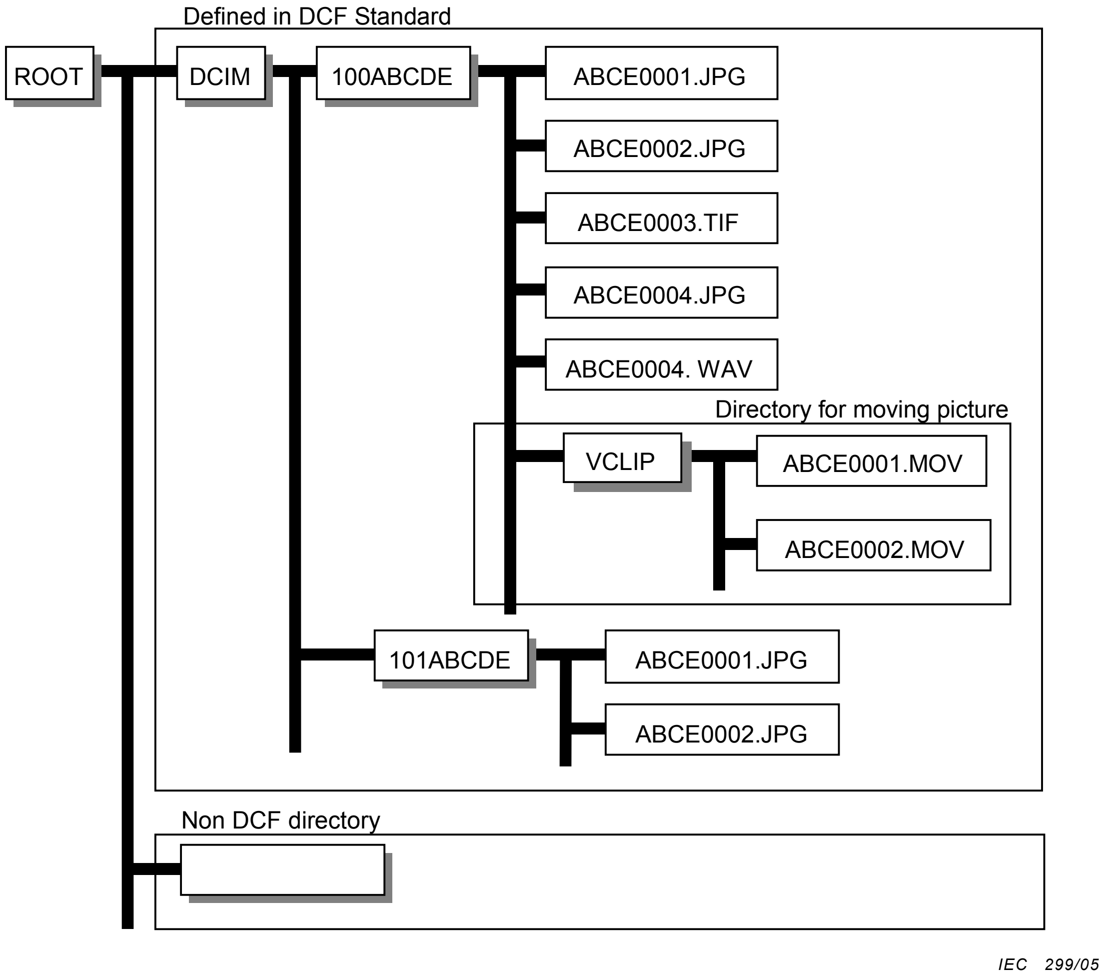


Figure 34 – Directory structure including motion picture

14.3 File Format

14.3.1 General description of the File Format

Still picture files, audio files and motion picture files are stored onto a 50 mm magneto-optical disc by a DCF file name specified in the DCF standard. A DCF object can be produced by assembling a file group consisting of files having the same file number as the DCF file name. Still picture files that have relation to an audio file can constitute a DCF object for that audio file.

If UDF file system file permission setting on a 50 mm magneto-optical disc has a delete flag bit off, the file is delete-protected. No other permission settings are defined. The directory is handled according to the DCF standard. When all the files comprising a DCF object are protected, the object is deletion-protected according to the DCF standard.

14.3.2 Interchangeability (compatible mode)

For interchangeability of still picture files, writer and reader specifications of the DCF standard are applied. Values of audio data and motion picture data vary with time base. To assure reproducing compatibility, the main data of audio and motion picture must be reproduced. This standard defines the compatible mode. The recording equipment must be capable of recording in at least one of the compatible modes specified in the audio and motion picture file, while audio and motion picture data recorded in this mode should be reproduced on any compatible reproducing equipment, which shall support all compatible modes.

Data recorded in a mode other than the compatible mode are not guaranteed for compatibility. Even if a file is recorded in a compatible mode, some functions may not be exactly reproduced when played on reproducing equipment that supports other functions only.

14.3.3 Image (still picture) File

Still picture files are compatible with Exif standard Ver. 2.1 and recorded according to the DCF basic file specified in the DCF standard. The DCF extended image file and the DCF thumb nail file specified in the DCF standard can also be used in recording.

The compatibility of still picture follows the definition given in the DCF standard.

The compatible mode specific to the 50 mm magneto-optical disc is not covered.

14.3.4 Sound File

Audio files are recorded in accordance with Exif standard, Ver. 2.1 audio file regulation.

The conditional requirements for audio file compatible mode are as follows.

Format:	Exif 2.1 Audio file regulation compatible RIFF WAVE Form Audio File
Modulation/compressing method:	PCM uncompressed
Sampling frequency:	8 kHz
Quantize bits:	8
Channel:	1 (monaural)
File name extension:	WAV

14.3.5 Movie (motion picture) File

Motion picture files are recorded in accordance with Apple Computer Inc. (US) QuickTime movie file format specification.

Reference URL
(http://www.apple.com/quicktime/resources/qtfileformat.pdf)

The conditional requirements for motion picture file compatible mode:
Format: Compatible with QuickTime Movie File Format Specification
QuickTime Flat Movie format

(Image/audio data)

Image compressing method:	Photo-JPEG compression
Image size:	320 pixels × 240 pixels
Frame rate:	15 frames/s
Audio modulation/ compressing method:	PCM uncompressed
Audio sampling frequency:	8 kHz
Audio quantize bits:	8
Audio channel:	1 (monaural)

(Thumb-nail data)
It is recommended to record the following thumb-nail in the movie file:

Type:	Still picture thumb-nail
Format:	PICT file containing DCF basic thumb-nail file specified by DCF standard Image
Size:	160 pixels × 120 pixels
Location:	Preview atom in a movie file
File name extension:	MOV

* Any motion picture files generated under the above-mentioned conditions must be reproduced in the compatible mode regardless of the header structure of the movie file.

Annex A
(normative)

Air cleanliness class 100000

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.

A.1 Definition

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

The statistical average particle size distribution is given in Figure A.1. Class 100000 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 sampling is taken.

A.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 in such a way that the number of particles in relation to particle size is registered or displayed.

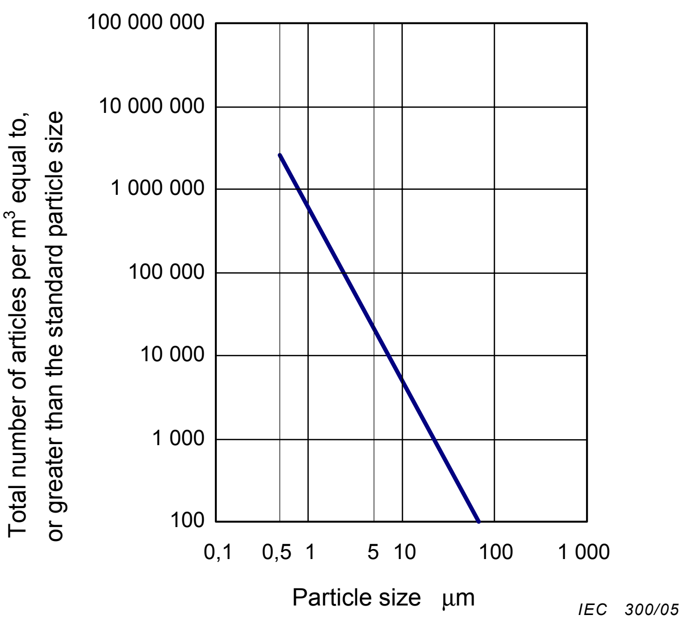


Figure A.1 – Particle size distribution curve

Annex B
(normative)

Measurement method of reference plane flatness

The flatness of the reference plane is measured with the standard tool shown in Figure B.1.

Place the cartridge on the standard tool.

Place 3 1N masses on the cartridge, each at a point corresponding to reference post A, B and C, respectively.

Measure the height of the reference plane measurement area D from the reference plane consisting of the reference posts A, B and C.

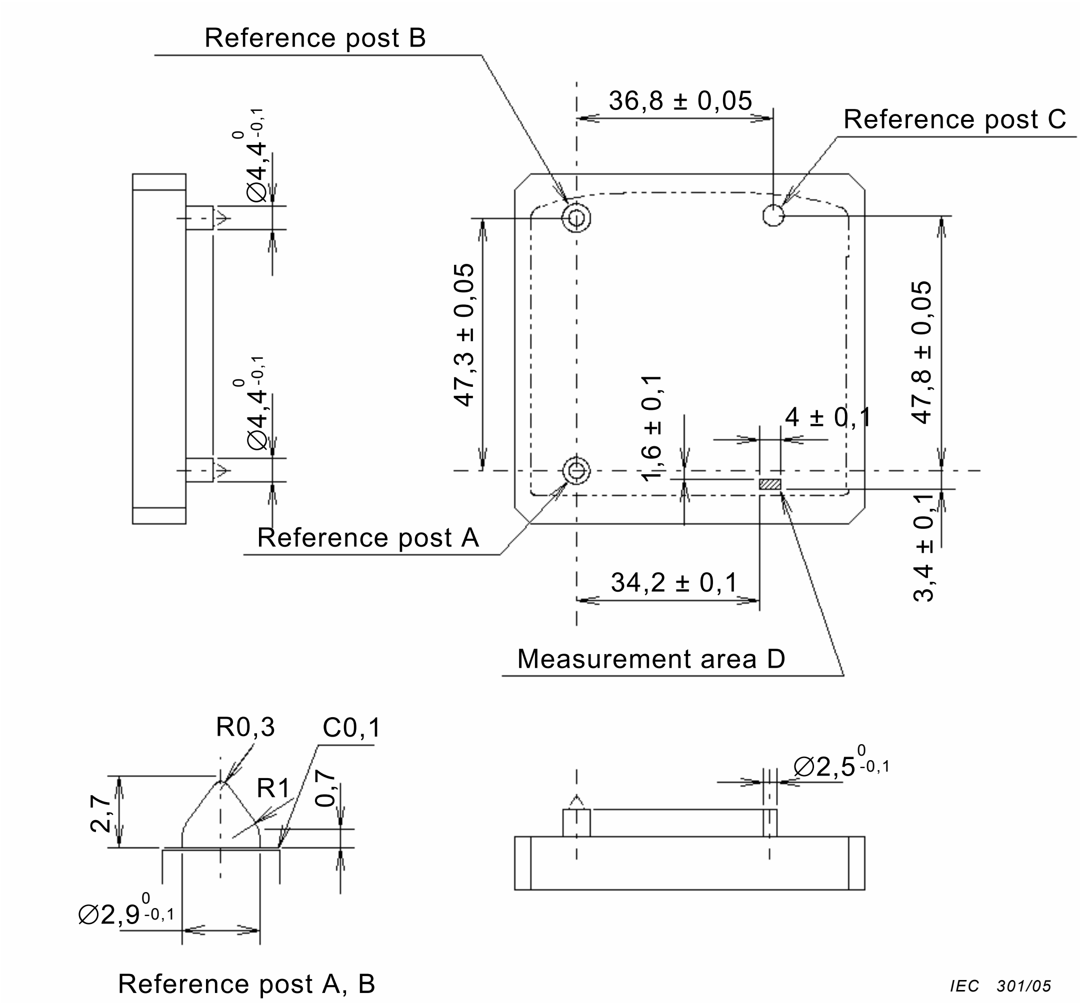


Figure B.1 – Measurement method of reference plane flatness

Annex C
(normative)

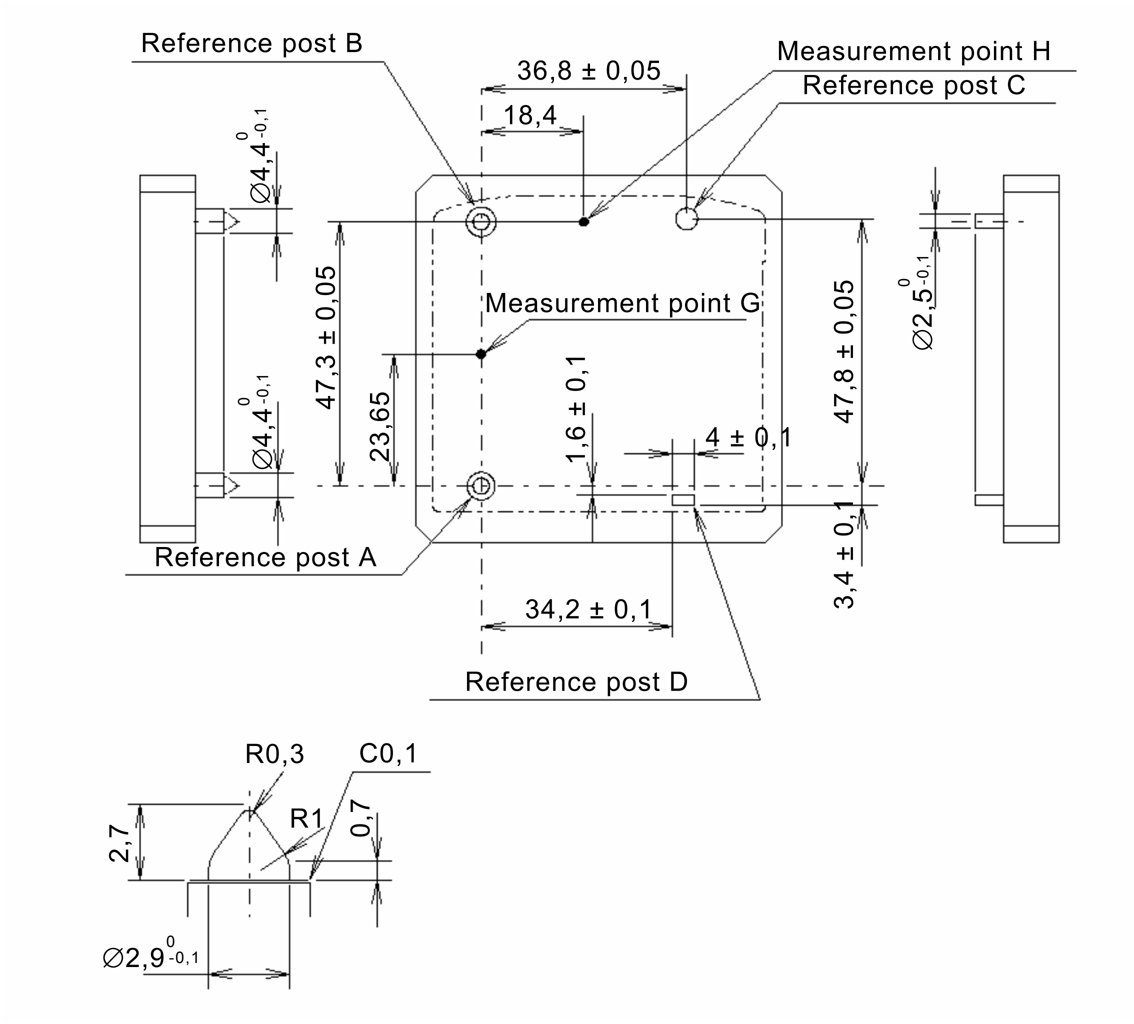
Measurement method of cartridge flatness

The flatness is measured with the standard tool shown in Figure C.1.

Place the cartridge on the standard tool.

Place 4 1 N masses on the cartridge, each at a point corresponding to reference post A, B, C and D, respectively.

Measure the height of the flatness measurement points G, H from the reference plane consisting of the reference posts A, B, C and D.



Reference post A, B

Figure C.1 – Measurement method of cartridge flatness

Annex D
(normative)

Measurement method of cartridge curvature

The curvature is measured with the standard tool shown in Figure D.1.

Insert the cartridge in the normal direction. The cartridge shall pass through the tool smoothly by its gravity.

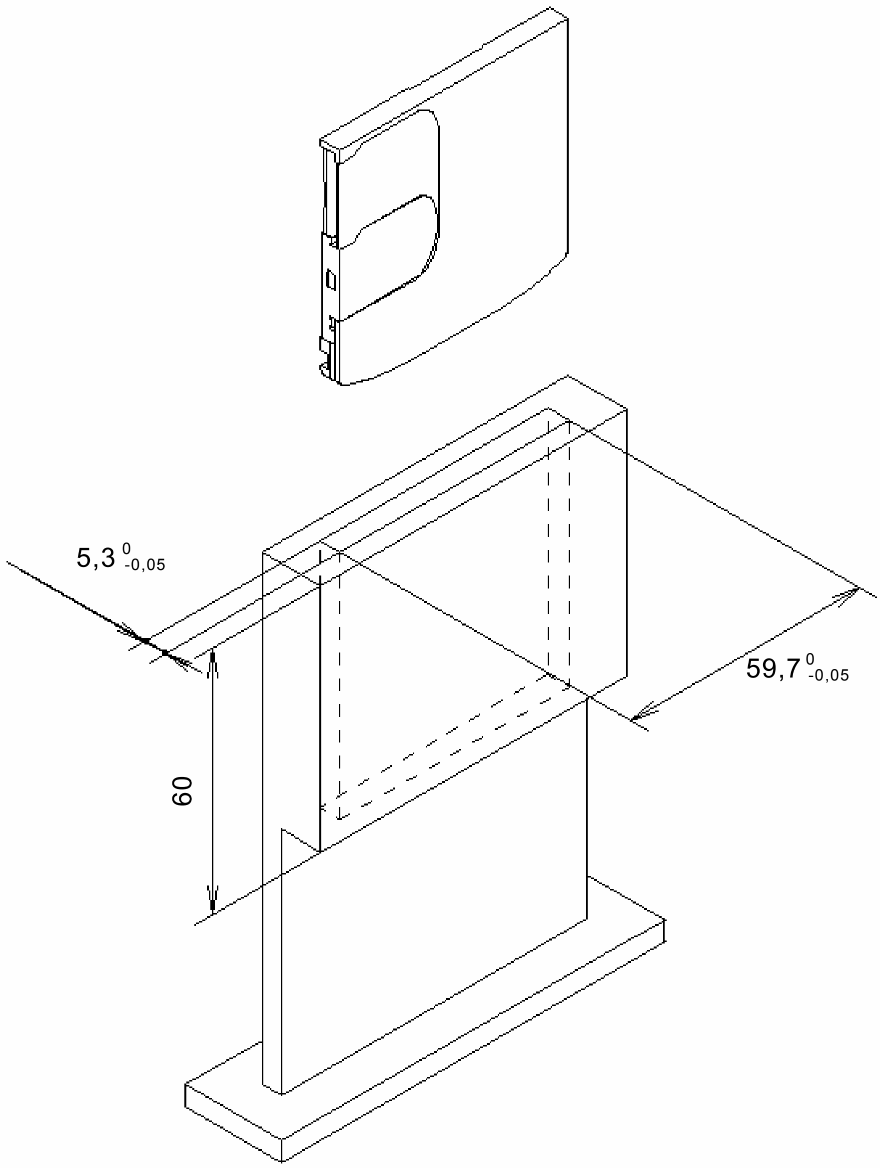


Figure D.1 – Measurement method of cartridge curvature

Annex E
(normative)

Test method for measuring the friction force

The measurement is executed by sensing friction force between a flying type of a testing chip and disc under conditions described below and shown in Figure E.1.

a) Material of testing chip:	$CaTiO_3$ (Vickers hardness 800 ± 50)
b) Shape of testing chip:	Spherical base
c) Air bearing surface roughness of testing chip:	< 5 nm
d) Mass of testing chip:	< 50 mg
e) Head loading force:	5 mN ± 1 mN
f) Minimum flying height:	4 µm (at load point under the condition of linear velocity 5,0 m/s)
g) Single rail structure	
h) Orientation of mounted testing chip	
Pitch angle:	0,8 ° ± 0,4 °
Roll angle:	± 0,5 °
Load point:	A load point is described by arrow A in Figure E.2
i) Cut-off frequency of strain gauge:	250 Hz ± 50 Hz
j) Linear velocity:	4,8 m/s
k) Air cleanness:	Class 100 000 (see Annex A)
l) Test cycle:	Contact Start-Stop cycle defined in Figure E.3

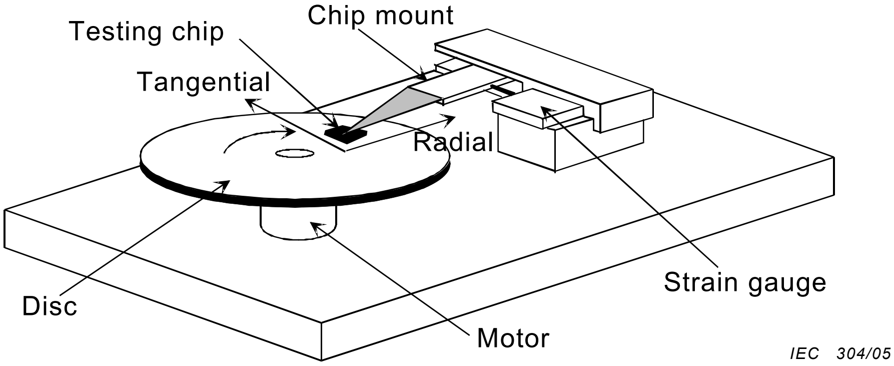
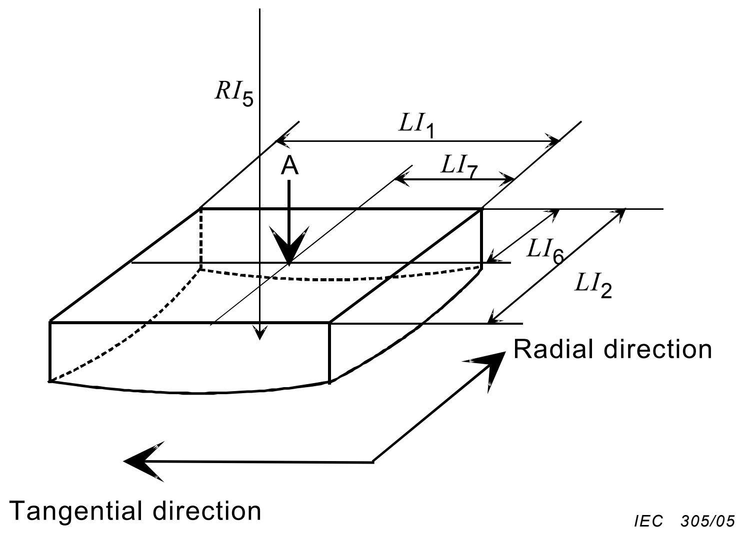


Figure E.1 – Arrangement of testing chip and disc for the measurement of friction force



The dimensions of the testing chip are

LI_1 = 3,20 mm ± 0,05 mm

LI_2 = 2,60 mm ± 0,05 mm

RI_5 = 1 000 mm ± 100 mm

LI_6 = 1,3 mm ± 0,1 mm

LI_7 = 1,7 mm ± 0,1 mm

Figure E.2 – Shape of testing chip

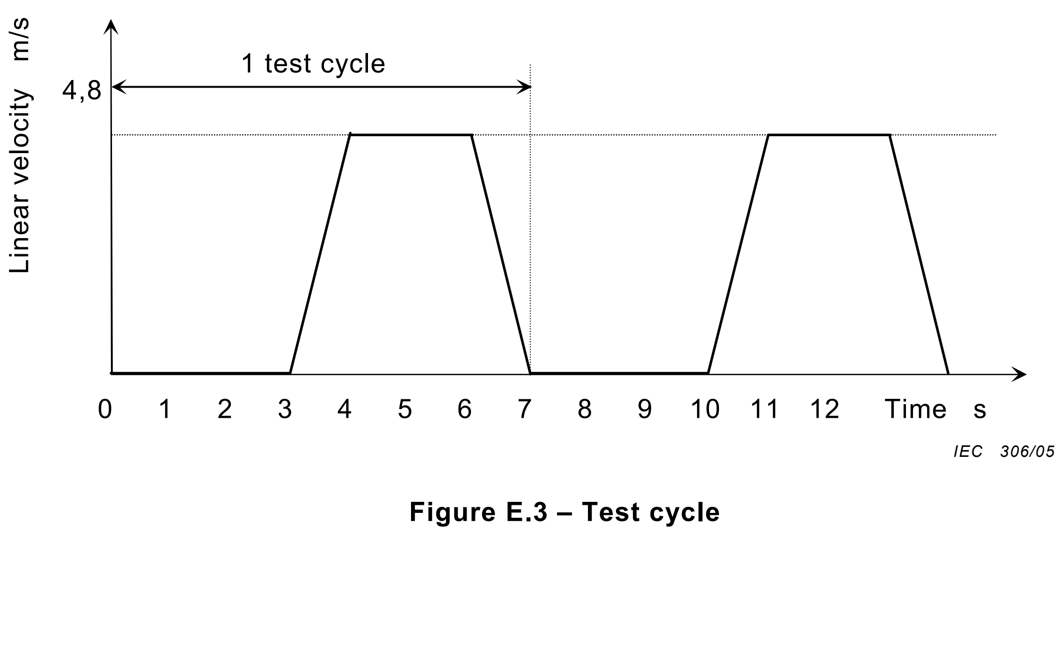


Figure E.3 – Test cycle

Annex F
(normative)

Format of the Data field

F.1 Contents of the Data field

The data that is recorded in the Data field is generated according to the process flow unit which is called Data unit 1, Data unit 2 and Data unit 3.

Data unit 1 consists of 12 bytes of the header, 2 048 bytes of Main Data and 4 bytes of EDC (Error Detection Code). The header of the data field consists of 4 bytes of Data ID, 2 bytes of IEC (ID Error Detection) and 6 bytes of reserved data.

After EDC calculation, EDC is attached to the header and the scrambled 2 048 bytes of Main Data.

The cross Reed-Solomon error correction code over 16 Data unit 1s is encoded. Data unit 2 is a unit after interleaving 16 rows of PO.

Data unit 3 is a unit after the modulation by NRZI Plus conversion from Data unit 2.

Figures F.1 and F.2 show the processing flow to generate each Data unit and the details are described in F.1.1.

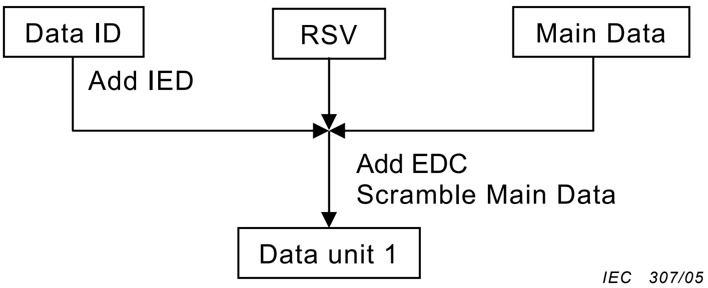


Figure F.1 – Processing flow to generate Data unit 1

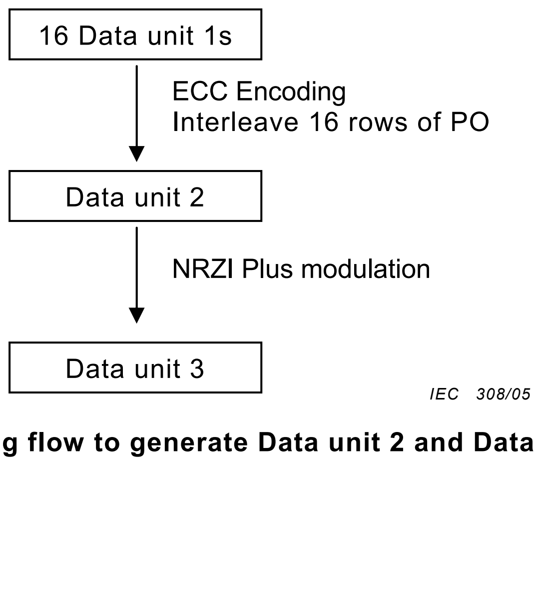
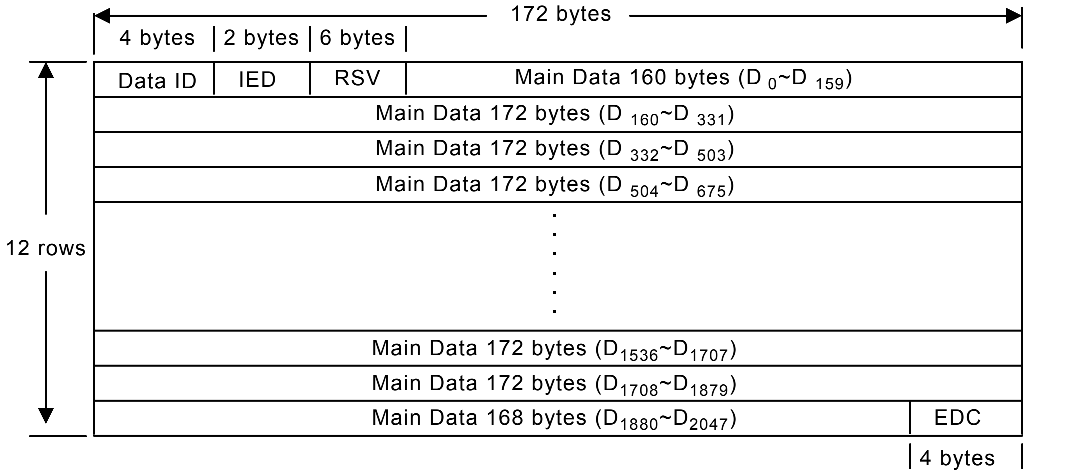


Figure F.2 – Processing flow to generate Data unit 2 and Data unit 3

F.1.1 Data unit1 configuration

As shown in Figure F.3, Data unit1 consists of 2 064 bytes, i.e. 172 bytes × 12 rows including the Main Data of 2 048 bytes.

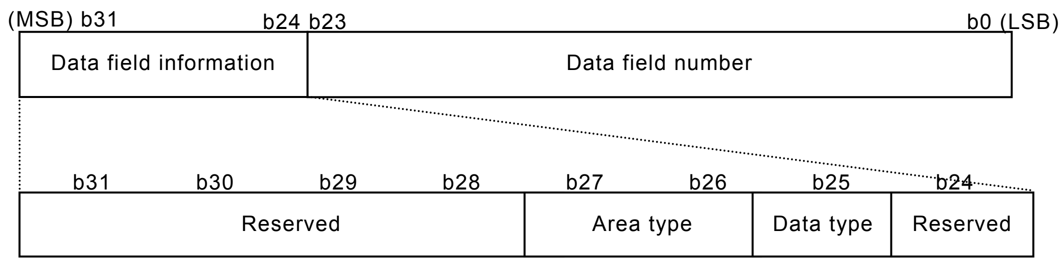


IEC 309/05

Figure F.3 – Data unit 1 configuration

F.1.2 Data ID

This consists of 4 bytes with the first byte (b31 to b24) comprising data field information and 3 bytes (b23 to b0) comprising a data field number.



IEC 310/05

Figure F.4 – Data ID information

Data field information

Area type	00b:	Data Zone
	01b:	Lead-in Zone
	10b:	Lead-out Zone
Data type	0b:	Read only data
	1b:	Rewritable data
Reserved	0b	

Data field number

The data field number of each frame in the user area, except for unused frames in the spare area, in other words, the data field number of the frames utilized, as user data field shall be greater than, or equal to, 310000h. The least significant 4 bits, that is b3 to b0, shall be a cyclic incremental number beginning from 0000b. In practice each ECC block shall consist of frames which have the following restriction. The least significant 4 bits in the data field number of the first frame composed of each ECC block shall be 0000b and the 4 bits of the consecutive frames shall be increased by one.

The 4 bits in the last frame of each ECC block shall be 1111b.

The rest of the data field that is 20 bits from b23 to b4 has no restriction if the data field itself is greater than, or equal to, 310000h.

The data field number of areas except for the user area (see Figure 22) and unused frames in the spare area shall be less than 310000h.

The least significant 4 bits, that is b3 to b0, shall be a cyclic incremental number beginning from 0000b. In practice, each ECC block shall consist of frames which have the following restriction. The least significant 4 bits in the data field number of the first frame composed of each ECC block shall be 0000b and the 4 bits of the consecutive frames shall be increased by one.

The 4 bits in the last frame of each ECC block shall be 1111b.

The rest of the data field that is 20 bits from b23 to b4 have no restriction if the data field itself is less than 310000h. The number 0h is acceptable.

NOTE If the boundary of each ECC block is physically changed by slipping replacement, the data field number should be modified.

F.1.3 Data ID Error Detection code (IED)

In Figure F.3, suppose each byte allocated in the matrix is $C_{i,j}$ (i = 0 to 11, j = 0 to 171) then each byte for IED: $C_{0,j}$ (j = 4 to 5) is as follows:

$$\begin{aligned} \mathrm{IED}(X) &= \sum_{j=4}^{5} C_{0,j} \bullet X^{5-j} \\ &= \left\{ \mathrm{I}(X) \bullet X^{2} \right\} \bmod \left\{ G_{\mathrm{E}}(X) \right\} \end{aligned}$$

where

$$I(X) = \sum_{j=0}^{3} C_{0,j} \bullet X^{3-j}$$

$$G_{\mathrm{E}}(X) = \prod_{k=0}^{1} \left(X + \alpha^{k} \right)$$

α represents the primitive root of the primitive polynomial;

$$\mathrm{P}(x) = x^{8} + x^{4} + x^{3} + x^{1} + 1$$

F.1.4 Reserve (RSV)

Six reservation bytes which are constantly set at ‘0’.

F.1.5 Error Detection Code (EDC)

This is 4-byte check code attached to 2 060 bytes in Data unit1 before scrambling.

In Figure F.3, suppose the MSB of the first byte of Data ID is b_{16511} and the LSB of the last byte of EDC is b_0, then each bit b_i (i = 31 to 0) for EDC is as follows:

$$\mathrm{EDC}(x) = \sum_{j=31}^{0} b_i x^i$$

$$= I(x) \bmod \{g(x)\}$$

where

$$I(x) = \sum_{i=16511}^{32} b_i x^i$$

$$g(x) = x^{32} + x^{31} + x^4 + 1$$

F.1.6 Scrambling of Main Data

The scramble data generation circuit is shown in Figure F.5. The circuit consists of a feedback bit shift resister in which bits r_7(MSB) to r_0(LSB) are used as a scramble data at each 8-bit shift.

The initial preset number in the table is equivalent to 4 bits of Data ID b_7 to b_4, in which b_7 is MSB and b_4 is LSB.

At the beginning of each data field, the initial value is preset to r_{14} to r_0 by the corresponding Data ID. Refer to Table F.1.

The part of initial value r_7 to r_0 is taken out as scramble data S_0. After that, the 8-bit shift is repeated 2 047 times. As a result, scramble data S_1 to $S_{2\,047}$ is taken out of the shift register at each 8-bit shift.

Table F.1 – Initial value of shift register

Initial preset umber	Initial value	Initial preset number	Initial value
(0h)	(0001h)	(8h)	(0010h)
(1h)	(5500h)	(9h)	(5000h)
(2h)	(0002h)	(0Ah)	(0020h)
(3h)	(2A00h)	(0Bh)	(2001h)
(4h)	(0004h)	(0Ch)	(0040h)
(5h)	(5400h)	(0Dh)	(4002h)
(6h)	(0008h)	(0Eh)	(0080h)
(7h)	(2800h)	(0Fh)	(0005h)

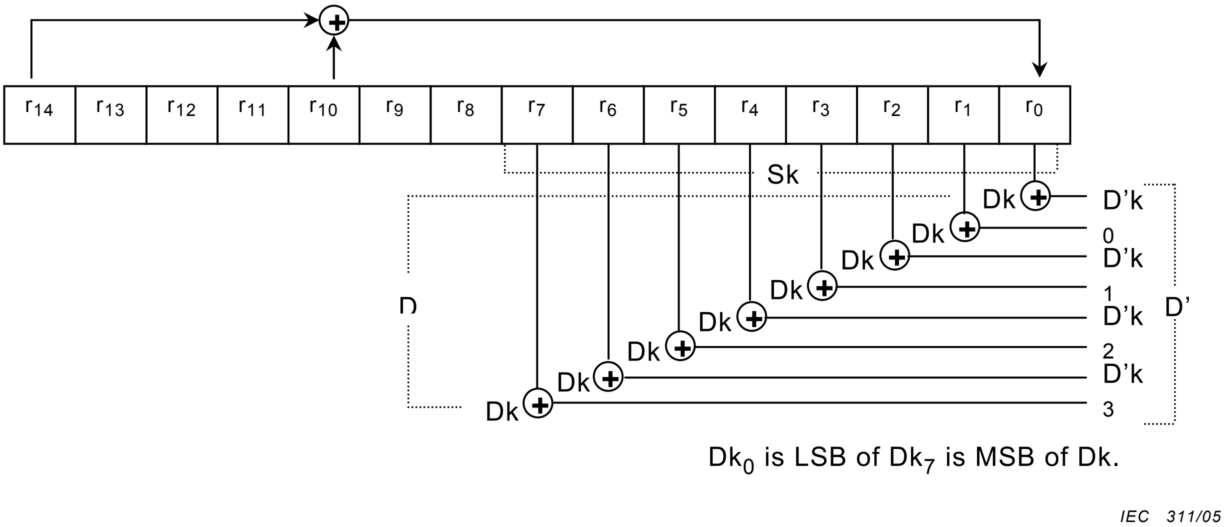


Figure F.5 – Feedback shift register for generation scramble data

The scrambling made for D'k in Figure F.5 is defined as

$$D'k = Dk \oplus Sk \quad (k = 0 \text{ to } 2\,047)$$

$\oplus$ means Exclusive-OR logical operation.

F.1.7 ECC block configuration

The ECC block is formed with the scrambled 16 Data unit1s as an information field as shown in Figure F.6. Suppose 172 bytes × 192 rows equivalent to 172 bytes × 12 rows × 16 Data unit1s is the information field, attach 16 bytes of the outer parity code (PO) to each column of 172 columns to form the outer code of RS (208,192,17). Next, attach 10 bytes of the inner parity code (PI) to each row of 208 rows which includes the PO to form the inner code of RS (182,172,11).

	172 bytes					PI 10 bytes		
192 rows	B 0, 0	B 0, 1		B 0, 170	B 0, 171	B 0, 172		B 0, 181
	B 1, 0	B 1, 1		B 1, 170	B 1, 171	B 1, 172		B 1, 181
	B 2, 0	B 2, 1		B 2, 170	B 2, 171	B 2, 172		B 2, 181

	B189, 0	B189, 1		B189, 170	B189, 171	B189, 172		B189, 181
	B190, 0	B190, 1		B190, 170	B190, 171	B190, 172		B190, 181
	B191, 0	B191, 1		B191, 170	B191, 171	B191, 172		B191, 181
PO 16 rows	B192, 0	B192, 1		B192, 170	B192, 171	B192, 172		B192, 181
	B193, 0	B193, 1		B193, 170	B193, 171	B193, 172		B193, 181

	B207, 0	B207, 1		B207, 170	B207, 171	B207, 172		B207, 181

IEC 312/05

Figure F.6 – ECC block configuration

To generate PO and PI of Figure F.6, it must be carried out so that codes identical to those from the following procedure should be obtained.

First, in column j (j=0 to 171), attach 16 bytes of $B_{i,j}$ (i= 192 to 207) defined by the following remainder polynomial R_j (X) to form 172 columns of outer code RS (208,192,17)

$$R_j(X) = \sum_{i=192}^{207} B_{i,j} \bullet X^{207-i}$$
$$= \left\{ I_j(X) \bullet X^{16} \right\} \bmod \{G_{PO}(X)\}$$

where

$$I_j(X) = \sum_{i=0}^{191} B_{i,j} \bullet X^{191-i}$$

$$G_{PO}(X) = \prod_{k=0}^{15} \left(X + \alpha^k \right)$$

Next, in row i (i=0 to 207), attach 10 bytes of $B_{i,j}$ (j=172 to 181) defined by the following remainder polynomial $R_i(X)$ to form 208 rows of inner code RS (182,172,11).

$$R_i(X) = \sum_{j=172}^{181} B_{i,j} \bullet X^{181-j}$$
$$= \left\{ I_i(X) \bullet X^{10} \right\} \bmod \{G_{PI}(X)\}$$

where

$$I_i(X) = \sum_{j=0}^{171} B_{i,j} \bullet X^{171-j}$$

$$G_{\mathrm{PI}}(X) = \prod_{k=0}^{9}\left(X+\alpha^{k}\right)$$

α represents the primitive root of the primitive polynomial ;

$$\mathrm{P}(x) = x^8 + x^4 + x^3 + x^1 + 1$$

F.1.8 Data unit2 configuration

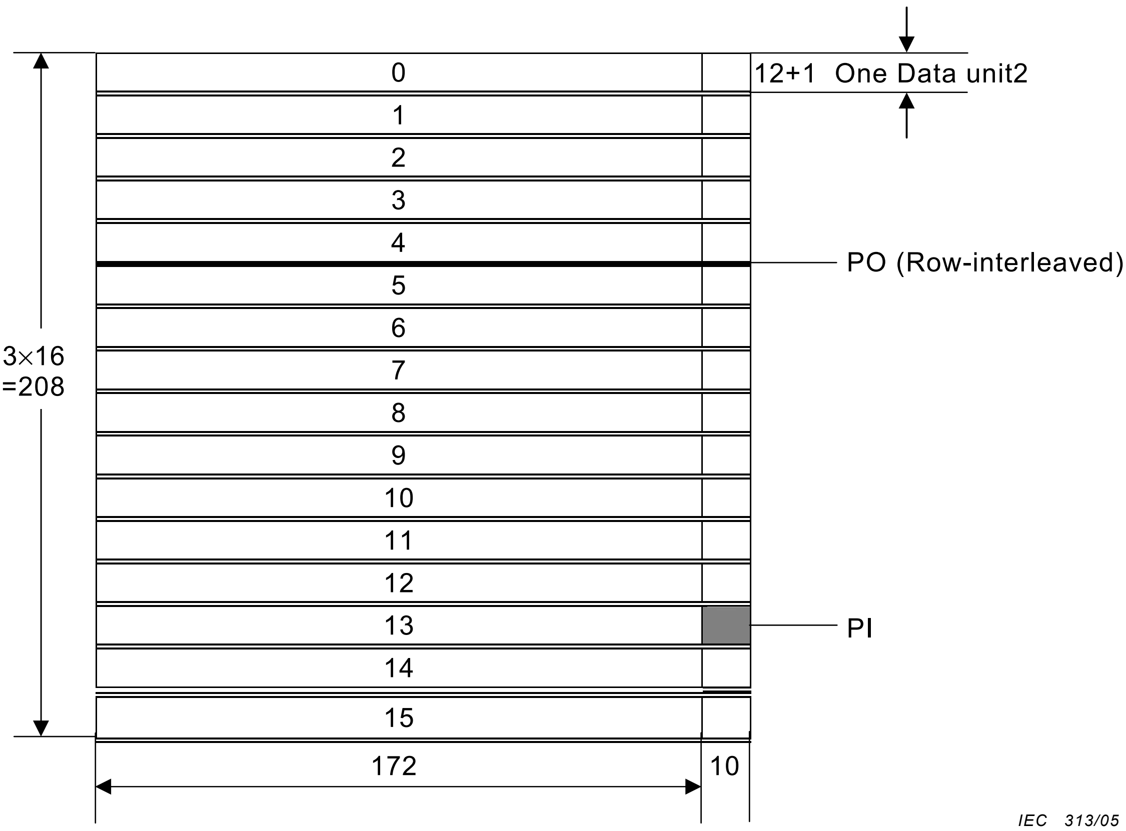
Each of the B matrix element $B_{i,j}$ in Figure F.6 consisting of 208 rows × 182 columns is interleaved in rows such that $B_{i,j}$ is relocated on $B_{m,n}$ by the following formula:

$m = i + \lfloor i/12 \rfloor^{*}$, $n = j$ [when $i \leq 191$]

$m = (i\text{-}191) \times 13\text{-}1$, $n = j$ [when $i \geq 192$]

$^{*}\lfloor \mathrm{P} \rfloor$ represents maximum integer not larger than P.

As a result, the 16 rows of the inner code RS (182,172,11) from 16 parity rows (rows 192 to 207) of the original B matrix are inserted one row at a time after every 12 rows. Refer to Figure F.7



The numbers within the frame represent the Data unit2 numbers in the ECC block

Figure F.7 – ECC block after row interleave

The 13 rows × 182 bytes part within the ECC block after row interleave is referred to as Data unit2. This means that the ECC block after row interleave consists of 16 Data unit2s.

Annex G
(normative)

Contents of Control Tracks

G.1 General description of Control Track

The Outer Control Zone and the Inner Control Zone shall contain information about disc structure and applicable conditions. Both Control Zones shall be recorded using the same address code modulation. The wobbling direction is the same as the primary address (Frame Number and Band Number) of the Address Segment. The layout of the Control Zones shall be as given in Table G.1.

The Control Zones shall have 2 boundary tracks of both inner side and outer side of each zone.

Table G.1 – Layout of the Control Zones

Zone or Band	Nominal Radius Start-End (mm)	Zone Number	Number of Tracks	Track Number Start-End
Outer Control Zone				
Boundary Tracks	23,927 6 to 23,927 0	0	2	477
Control Tracks	23,926 4 to 23,921 0	0	10	478 to 482
Boundary Tracks	23,920 4 to 23,919 8	0	2	483
Lead-out Zone				
Inner Control Zone				
Boundary Tracks	14,674 4 to 14,673 8	13	2	16
Control Tracks	14,673 2 to 14,667 8	13	10	17 to 21
Boundary Tracks	14,667 2 to 14,666 6	13	2	22

G.2 Track format of the Control Zone

On each track of the Outer Control Zone, there shall be 30 frames. And on each track of the Inner Control Zone, there shall be 19 frames. A frame shall comprise 1 Address Segment and 38 Control Segments. Each segment shall have a length of 532 Data Channel bits.

The layout of the track shall be as specified in Figure G.1.

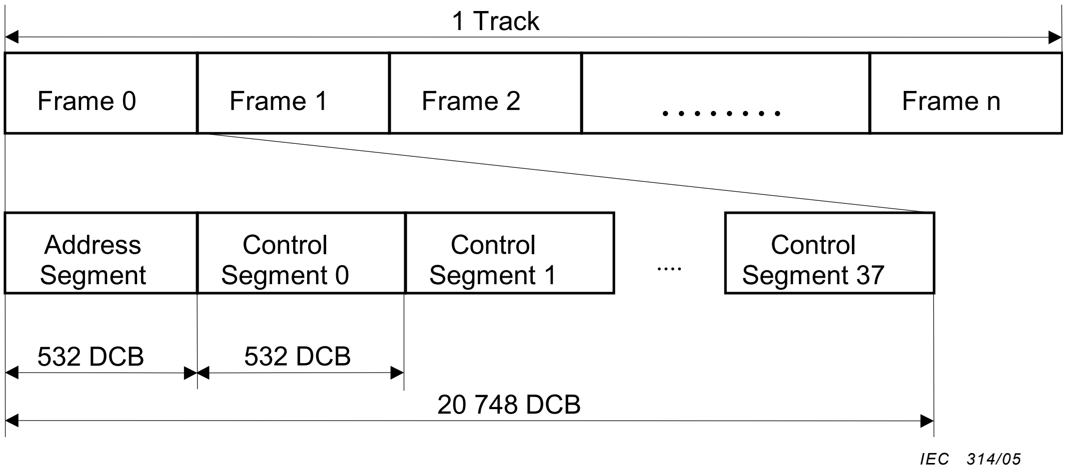


Figure G.1 – Track layout of the Control Zone

G.3 Control Segment

Each Control Segment shall be comprised of a Fine Clock Mark field, a Pre-buffer, a synchronization field, a Control Data field, a Post-amble and Post-buffer. The Synchronization field, the Biphase-Mark modulation rule is violated and the pattern is 01010101010101010111000101000111 (in double rate expression). The post-amble shall be set to 00000.

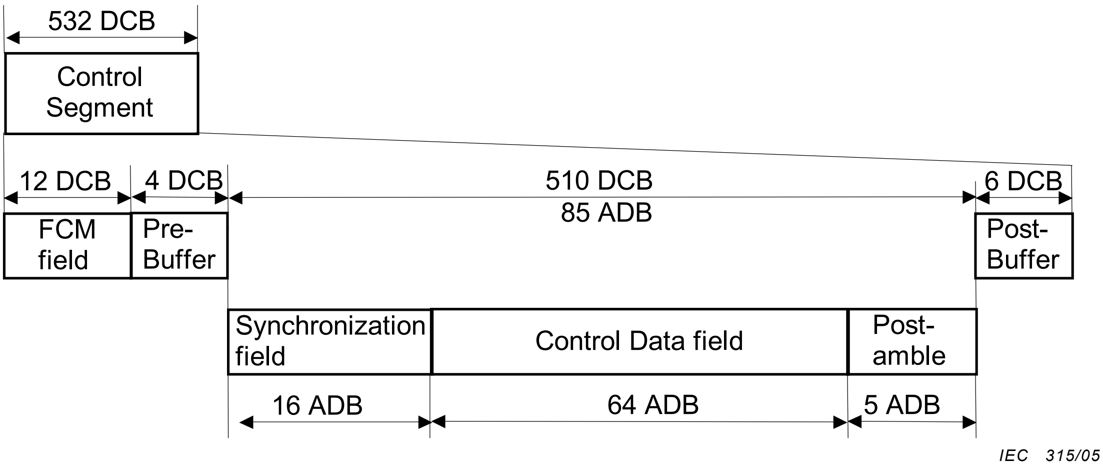
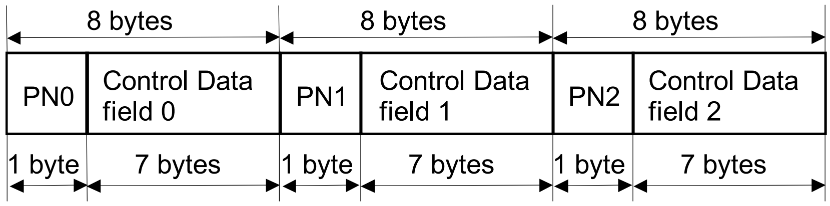


Figure G.2 – Layout of the Control Segment

G.4 Control Data unit

A unit of the control data shall comprise 3 Control Data fields. Thus, there shall be 12 units, a Control Data field 0 and a Control Data field 1 per frame. A Control Data field have the Page Number (PN). The PN is from 0 to 2.



IEC 316/05

Figure G.3 – Unit of the Control Segment

Page Number 0: Media Physical and Format

Byte 0: **Sector format**

0000 1000:32kB sector format

Byte 1 to 3: **Vender Code**

3 bytes code data written by disc manufacture with free format..

Byte 4: **Disc type / Security option**

bits 7 to 6 00: MO full rewritable disc

bits 5 to 4 reserved for security feature

bit 3 bit 3 shall be set to 0.

bit 2 0: Media –ID not available

1: Media –ID available

bits 1 to 0 bits 1 to 0 shall be set to 10.

Byte 5: **Book version / Disc size**

Bits 7 to 4 shall specify the Book version.

0000: Version x.x

Others: reserved

Bits 3 to 0 shall specify the disc size.

0000: 50mm disc

Others: reserved

Byte 6: **Parity of Byte 0 to Byte 6**

Byte 6 shall be set to [00h]+[byte 0]+[byte 1]+[byte 2]+[byte 3]+[byte 4]+[byte 5]

Page Number 1: Read and Write Power Description

Byte 0: Maximum read power

Byte 0 shall specify the maximum read power $P_{r\ max}$, in milliwatts, permitted for reading the disc.

It is specified as a number n such that

$$n = 10 \times P_{r\ max}$$

Byte 0 shall be set to n = 0A, representing a maximum read power of 1,0 mW.

Byte 1: Minimum read power

Byte 1 shall specify the minimum read power $P_{r\ min}$, in milliwatts, permitted for reading the disc.

It is specified as a number n such that

$$n = 10 \times P_{r\ min}$$

Byte 1 shall be set to n = 0A, representing a minimum read power of 1,0 mW.

Byte 2: Maximum write power

Byte 2 shall specify the maximum write power $P_{w\ max}$, in milliwatts, permitted for writing the disc. It is specified as a number n such that

$$n = 10 \times P_{w\ max}$$

Byte 2 shall be set to n = 0A, representing a maximum write power of 1,0 mW.

Byte 3: Minimum write power

Byte 3 shall specify the minimum write power $P_{w\ min}$, in milliwatts, permitted for writing the disc. It is specified as a number n such that

$$n = 10 \times P_{w\ min}$$

Byte 3 shall be set to n = 0A, representing a minimum write power of 1,0 mW.

Byte 4 to 5: Reserved

Byte 4 to 5 shall be set to 00h.

Byte 6: Parity of Byte 0 to Byte 6

Byte 6 shall be set to [00h]+[byte 0]+[byte 1]+[byte 2]+[byte 3]+[byte 4]+[byte 5]

Page Number 2: Vender description

Byte 0 to 5: Vender description (free area).

Text or code data written by disc manufacture with free format.

Byte 6: Parity of Byte 0 to Byte 6

Byte 6 shall be set to [00h]+[byte 0]+[byte 1]+[byte 2]+[byte 3]+[byte 4]+[byte 5]

Annex H
(normative)

Relaxation by zones of the requirement for signals

Table H.1 shows the zones in which the requirements specified in the body of this 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 H.1 – Requirements for signals in each zone

Clause	Signal	Zones								
		Outer buffer	Outer control	Outer buffer	Outer test	Data	Inner test	Inner buffer	Inner control	Inner buffer
11.5.3	Reflectance									
22.1	Cross-track signal									
22.2	Divided push-pull signal									
22.3	Phase depth									
23.1	Wobble signal									
23.2	Imbalance of wobble signal									
24.1	Fine clock mark									
24.2	Timing jitter									
24.3	Radial push-pull on fine clock mark									
26.1	Imbalance of MO signal									
26.2	Resolution									
26.2	SNR									
26.4	Crosstalk signal									
26.5	Overwrite									
26.6	Cross-erase									

Annex I
(informative)

Transportation

I.1 General

As transportation occurs within 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.

I.2 Packaging

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

I.2.1 Temperature and humidity

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

I.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 J
(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.

J.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 disc (see 9.2.4.6 and 9.2.4.8) is a measure for the allowed deviations of the tracks. An additional measure is the allowed tracking error between the focus and track (see 11.1.3.4). The relation between both is given in Figure J.1, where the maximum allowed amplitude of a sinusoidal track deviation is given as function of the frequency of the deviation. It is assumed in the figure that there is only one sinusoidal deviation present at a time.

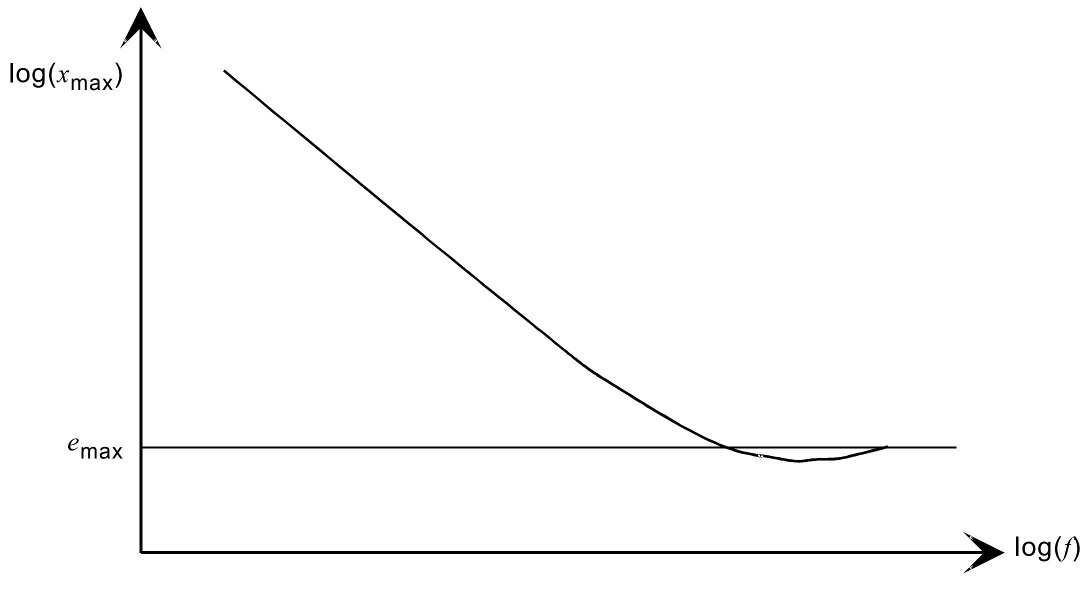


Figure J.1 – Maximum allowed amplitude of a sinusoidal track deviation

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

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

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

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

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

J.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 J.1. The open-loop transfer function of the Reference Servo shall be

$$H_S(i\omega) = \frac{1}{c} \times \left(\frac{\omega_0}{i\omega}\right)^2 \times \frac{1 + \frac{i\omega_c}{\omega_0}}{1 + \frac{i\omega}{c\omega_0}} \tag{J.3}$$

where $i = \sqrt{-1}$, $\omega = 2\pi f$ and $\omega_0 = 2\pi f_0$, with f_0 the 0 dB frequency of the open-loop transfer function. The constant c gives the crossover 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

$$\frac{e}{x} = \frac{1}{1 + H_S} \tag{J.4}$$

If the 0 dB frequency is specified as

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

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 J.1 is given by

$$x_{max} = e_{max} \left|1 + H_S\right| \tag{J.6}$$

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

$$a_{max}(\text{motor}) = e_{max}\omega^2 \left|1 + H_S\right| \tag{J.7}$$

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

At low frequencies ($f \le f_0/c$) applies.

Hence, it is permitted to use a_{max}(motor) as specified for low frequencies in 9.2.4.6 and 9.2.4.8 for the calculation of ω_0 of a reference servo.

J.3 Requirement for track deviations

The track deviations shall be such that, when tracking with a Reference Servo on a disc 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 (J.3) within an accuracy such that $|1+H|$ 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 (J.5), where a_{max} and e_{max} for axial and radial tracking are specified in 11.1.3.4, 9.2.4.6 and 9.2.4.8.

J.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 (J.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 Clause J.3.

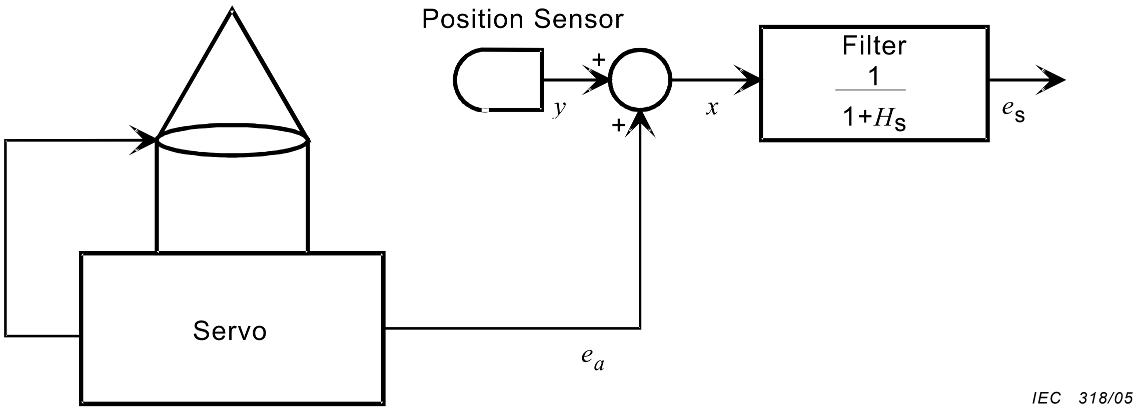


Figure J.2 – Implementation of a Reference Servo by filtering the track position signal with the reduction characteristics of the Reference Servo

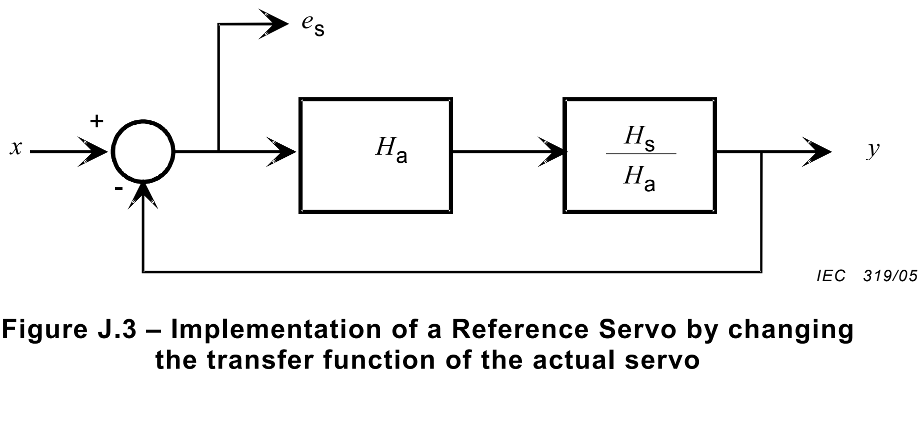


Figure J.3 – Implementation of a Reference Servo by changing the transfer function of the actual servo

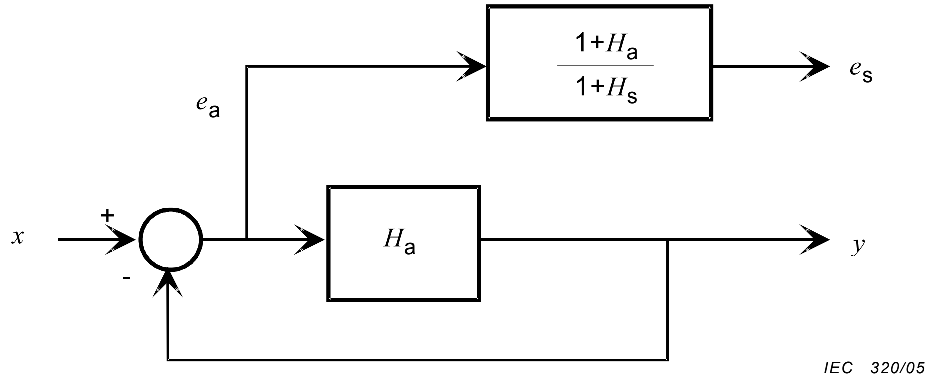


Figure J.4 – Implementation of a Reference Servo by changing the tracking error of the actual servo

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 J.2 is used in the low-frequency channel, while that of Figures J.3 or J.4 is used in the high-frequency channel. The signals from both channels are added with a reversed crossover filter to get the required tracking error. In the low-frequency channel, one can also use the current through the motor as a measure of the acceleration of the motor, provided the latter is free from hysterics. The current must be corrected for the transfer function of the motor and then be converted to a tracking error with a filter with a transfer function $e/a = e/(x\omega^2)$, derived from equation (J.4).

Annex K
(informative)

Digital still camera image file format standard – Exif

Exif Standard: JEITA JEIDA-49-1998, Digital still camera image file format standard version 2.1. Japan Electronics and Information Technology Industries Association (JEITA) 1998

The document JEIDA/Electronic Still Camera Working Group, "Digital Still Camera Image File Format (Exchangeable image file format for Digital Still Camera: Exif)", Version 2.1 (Dec. 1998) is an informative part of this annex and contains further definition of the Exif format described in Clause 14. Those choosing to support Exif should implement this annex.

Annex L
(informative)

Design Rule for Camera File System – DCF

DCF Standard: JEITA JEIDA-49-2-1998, Design Rule for Camera File System. Japan Electronics and Information Technology Industries Association (JEITA) 1998

The document JEIDA/Electronic Still Camera Working Group, “Design Rule for Camera File System”, Version 1.0 (Dec. 1998) is an informative part of this annex and contains further definition of the DCF format described in Clause 14. Those choosing to support DCF should implement this annex.

Annex M
(informative)

Movie file format – QuickTime

QuickTime movie file specification: 1996, QuickTime Movie File Format Specification 1996 Apple Computer Inc. (Reference URL http://www.apple.com/quicktime/resources /qtfileformat.pdf) is an informative part of this annex and contains further definition of the movie file format described in Clause 14. Those choosing to support movie file should implement this annex.

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