
**Information technology — 120 mm
(4,7 Gbytes per side) and 80 mm
(1,46 Gbytes per side) DVD rewritable
disk (DVD-RAM)**

*Technologies de l'information — Disque DVD réenregistrable
(DVD-RAM) de 120 mm (4,7 Go par face) et 80 mm (1,46 Go par face)*

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Foreword

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International Standards are drafted in accordance with the rules given in the ISO/IEC Directives, Part 2.

The main task of the joint technical committee is to prepare International Standards. Draft International Standards adopted by the joint technical committee are circulated to national bodies for voting. Publication as an International Standard requires approval by at least 75 % of the national bodies casting a vote.

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ISO/IEC 17592 was prepared by Ecma International (as ECMA-330) and was adopted, under a special “fast-track procedure”, by Joint Technical Committee ISO/IEC JTC 1, *Information technology*, in parallel with its approval by national bodies of ISO and IEC.

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Information technology — 120 mm (4,7 Gbytes per side) and 80 mm (1,46 Gbytes per side) DVD rewritable disk (DVD-RAM)

Section 1 - General

1 Scope

This International Standard specifies the mechanical, physical and optical characteristics of an optical disk, identified as DVD Rewritable Disk (DVD-RAM), to enable interchange of such disks. It specifies the quality of the recorded signals, the format of the data and the recording method, thereby allowing for information interchange by means of such disks. The data can be written, read and overwritten many times using the phase change method. Two Types are specified that differ only by their diameter of 120 mm and 80 mm, and the resulting difference of capacity.

This International Standard specifies

- two related but different Types of this disk (see clause 7),
- the conditions for conformance,
- the environments in which the disk is to be tested, operated and stored,
- the mechanical, physical and dimensional characteristics of the disk, so as to provide mechanical interchange between data processing systems,
- the format of the information on the disk, including the physical disposition of the tracks and sectors, the error correcting codes and the coding method,
- the characteristics of the signals recorded on the disk, thus enabling data processing systems to read the data from the disk.

This International Standard provides for the interchange of disks between optical disk drives. Together with a standard for volume and file structure, it provides for full data interchange between data processing systems. The optical disks specified by this International Standard may be enclosed in cases according to ISO/IEC 17594 as specified therein.

2 Conformance

2.1 Optical Disk

A claim of conformance with this International Standard shall specify the Type implemented. An optical disk shall be in conformance with this International Standard if it meets all mandatory requirements specified for this Type.

2.2 Generating system

A generating system shall be in conformance with this International Standard if the optical disk it generates is in accordance with 2.1.

2.3 Receiving system

A receiving system shall be in conformance with this International Standard if it is able to handle both Types of optical disk according to 2.1.

3 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.

ISO/IEC 10646-1:2000, *Information technology — Universal Multiple-Octet Coded Character Set (UCS) — Part 1: Architecture and Basic Multilingual Plane*

ISO/IEC 17594:2004, *Information technology — Cases for 120 mm and 80 mm DVD-RAM disks*

ECMA-287:2002, *Safety of electronic equipment*

4 Terms and definitions

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

4.1

Case

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

4.2

Channel bit

The elements by which the binary values ZERO and ONE are represented by marks and pits on the disk.

4.3

Digital Sum Value (DSV)

The arithmetic sum obtained from a bit stream by allocating the decimal value 1 to Channel bits set to ONE and the decimal value -1 to Channel bits set to ZERO.

4.4

Disk Reference Plane

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

4.5

Dummy substrate

A layer which may be transparent or not, provided for the mechanical support of the disk and/or a recording layer.

4.6

Embossed mark

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

4.7

Entrance surface

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

4.8

Land and Groove

A trench-like feature of the disk, applied before the recording of any information, and used to define the track location. The groove is located nearer to the entrance surface than the land. The recording is made either on the centre of the groove or on the centre of the land.

4.9**Mark**

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

4.10**Phase change**

A physical effect by which the area of a recording layer irradiated by a laser beam is heated so as to change from an amorphous state to a crystalline state and vice versa.

4.11**Polarization**

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

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

4.12**Recording layer**

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

4.13**Sector**

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

4.14**Space**

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

4.15**Substrate**

A transparent layer of the disk, provided for mechanical support of the recorded layer(s), through which the optical beam can access a recording layer.

4.16**Track**

A 360° turn of a continuous spiral.

4.17**Track pitch**

The distance between centrelines of adjacent tracks (a groove and a land), measured in a radial direction.

4.18**ZCLV**

A disk format requiring Zoned Constant Linear Velocity operations.

4.19**Zone**

An annular area of the disk.

5 Conventions and notations

5.1 Representation of numbers

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

Numbers in decimal notations are represented by the digits 0 to 9.

Numbers in hexadecimal notation are represented by the hexadecimal digits 0 to 9 and A to F in parentheses.

The setting of bits is denoted by ZERO and ONE.

Numbers in binary notations and bit patterns are represented by strings of digits 0 and 1, with the most significant bit shown to the left.

Negative values of numbers in binary notation are given as Two's complement.

In each field the data is recorded so that the most significant byte (MSB), identified as Byte 0, is recorded first and the least significant byte (LSB) last.

In a field of $8n$ bits, bit $b_{(8n-1)}$ shall be the most significant bit (msb) and bit b_0 the least significant bit (lsb). Bit $b_{(8n-1)}$ is recorded first.

A binary digit which can be set indifferently to ZERO or to ONE is represented by "x".

5.2 Names

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

6 List of acronyms

AM	Address Mark	MSB	Most Significant Byte
BCA	Burst Cutting Area	NRZ	Non Return to Zero
BPF	Band Pass Filter	NRZI	Non Return to Zero Inverted
DCC	DC Component Suppress Control	PA	Postamble
DDS	Disk Definition Structure	PDL	Primary Defect List
DMA	Defect Management Area	PED	P(ID) Error Detection code
DSV	Digital Sum Value	PI	Parity of Inner-code
ECC	Error Correcting Code	PID	Physical Identification Data
EDC	Error Detection Code	PLL	Phase-Locked Loop
HF	High Frequency	PO	Parity of Outer-Code
ID	Identification Data	PS	Pre-Synchronous Code
IED	ID Error Detection Code	RS	Reed-Solomon Code
LPF	Low Pass Filter	SDL	Secondary Defect List
lsb	least significant bit	SLR	Status of Linear Replacement
LSB	Least Significant Byte	SYNC Code	Synchronous Code
LSN	Logical Sector Number	VFO	Variable Frequency Oscillator
msb	most significant bit	ZCLV	Zoned Constant Linear Velocity

7 General description of the optical disk

The optical disk that is the subject of this International Standard consists of two substrates bonded together by an adhesive layer, so that the recording layer(s) is on the inside. The centring of the disk is performed on the edge of the centre hole of the assembled disk on the side currently read. Clamping is performed in the Clamping Zone. The area of the inner diameter of the Clamping Zone to the outer diameter of the Lead-out Zone shall be glued.

The two Types of disk specified by this International Standard are

Type 1S consists of a substrate, a single recording layer and a dummy substrate. The recording layer can be accessed from one side only. The nominal capacity is 4,7 Gbytes for a 120 mm disk and 1,46 Gbytes for an 80 mm disk.

Type 2S consists of two substrates and two recording layers. From one side of the disk, only one of these recording layers can be accessed. The nominal capacity is 9,4 Gbytes for a 120 mm disk and 2,92 Gbytes for an 80 mm disk.

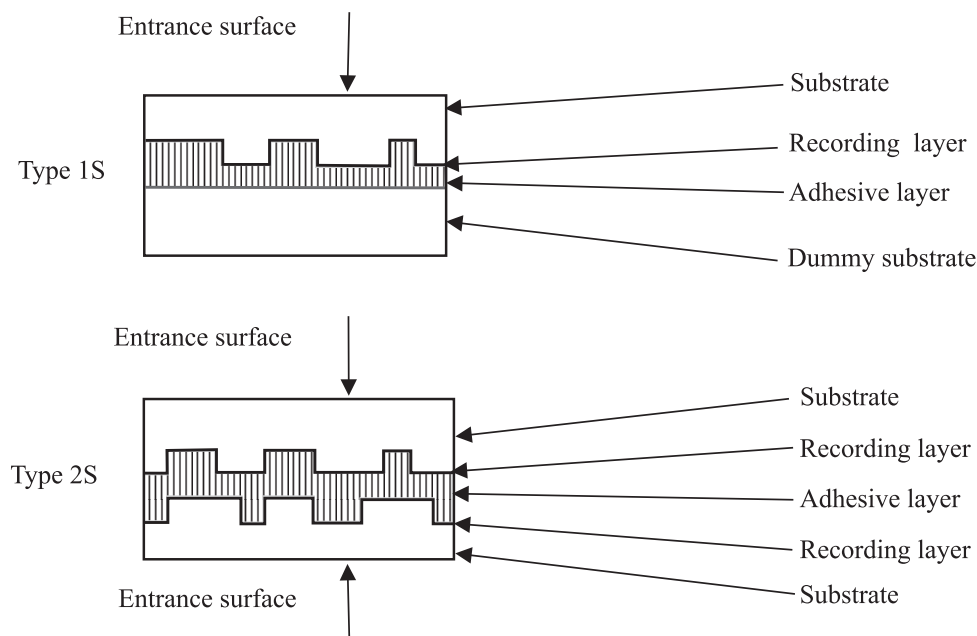
In Type 1S, the recording layer may also be placed, for instance embossed, on the dummy substrate.

When used with the cases specified in ISO/IEC 17594, a 120 mm disk of Type 1S may be enclosed in either a Type 1, a Type 2, a Type 3 or a Type 5 case; a 120 mm disk of Type 2S may be enclosed in either a Type 1, a Type 3, a Type 4 or a Type 5 case; an 80 mm disk of Type 1S may be enclosed in either a Type 7 or a Type 9 case; an 80 mm disk of Type 2S may be enclosed in either a Type 6 or a Type 8 case.

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

Part of the disk contains read-only data for the drive in the form of pits embossed by the manufacturer. This data can be read using the diffraction of the optical beam by the embossed pits.

Figure 1 shows schematically the two Types.



97-0122-A

Figure 1 – The two Types of DVD-RAM disks

8 General requirements

8.1 Environments

8.1.1 Test environment

In the test environment, the air immediately surrounding the disk shall have the following properties.

Temperature:	23 °C ± 2 °C
Relative humidity:	50 % ± 5 %
Atmospheric pressure:	86 kPa to 106 kPa

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

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

8.1.2 Operating environment

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

The operating environment is the environment where the air immediately surrounding the disk has the following properties.

Temperature:	5 °C to 60 °C
Relative humidity:	3 % to 85 %
Absolute humidity:	1 g/m ³ to 30 g/m ³
Temperature gradient:	10 °C/h max.
Relative humidity gradient:	10 %/h max.

No condensation on the disk shall occur. If the disk has been exposed to conditions outside those specified above, it shall be acclimatized in the operating environment for at least 2 h before use.

8.1.3 Storage environment

The storage environment is defined as an environment where the air immediately surrounding the disk shall have the following properties.

Temperature:	-10 °C to 50 °C
Relative humidity:	3 % to 85 %
Absolute humidity:	1 g/m ³ to 30 g/m ³
Atmospheric pressure:	75 kPa to 106 kPa
Temperature gradient:	10 °C/h max.
Relative humidity gradient:	10 %/h max.

No condensation on the disk shall occur.

8.1.4 Transportation

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

8.2 Safety requirement

The optical disk shall satisfy the safety requirements of Standard ECMA-287. The cartridge and its components shall not constitute any safety or health hazard when used in the intended manner or in any foreseeable use in an information processing system.

8.3 Flammability

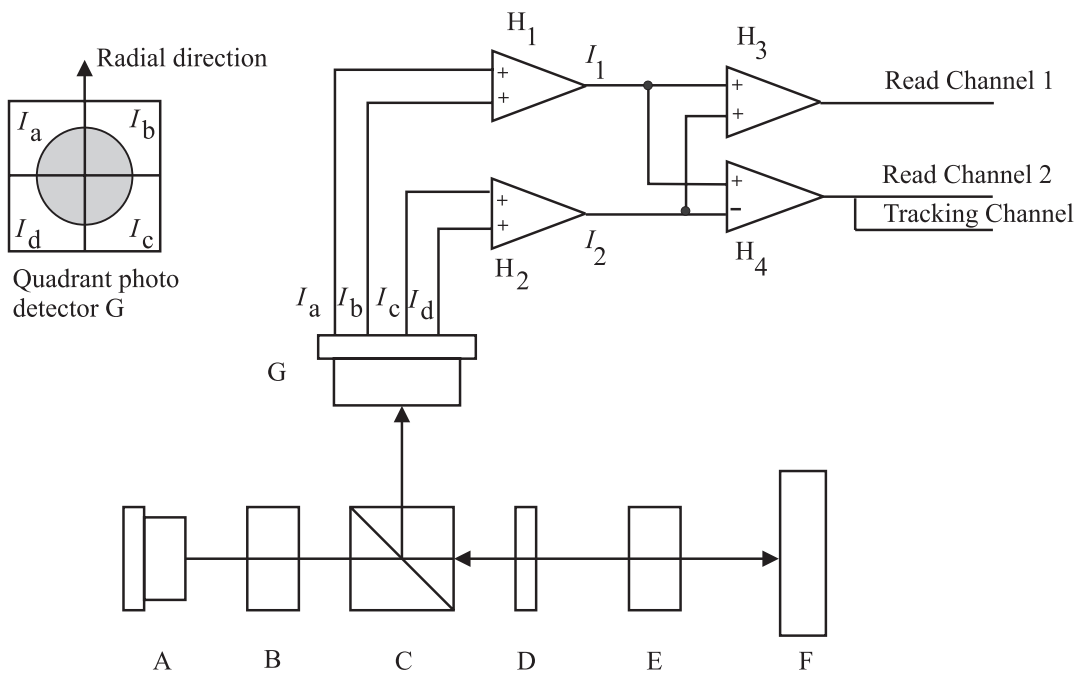
The disk shall be made from materials that, if ignited from a match flame, do not continue to burn in a still carbon dioxide atmosphere.

9 Reference Drive

The Reference Drive shall be used for the measurement of optical parameters for conformance with the requirements of this International Standard. The critical components of this device have the characteristics specified in this clause.

9.1 Optical Head

The basic set-up of the optical system of the Reference Drive used for measuring the overwrite and read parameters are shown in figure 2. Different components and locations of components are permitted, provided that the performance remains the same as that of the set-up in figure 2. The optical system shall be such that the detected light reflected from the entrance surface of the disk is minimized so as not to influence the accuracy of the measurements.



97-0123-A

A	Laser diode	F	Optical disk
B	Collimator lens	G	Quadrant photo detector
C	Polarizing beam splitter	H ₁ , H ₂ , H ₃ , H ₄	d.c.-coupled amplifier
D	Quarter-wave plate	I _a , I _b , I _c , I _d	Output currents from the quadrant photo detector
E	Objective lens		

Figure 2 - Optical system of the Reference Drive

The combination of polarizing beam splitter C and a quarter-wave plate D shall separate the entrance optical beam from a laser diode A and the reflected optical beam from an optical disk F. The beam splitter C shall have a p-s intensity reflectance ratio of at least 100.

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

Wavelength (λ)	650 nm
	+10 nm
	-5 nm
Polarization	circularly polarized light

Polarizing beam splitter	shall be used unless otherwise stated.
Numerical aperture	$0,60 \pm 0,01$
Light intensity at the rim of the pupil of the objective lens	30 % to 55 % of the maximum intensity level in the radial direction at least 50 % of the maximum intensity level in the tangential direction
Wave front aberration after passing through an ideal substrate of the single layer disk (Thickness: 0.6mm and index refraction: 1.56)	$0,033 \lambda$ rms max.
Relative Intensity Noise (RIN) of the laser diode $10 \log [(a.c. \text{ power density/Hz}) / d.c. \text{ light power}]$	-134 dB/Hz max.

9.2 Read channels

A Read channel 1 shall detect the total amount of light in the exit pupil of the objective lens.

A Read channel 2 shall detect the differential output of the quadrant photo detectors.

Frequency characteristics of the equalizer, characteristics of the PLL, slicer etc. are specified in annex F.

9.3 Rotation speed

The actual rotation speed shall be within 1 % of the nominal rotation speed(s) specified in tables 3 and 4.

9.4 Disk clamping

Clamping force: $2,0 \text{ N} \pm 0,5 \text{ N}$

Tapered cone angle: $40,0^\circ \pm 0,5^\circ$ (see annex E)

9.5 Normalized servo transfer function

In order to specify the servo system for axial and radial tracking, a function H_s is used (equation I). It specifies the nominal values of the open-loop transfer function H of the Reference Servo(s) in the frequency range 31,2 Hz to 10 kHz.

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

where

$$\omega = 2\pi f$$

$$\omega_0 = 2\pi f_0$$

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

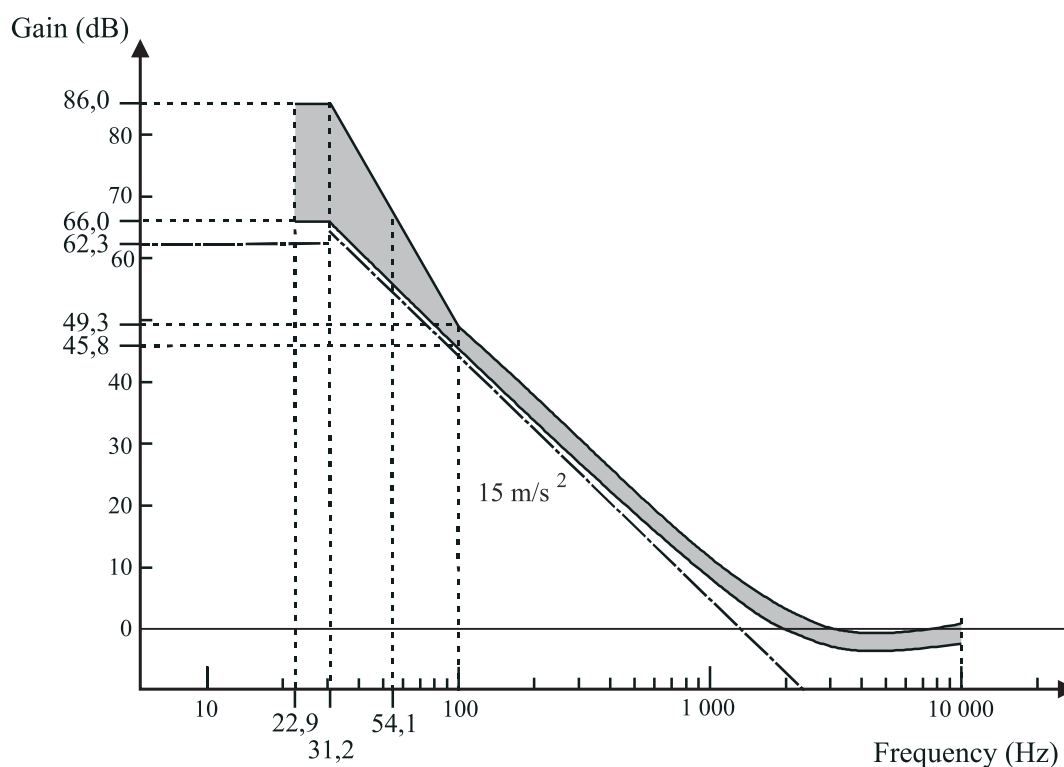
f_0 is the 0 dB crossover frequency of the open loop transfer function. The crossover frequencies of the lead-lag network of the servo are given by

$$\text{lead break frequency} \quad f_1 = f_0 \times 1/3$$

$$\text{lag break frequency} \quad f_2 = f_0 \times 3.$$

9.6 Reference Servo for axial tracking

For an open loop transfer function H of the Reference Servo for axial tracking, $|1+H|$ is limited as schematically shown by the shaded surface of figure 3.



01-0010-A

Figure 3 - Reference Servo for axial tracking

Bandwidth 100 Hz to 10 kHz

$|1 + H|$ shall be within 20 % of $|1 + H_s|$.

The crossover frequency $f_o = \omega_o / 2\pi$ shall be specified by equation (II), where $\alpha_{\max}$ shall be 1,5 times larger than the expected maximum axial acceleration of 15 m/s^2 . The tracking error $e_{\max}$ shall not exceed $0,23 \text{ }\mu\text{m}$. Thus the crossover frequency f_o shall be

$$f_o = \frac{1}{2\pi} \sqrt{\frac{3\alpha_{\max}}{e_{\max}}} = \frac{1}{2\pi} \sqrt{\frac{15 \times 1,5 \times 3}{0,23 \times 10^{-6}}} = 2,7 \text{ kHz} . \quad (\text{II})$$

The axial tracking error $e_{\max}$ is the peak deviation measured axially above or below the 0 level.

Bandwidth 31,2 Hz to 100 Hz

$|1 + H|$ shall be within the limits defined by the following four points.

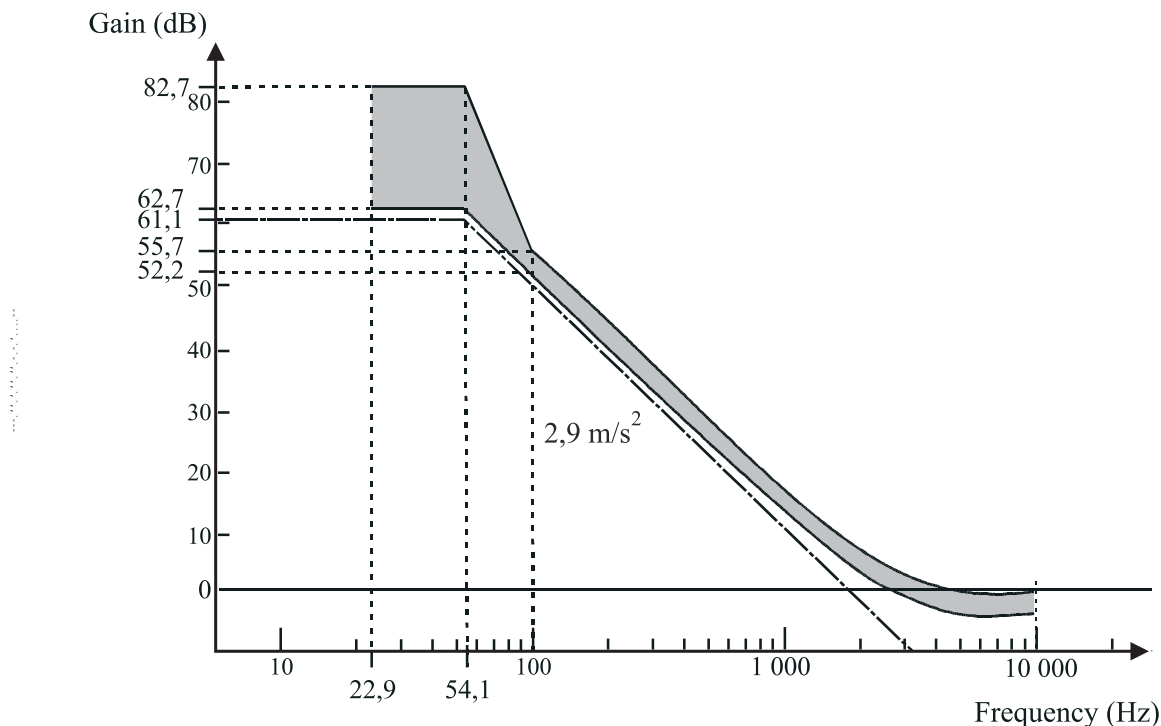
- 45,8 dB at 100 Hz ($|1 + H_s|$ - 20 % at 100 Hz)
- 66,0 dB at 31,2 Hz ($|1 + H_s|$ - 20 % at 31,2 Hz)
- 86,0 dB at 31,2 Hz ($|1 + H_s|$ - 20 % at 31,2 Hz add 20 dB)
- 49,3 dB at 100 Hz ($|1 + H_s|$ + 20 % at 100 Hz)

Bandwidth 22,9 Hz to 31,2 Hz

$|1 + H|$ shall be between 66,0 dB and 86,0 dB.

9.7 Reference Servo for radial tracking

For an open-loop transfer function H of the Reference Servo for radial tracking, $|1+H|$ is limited as schematically shown by the shaded surface of figure 4.



01-0028-A

Figure 4 - Reference Servo for radial tracking

Bandwidth from 100 Hz to 10 kHz

$|1 + H|$ shall be within 20 % of $|1 + H_s|$.

The crossover frequency $f_o = \omega_o / 2\pi$ shall be specified by equation (III), where $\alpha_{\max}$ shall be 1,5 times larger than the expected maximum radial acceleration of $2,9 \text{ m/s}^2$. The tracking error $e_{\max}$ shall not exceed $0,022 \text{ }\mu\text{m}$. Thus the crossover frequency f_o shall be

$$f_o = \frac{1}{2\pi} \sqrt{\frac{3\alpha_{\max}}{e_{\max}}} = \frac{1}{2\pi} \sqrt{\frac{2,9 \times 1,5 \times 3}{0,022 \times 10^{-6}}} = 3,9 \text{ kHz} \quad (\text{III})$$

The radial tracking error is the peak deviation measured radially inwards or outwards the 0 level.

Bandwidth from 54,1 Hz to 100 Hz

$|1 + H|$ shall be within the limits defined by the following four points.

- 52,2 dB at 100 Hz ($|1 + H_s| - 20 \text{ \%}$ at 100 Hz)
- 62,7 dB at 54,1 Hz ($|1 + H_s| - 20 \text{ \%}$ at 54,1 Hz)
- 82,7 dB at 54,1 Hz ($|1 + H_s| - 20 \text{ \%}$ at 54,1 Hz add 20 dB)
- 55,7 dB at 100 Hz ($|1 + H_s| + 20 \text{ \%}$ at 100 Hz)

Bandwidth from 22,9 Hz to 54,1 Hz

$|1 + H|$ shall be between 62,7 dB and 82,7 dB.

Section 2 - Dimensional, mechanical and physical characteristics of the disk

10 Dimensional characteristics

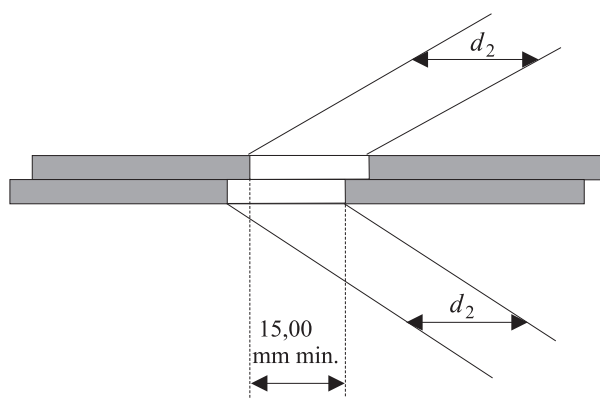
Dimensional characteristics are specified for those parameters deemed mandatory for interchange and compatible use of the disk. Where there is freedom of design, only the functional characteristics of the elements described are indicated. The enclosed drawings show the dimensional requirements in summarized form. The different parts of the disk are described from the centre hole to the outside rim.

The dimensions are referred to two Reference Planes P and Q.

Reference Plane P is the primary Reference Plane. It is the plane on which the bottom surface of the Clamping Zone (see 10.4) rests.

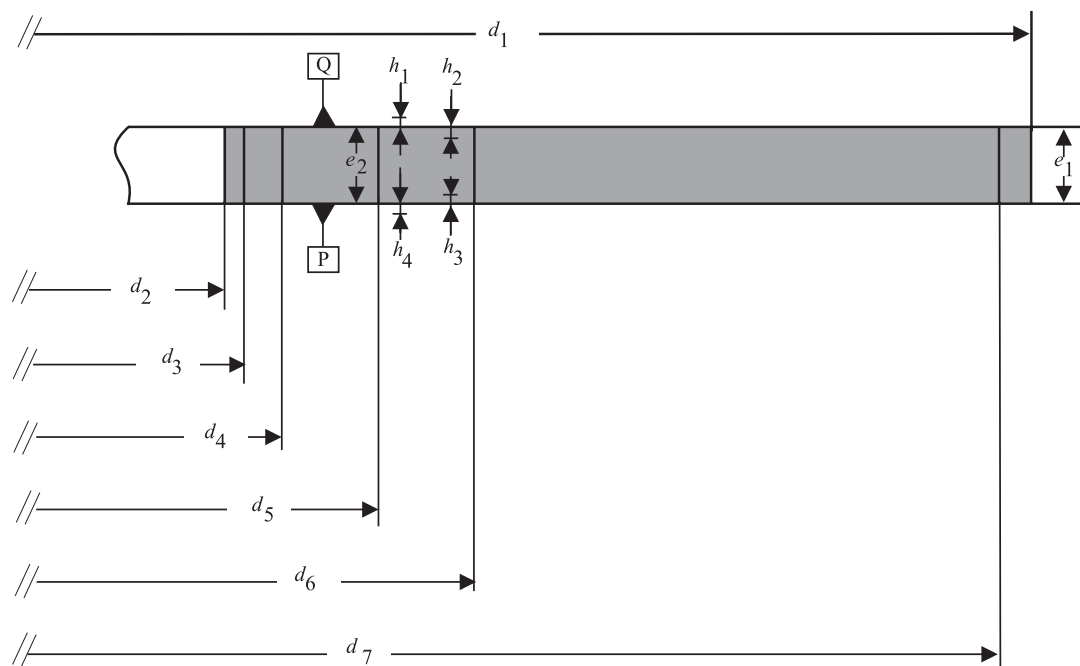
Reference Plane Q is the plane parallel to Reference Plane P at the height of the top surface of the Clamping Zone.

See figures 5 to 7.



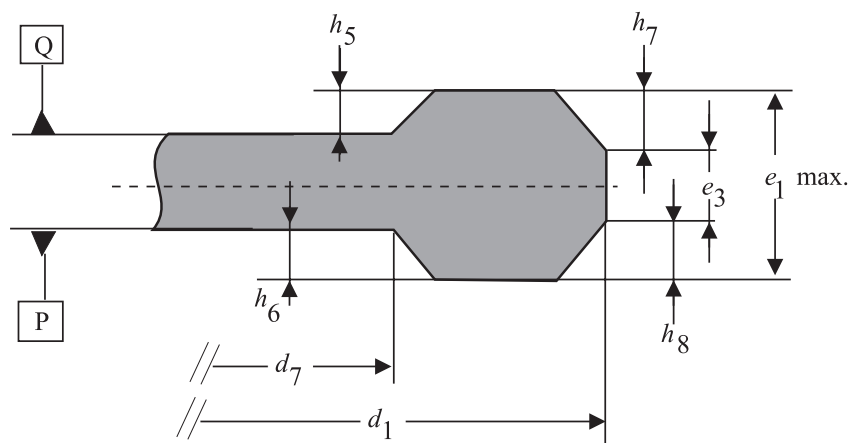
97-0001-A

Figure 5 - Hole of the assembled disk



97-0126-A

Figure 6 - Areas of the disk



97-0127-A

Figure 7 - Rim area

10.1 Overall dimensions

The 120 mm disk shall have an overall diameter

$$d_1 = 120,00 \text{ mm} \pm 0,30 \text{ mm.}$$

The 80 mm disk shall have an overall diameter

$$d_1 = 80,00 \text{ mm} \pm 0,30 \text{ mm.}$$

The centre hole of a substrate or a dummy substrate shall have a diameter

$$d_2 = 15,00 \text{ mm.}$$

+ 0,15 mm
- 0,00 mm

The diameter of the hole of an assembled disk, i.e. with both parts bonded together, shall be 15,00 mm min., see figure 5.

There shall be no burr on both edges of the centre hole.

The edge of the centre hole shall be rounded off or chamfered. The rounding radius shall be 0,1 mm max. The height of the chamfer shall not exceed 0,1 mm.

The thickness of the disk, including adhesive layer, spacer(s) and label(s), shall be

$$e_1 = 1,20 \text{ mm.} \begin{array}{l} + 0,30 \text{ mm} \\ - 0,06 \text{ mm} \end{array}$$

10.2 First transition area

In the area extending between diameter d_2 and diameter

$$d_3 = 16,0 \text{ mm min.}$$

the surface of the disk is permitted to be above Reference Plane P and/or below Reference Plane Q by 0,10 mm max.

10.3 Second transition area

This area shall extend between diameter d_3 and diameter

$$d_4 = 22,0 \text{ mm max.}$$

In this area the disk may have an uneven surface or burrs up to 0,05 mm max. beyond Reference Planes P and/or Q.

10.4 Clamping Zone

This zone shall extend between diameter d_4 and diameter

$$d_5 = 33,0 \text{ mm min.}$$

Each side of the Clamping Zone shall be flat within 0,1 mm. The top side of the Clamping Zone, i.e. that of Reference Plane Q shall be parallel to the bottom side, i.e. that of Reference Plane P within 0,1 mm.

In the Clamping Zone the thickness e_2 of the disk shall be

$$e_2 = 1,20 \text{ mm.} \begin{array}{l} + 0,20 \text{ mm} \\ - 0,10 \text{ mm} \end{array}$$

10.5 Third transition area

This area shall extend between diameter d_5 and diameter

$$d_6 = 44,0 \text{ mm max.}$$

In this area the top surface is permitted to be above Reference Plane Q by

$$h_1 = 0,25 \text{ mm max.}$$

or below Reference Plane Q by

$$h_2 = 0,10 \text{ mm max.}$$

The bottom surface is permitted to be above Reference Plane P by

$$h_3 = 0,10 \text{ mm max.}$$

or below Reference Plane P by

$$h_4 = 0,25 \text{ mm max.}$$

An Information Zone of the 120 mm disk shall extend from diameter d_6 to diameter

$$d_7 = 117,2 \text{ mm.} \\ \begin{array}{l} + 0,0 \text{ mm} \\ - 0,4 \text{ mm} \end{array}$$

An Information Zone of the 80 mm disk shall extend from diameter d_6 to diameter

$$d_7 = 77,0 \text{ mm.} \\ \begin{array}{l} + 0,0 \text{ mm} \\ - 0,4 \text{ mm} \end{array}$$

10.6 Rim area

The rim area shall extend from diameter d_7 to diameter d_1 (see figure 7). In this area the top surface is permitted to be above Reference Plane Q by

$$h_5 = 0,1 \text{ mm max.}$$

and the bottom surface is permitted to be below Reference Plane P by

$$h_6 = 0,1 \text{ mm max.}$$

The total thickness of this area shall not be greater than 1,50 mm, i.e. the maximum value of e_1 . The thickness of the rim proper shall be

$$e_3 = 0,6 \text{ mm min.}$$

The outer edges of the disk shall be either rounded off with a rounding radius of 0,2 mm max. or be chamfered over

$$h_7 = 0,2 \text{ mm max.}$$

$$h_8 = 0,2 \text{ mm max.}$$

10.7 Remark on tolerances

All heights specified in the preceding clauses and indicated by h_i are independent from each other. This means that, for example, if the top surface of the third transition area is below Reference Plane Q by up to h_2 , there is no implication that the bottom surface of this area has to be above Reference Plane P by up to h_3 . Where dimensions have the same - generally maximum - numerical value, this does not imply that the actual values have to be identical.

10.8 Label

A disk without a case or a disk within a Type 2, a Type 4, a Type 6 or a Type 7 case shall have a label placed on the side of the disk opposite the entrance surface for the information to which the label is related. The label shall be placed either on an outer surface of the disk or inside the disk bonding plane. In the former case, the label shall not extend over the Clamping Zone. In the latter case, the label may extend over the Clamping Zone. In both cases, the label shall not extend over the rim of the centre hole nor over the outer edge of the disk.

11 Mechanical characteristics

11.1 Mass

The mass of the 120 mm disk shall be in the range 14,0 g to 20,0 g.

The mass of the 80 mm disk shall be in the range 6,0 g to 9,0 g.

11.2 Moment of inertia

The moment of inertia of the 120 mm disk, relative to its rotation axis, shall not exceed 0,040 g·m².

The moment of inertia of the 80 mm disk, relative to its rotation axis, shall not exceed 0,010 g·m².

11.3 Dynamic imbalance

The dynamic imbalance of the 120 mm disk, relative to its rotation axis, shall not exceed 0,010 g·m.

The dynamic imbalance of the 80 mm disk, relative to its rotation axis, shall not exceed 0,0045 g·m.

11.4 Sense of rotation

The sense of rotation of the disk shall be counter clockwise as seen by the optical system.

11.5 Runout

11.5.1 Axial runout

When measured by the Optical Head with the Reference Servo for axial tracking, the disk rotating at the scanning velocity, the deviation of the recorded layer from its nominal position in the direction normal to the Reference Planes shall not exceed 0,3 mm for the 120 mm disk and 0,2 mm for the 80 mm disk.

The residual tracking error below 10 kHz, measured using the Reference Servo for axial tracking, shall not exceed 0,23 µm. The measuring filter shall be a Butterworth LPF, f_c (-3dB) : 10 kHz, slope : -80 dB/decade.

11.5.2 Radial runout

The runout of the outer edge of the disk shall not exceed 0,30 mm, peak-to-peak.

The radial runout of tracks shall not exceed 50 µm, peak-to-peak.

The residual tracking error below 2,3 kHz, measured using the Reference Servo for radial tracking, shall not exceed 0,022 µm. The measuring filter shall be a Butterworth LPF, f_c (-3dB) : 2,3 kHz, slope : -80 dB/decade.

The rms noise value of the residual error signal in the frequency band from 2,3 kHz to 10 kHz, measured with an integration time of 20 ms, using the Reference Servo for radial tracking, shall not exceed 0,016 µm in the Rewritable Area and shall not exceed 0,025 µm in the Embossed Area (refer to clause 13). The measuring filter shall be a Butterworth BPF, frequency range (-3 dB) : 2,3 kHz, slope : +80 dB/decade to 10 kHz, slope : -80 dB/decade.

12 Optical characteristics

12.1 Index of refraction

The index of refraction of the transparent substrate shall be $1,55 \pm 0,10$.

12.2 Thickness of the transparent substrate

The thickness of the transparent substrate shall be a function of its index of refraction as specified in figure 8.

12.3 Angular deviation

The angular deviation is the angle α between a parallel incident beam and the reflected beam. The incident beam shall have a diameter in the range 0,3 mm to 3,0 mm. This angle includes deflection due to the entrance surface and to unparallelism of the recorded layer, see figure A.1. It shall meet the following requirements when measured according to annex A.

In radial direction: $\alpha = 0,70^\circ$ max.

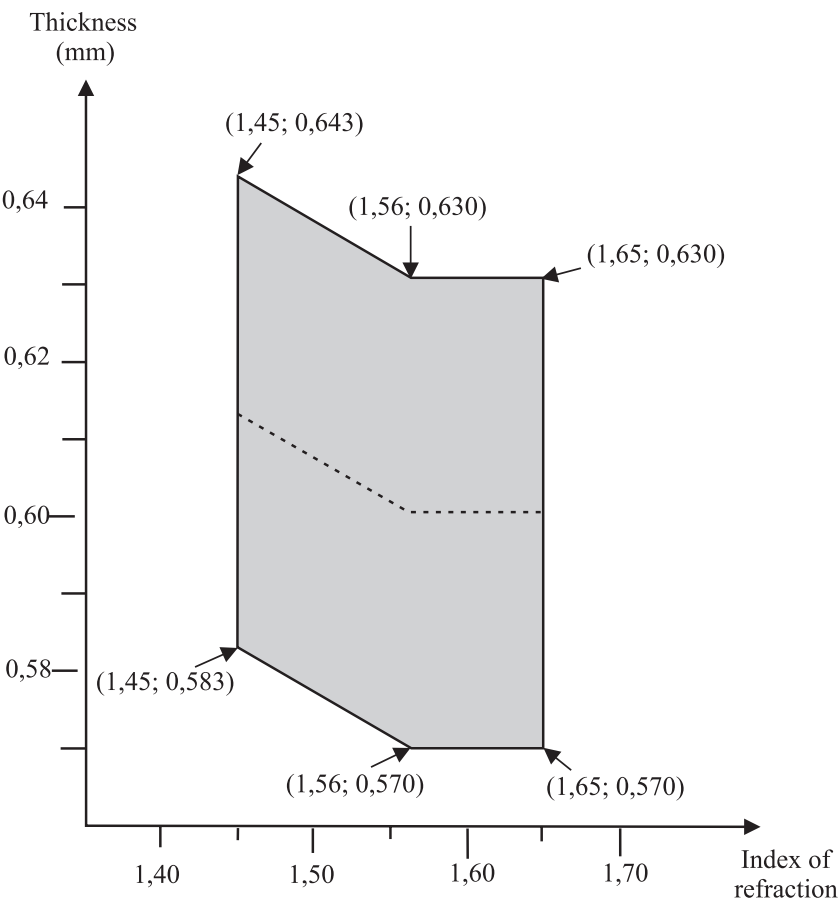
In tangential direction: $\alpha = 0,30^\circ$ max.

12.4 Birefringence of the transparent substrate

The birefringence of the transparent substrate shall be 60 nm max. when measured according to annex B.

12.5 Reflectivity

When measured according to annex D, the reflectivity of the recorded layer(s) shall be in the range 15 % to 25 %.



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Figure 8 - Thickness of the substrate in function of the index of refraction

Section 3 - Format of information

13 Data format

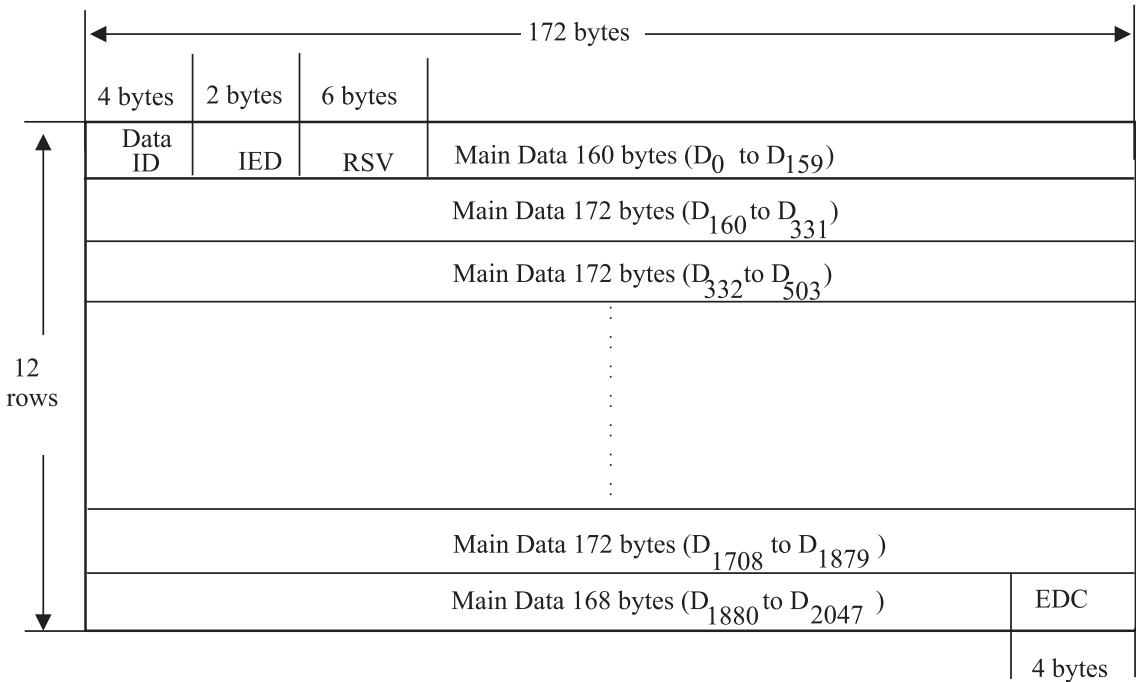
The data received from the host, called Main Data, is formatted in a number of steps before being recorded on the disk. It is transformed successively into

- a Data Frame
- a Scrambled Frame
- an ECC Block
- a Recording Frame
- a Recorded Data Field

These steps are specified in the following clauses.

13.1 Data Frames

A Data Frame shall consist of 2 064 bytes arranged in an array of 12 rows containing each 172 bytes (see figure 9). The first row shall start with three fields, called Data Identification Data (Data ID), ID Error Detection Code (IED), and Reserved bytes (RSV), followed by 160 Main Data bytes. The next 10 rows shall each contain 172 Main Data bytes, and the last row shall contain 168 Main Data bytes followed by four bytes for recording an Error Detection Code (EDC). The 2 048 Main Data bytes are identified as D₀ to D₂₀₄₇.



97-0151-A

Figure 9 - Data Frame

13.1.1 Data ID

This field shall consist of four bytes, the bits of which are numbered consecutively from b_0 (lsb) to b_{31} (msb), see figures 10 and 11.

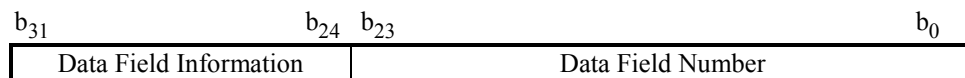


Figure 10 - Data ID

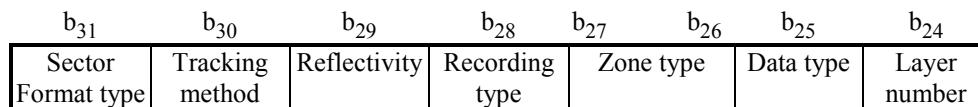


Figure 11 - Data Field Information

The bits of the Data Field Information field shall be set as follows:

Bit b_{31} shall be set to ONE, indicating Zoned format type.

Bit b_{30} shall be set to
ZERO in the Embossed Area, indicating pit tracking (see 16.1),
ONE in the Rewritable Area, indicating groove tracking (see 16.1).

Bit b_{29} shall be set to ONE, indicating that the reflectivity does not exceed 40 %.

Bit b_{28} shall be set to
ZERO in the Embossed Area (see 16.1), in the Lead-in Zone (see 16.2), in the Lead-out Zone (see 16.4) and for a Block in the Data Zone (see 16.3) containing data to which Linear Replacement Algorithm (see 17.5) is applied if the Block is defective,
ONE for a Block in the Data Zone (see 16.3) containing data to which Linear Replacement Algorithm is not applied even if the Block is defective.

Bits b_{27} and b_{26} shall be set to
ZERO ZERO in the Data Zone,
ZERO ONE in the Lead-in Zone,
ONE ZERO in the Lead-out Zone.

Bit b_{25} shall be set to
ZERO in the Embossed Area,
ONE in the Rewritable Area.

Bit b_{24} shall be set to ZERO, indicating that through an entrance surface only one recording layer can be accessed.

Bits b_{23} to b_0 shall be set to the sector number in the Embossed Area (see 16.1), in the DMAs (see 17.1) and in the Reserved Zones of the Lead-in Zone (see 16.2) and of the Lead-out Zone (see 16.4), to the values specified in 17.8.3 in the Data Zone (see 16.3).

Other settings are prohibited by this International Standard, see also annex L.

13.1.2 Data ID Error Detection code (IED)

When identifying all bytes of the array shown in figure 9 as $C_{i,j}$ for $i = 0$ to 11 and $j = 0$ to 171, the bytes of IED are represented by $C_{0,j}$ for $j = 4$ to 5. Their setting is obtained as follows:

$$\text{IED}(x) = \sum_{j=4}^5 C_{0,j} x^{5-j} = I(x) x^2 \mod G_E(x)$$

where:

$$I(x) = \sum_{j=0}^3 C_{0j} x^{3-j}$$

$$G_E(x) = \prod_{k=0}^1 (x + \alpha^k)$$

α is the primitive root of the primitive polynomial $P(x) = x^8 + x^4 + x^3 + x^2 + 1$.

13.1.3 Reserved bytes

All the bytes of this 6-byte field shall be set to (00).

13.1.4 Error Detection Code (EDC)

This 4-byte field shall contain an Error Detection Code computed over the preceding 2 060 bytes of the Data Frame. Considering the Data Frame as a single bit field starting with the most significant bit of the first byte of the ID field and ending with the least significant bit of the EDC field, then this msb will be $b_{16\ 511}$ and the lsb will be b_0 . Each bit b_i of the EDC is as follows for $i = 31$ to 0:

$$EDC(x) = \sum_{i=31}^0 b_i x^i = I(x) \bmod G(x)$$

where:

$$I(x) = \sum_{i=16\ 511}^{32} b_i x^i$$

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

13.2 Scrambled Frames

The 2 048 Main Data bytes shall be scrambled by means of the circuit shown in figure 12 which shall consist of a feedback bit shift register in which bits r_7 (msb) to r_0 (lsb) represent a scrambling byte at each 8-bit shift. At the beginning of the scrambling procedure of a Data Frame, positions r_{14} to r_0 shall be pre-set to the value(s) specified in table 3. The same pre-set value shall be used for 16 consecutive Data Frames. After 16 groups of 16 Data Frames, the sequence is repeated. The initial pre-set number is equal to the value represented by bits b_7 (msb) to bit b_4 (lsb) of the Data ID field of the Data Frame. Table 1 specifies the initial pre-set value of the shift register corresponding to the 16 initial pre-set numbers.

Table 1 - Initial values of the shift register

Initial pre-set number	Initial pre-set value	Initial pre-set number	Initial pre-set value
(0)	(0001)	(8)	(0010)
(1)	(5500)	(9)	(5000)
(2)	(0002)	(A)	(0020)
(3)	(2A00)	(B)	(2001)
(4)	(0004)	(C)	(0040)
(5)	(5400)	(D)	(4002)
(6)	(0008)	(E)	(0080)
(7)	(2800)	(F)	(0005)

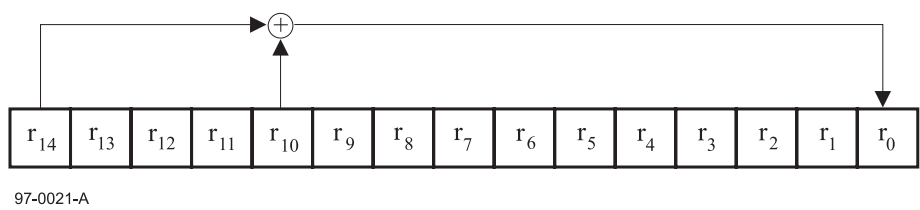


Figure 12 - Feedback shift register

The part of the initial value of r_7 to r_0 is taken out as scrambling byte S_0 . After that, 8-bit shift is repeated 2 047 times and the following 2 047 bytes shall be taken from r_7 to r_0 as scrambling bytes S_1 to $S_{2\,047}$. The Main Data bytes D_k of the Data Frame become scrambled bytes D'_k where

$$D'_k = D_k \oplus S_k \quad \text{for } k = 0 \text{ to } 2\,047,$$

 $\oplus$ stands for Exclusive OR.

13.3 ECC Blocks

An ECC Block is formed by arranging 16 consecutive Scrambled Frames in an array of 192 rows of 172 bytes each (see figure 13). To each of the 172 columns, 16 bytes of Parity of Outer Code are added, then, to each of the resulting 208 rows, 10 byte of Parity of Inner Code are added. Thus a complete ECC Block comprises 208 rows of 182 bytes each. The bytes of this array are identified as $B_{i,j}$ as follows, where i is the row number and j the column number.

- $B_{i,j}$ for $i = 0$ to 191 and $j = 0$ to 171 are bytes from the Scrambled Frames.
- $B_{i,j}$ for $i = 192$ to 207 and $j = 0$ to 171 are bytes of the Parity of Outer Code.
- $B_{i,j}$ for $i = 0$ to 207 and $j = 172$ to 181 are bytes of the Parity of Inner Code.

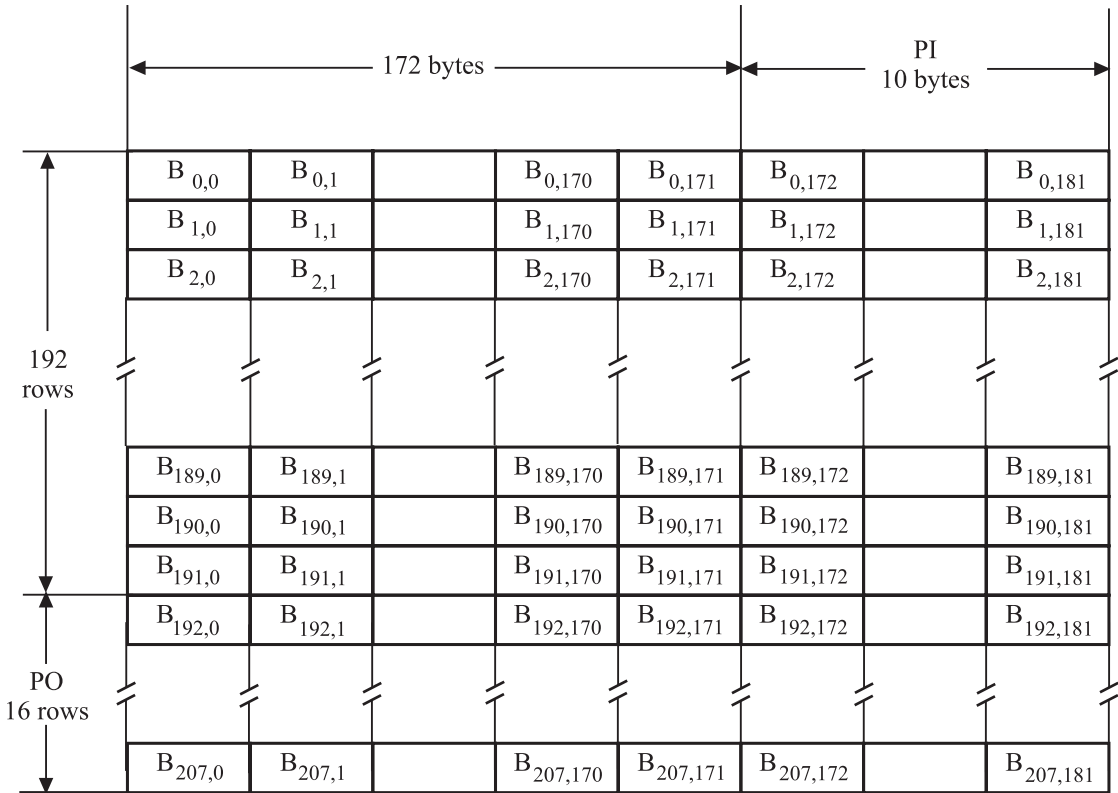


Figure 13 - ECC Block configuration

The PO and PI bytes shall be obtained as follows.

In each of columns $j = 0$ to 171, the 16 PO bytes are defined by the remainder polynomial $R_j(x)$ to form the outer code RS (208,192,17).

$$R_j(x) = \sum_{i=192}^{207} B_{i,j} x^{207-i} = I_j(x) x^{16} \mod G_{PO}(x)$$

where:

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

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

In each of rows $i = 0$ to 207, the 10 PI bytes are defined by the remainder polynomial $R_i(x)$ to form the inner code RS (182,172,11).

$$R_i(x) = \sum_{j=172}^{181} B_{i,j} x^{181-j} = I_i(x) x^{10} \mod G_{PI}(x)$$

where:

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

$$G_{PI}(x) = \prod_{k=0}^9 (x + \alpha^k)$$

α is the primitive root of the primitive polynomial $P(x) = x^8 + x^4 + x^3 + x^2 + 1$.

13.4 Recording Frames

Sixteen Recording Frames shall be obtained by interleaving one of the 16 PO rows at a time after every 12 rows of an ECC Block (figure 13). This is achieved by re-locating the bytes $B_{i,j}$ of the ECC Block as $B_{m,n}$ for

$$\begin{aligned} m &= i + \text{int}[i / 12] \quad \text{and} \quad n = j \quad \text{for } i \leq 191 \\ m &= 13(i - 191) - 1 \quad \text{and} \quad n = j \quad \text{for } i \geq 192 \end{aligned}$$

where $\text{int}[x]$ represents the largest integer not greater than x .

Thus the 37 856 bytes of an ECC Block are re-arranged into 16 Recording Frames of 2 366 bytes. Each Recording Frame consists of an array of 13 rows of 182 bytes (see figure 14).

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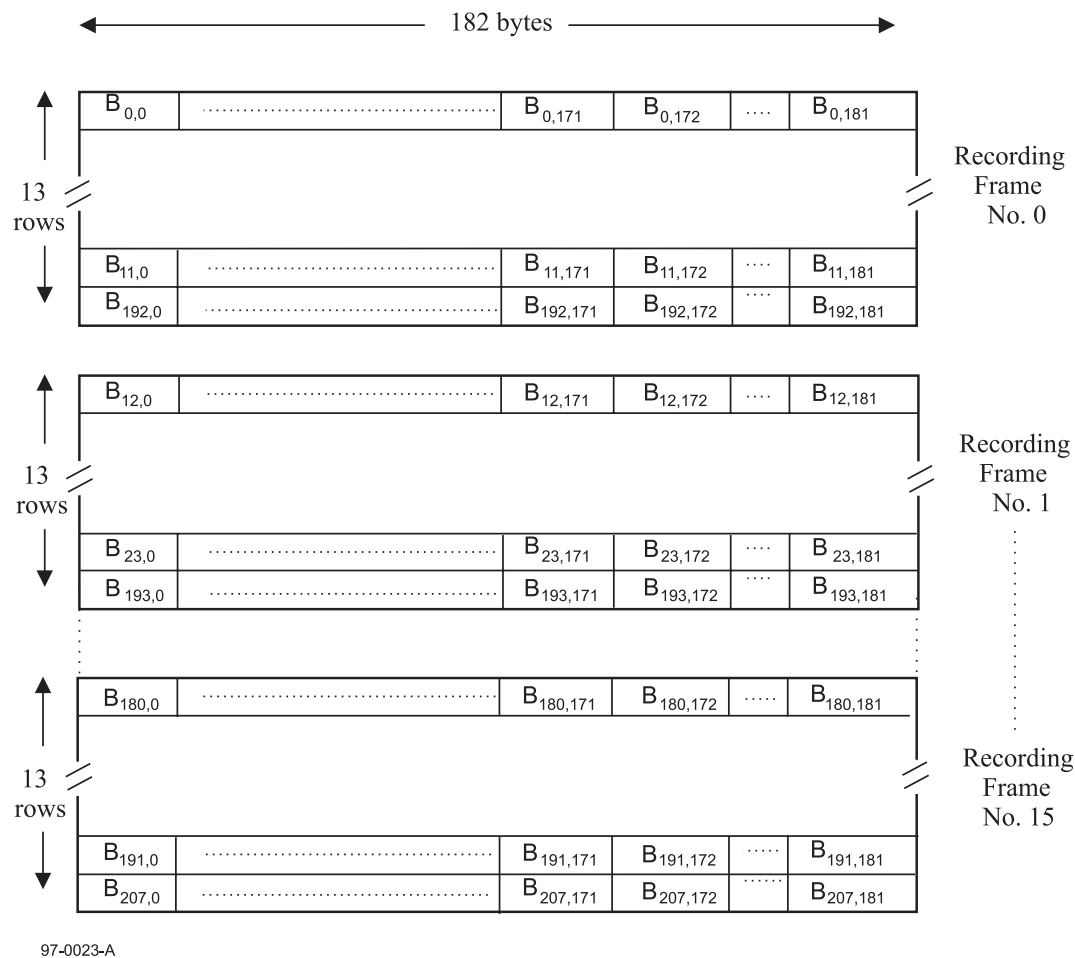


Figure 14 - Recording Frames obtained from an ECC Block

13.5 Recording code and NRZI conversion

The 8-bit bytes of each Recording Frame shall be transformed into 16-bit Code Words with the run length limitation that between 2 ONEs there shall be at least 2 ZEROs and at most 10 ZEROs (RLL 2,10). Annex G specifies the conversion tables to be applied. The Main Conversion table and the Substitution table specify a 16-bit Code Word for each 8-bit bytes with one of 4 States. For each 8-bit byte, the tables indicate the corresponding Code Word, as well as the State for the next 8-bit byte to be encoded.

The 16-bit Code Words shall be NRZI-converted into Channel bits before recording on the disk. (figure 15).

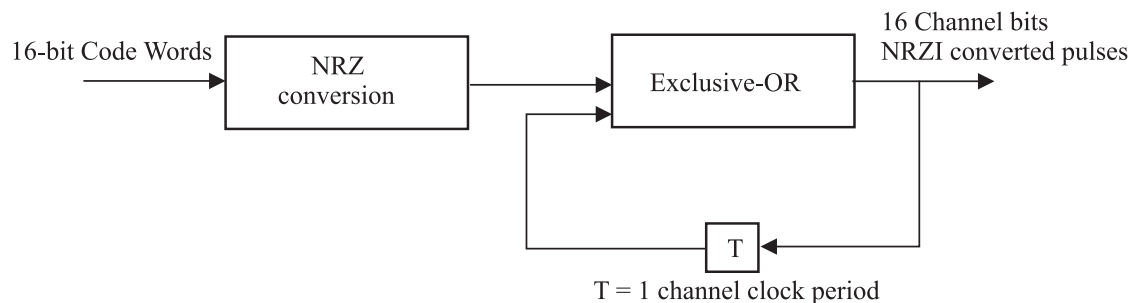
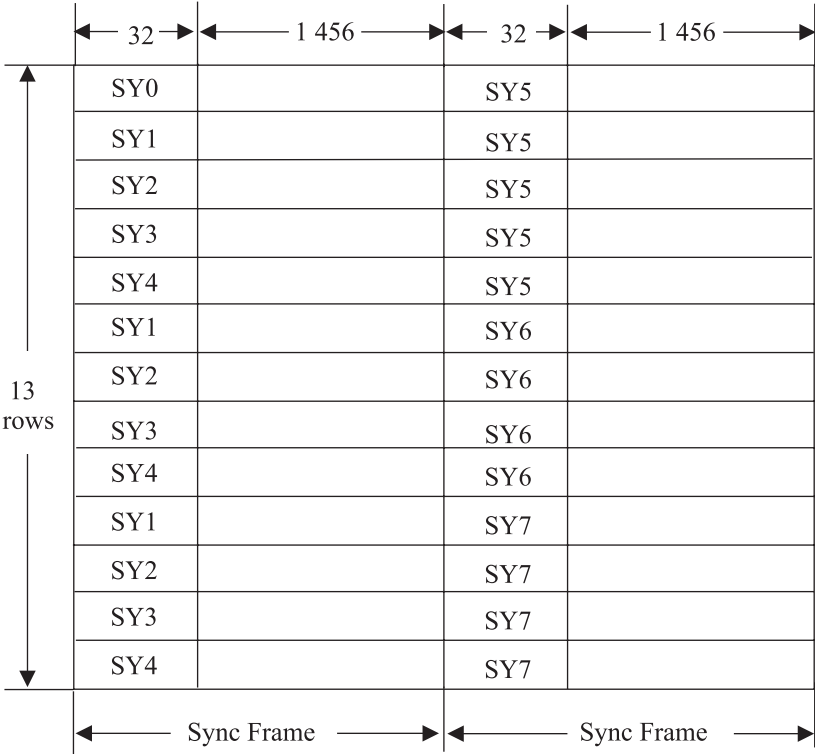


Figure 15 - NRZI conversion

13.6 Recorded Data Field

The structure of a Recorded Data Field is shown in figure 16. It shall consist of 13 rows, each comprising two Sync Frames. A Sync Frame shall consist of a SYNC Code from table 2 and 1 456 Channel bits representing the first, respectively the second 91 8-bit bytes of a row of a Recording Frame. The first row of the Recording Frame is represented by the first row of the Recorded Data Field, the second by the second, and so on.



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Figure 16 - Recorded Data Field

Recording shall start with the first Sync Frame of the first row, followed by the second Sync Frame of that row, and so on row-by-row.

For the selection of the Primary and Secondary SYNC Codes, see 13.7.

Table 2 - SYNC Codes

State 1 and State 2			
Primary SYNC codes		Secondary SYNC codes	
(msb)	(lsb)	(msb)	(lsb)
SY0	= 0001001001000100 0000000000010001	/	0001001000000100 0000000000010001
SY1	= 0000010000000100 0000000000010001	/	0000010001000100 0000000000010001
SY2	= 0001000000000100 0000000000010001	/	0001000001000100 0000000000010001
SY3	= 0000100000000100 0000000000010001	/	0000100001000100 0000000000010001
SY4	= 0010000000000100 0000000000010001	/	0010000001000100 0000000000010001
SY5	= 0010001001000100 0000000000010001	/	0010001000000100 0000000000010001
SY6	= 0010010010000100 0000000000010001	/	0010000010000100 0000000000010001
SY7	= 0010010001000100 0000000000010001	/	0010010000000100 0000000000010001

State 3 and State 4			
Primary SYNC codes		Secondary SYNC codes	
(msb)	(lsb)	(msb)	(lsb)
SY0 = 1001001000000100	0000000000010001	/ 1001001001000100	0000000000010001
SY1 = 1000010001000100	0000000000010001	/ 1000010000000100	0000000000010001
SY2 = 1001000001000100	0000000000010001	/ 1001000000000100	0000000000010001
SY3 = 1000001001000100	0000000000010001	/ 1000001000000100	0000000000010001
SY4 = 1000100001000100	0000000000010001	/ 1000100000000100	0000000000010001
SY5 = 1000100100000100	0000000000010001	/ 1000000100000100	0000000000010001
SY6 = 1001000010000100	0000000000010001	/ 1000000010000100	0000000000010001
SY7 = 1000100010000100	0000000000010001	/ 1000000010000100	0000000000010001

13.7 DC component suppress Control (DCC)

13.7.1 DCC for the data in the Rewritable Area

The DC component suppress Control (DCC) minimizes the absolute value of the accumulated DSV (Digital Sum Value, see 4.3).

The DCC algorithm controls the choice of SYNC codes and 16-Channel bit Code Words in each of following three cases so that DSV is minimized.

The choice shall be determined so that, for each 16-bit Code Word (or SYNC Code), the accumulated DSV is a minimum at the end of the 16-bit Code Word (or SYNC Code) to be selected.

- Choice of the SYNC Codes between Primary or Secondary SYNC Codes.
- For the 8-bit bytes in the range 0 to 87, the Substitution table offers an alternative 16-bit Code Word for all States.
- For the 8-bit bytes in the range 88 to 255, when the prescribed State is 1 or 4, then the 16-bit Code Word can be chosen either from State 1 or from State 4, so as to ensure that the RLL requirement is met.

13.7.2 DCC for the data in the Embossed Area

The DC component suppress control (DCC) minimizes the absolute value of the accumulated DSV.

To ensure a reliable radial tracking and a reliable detection of the HF signals, the low frequency content of the stream of Channel bit patterns should be kept as low as possible. In order to achieve this, the Digital Sum Value shall be kept as low as possible. At the beginning of recording, the DSV shall be set to 0.

The different ways of diminishing the current value of the DSV are as follows.

- Choice of SYNC Codes between Primary or Secondary SYNC Codes.
- For the 8-bit bytes in the range 0 to 87, the Substitution table offers an alternative 16-bit Code Word for all States
- For the 8-bit bytes in the range 88 to 255, when the prescribed State is 1 or 4, then the 16-bit Code Word can be chosen either from State 1 or from State 4, so as to ensure that the RLL requirement is met.

In order to use these possibilities, two data streams, Stream 1 and Stream 2, are generated for each Sync Frame. Stream 1 shall start with the Primary SYNC Code and Stream 2 with the Secondary SYNC Code of the same category of SYNC Codes. As both streams are modulated individually, they generate a different DSV because of the difference between the bit patterns of the Primary and Secondary SYNC Codes.

In the cases b) and c), there are two possibilities to represent a 8-bit byte. The DSV of each stream is computed up to the 8-bit byte preceding the 8-bit byte for which there is this choice. The stream with the lowest |DSV| is selected and duplicated to the other stream. Then, one of the representations of the next 8-bit byte is entered into Stream 1 and the other into Stream 2. This operation is repeated each time case b) or c) occurs.

Whilst case b) always occurs at the same pattern position in both streams, case c) may occur in one of the streams and not in the other because, for instance, the next State prescribed by the previous 8-bit byte can be 2 or 3 instead of 1 or 4. In that case the following 3-step procedure shall be applied.

- 1) Compare the $|DSV|$ s of both streams.
- 2) If the $|DSV|$ of the stream in which case c) occurs is smaller than that of the other stream, then the stream in which case c) has occurred is chosen and duplicated to the other stream. One of the representations of the next 8-bit byte is entered into this stream and the other into the other stream.
- 3) If the $|DSV|$ of the stream in which case c) has occurred is larger than that of the other stream, then case c) is ignored and the 8-bit byte is represented according to the prescribed State.

In both cases b) and c), if the $|DSV|$ s are equal, the decision to choose Stream 1 or Stream 2 is implementation-defined.

The procedure for case a) shall be as follows. At the end of a Sync Frame, whether or not case b) and or case c) have occurred, the DSV of the whole Sync Frame is computed and the stream with the lower $|DSV|$ is selected. If this DSV is greater than + 63 or smaller than -64, then the SYNC Code at the beginning of the Sync Frame is changed from Primary to Secondary or vice versa. If this yields a smaller $|DSV|$, the change is permanent, if the $|DSV|$ is not smaller, the original SYNC Code is retained.

During the DSV computation, the actual values of the DSV may vary between -1000 and +1000, thus it is recommended that the count range for the DSV be at least from -1 024 to +1 023.

13.7.3 PID and PED recording

PID and PED (see 15.4 and 15.5) shall be recorded in the same manner as specified for Data Fields in 13.5, or in a simplified manner using only the Main Conversion Table G.1.

In the first case, the value of the accumulated DSV shall be reset to 0 at the beginning of VFO 1 in the Header 1 field.

In both cases recording of PID 1, PID 2, PID 3 and PID 4 shall start with the State 1.

14 Track format

14.1 Track shape

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

In the Embossed Area (see 16.1) of the Information Zone, tracks shall be formed by a series of embossed pits.

In the Rewritable Area (see 16.1) of the Information Zone, tracks shall be formed by a land and groove pattern. Recording is made on the land between the grooves as well as in the grooves themselves.

A track in the grooves is called a groove track. A track on the land between the grooves is called a land track. The end of a groove track is followed by the beginning of a land track, and vice versa.

A sector in a groove track is called a groove sector, a sector in a land track is called a land sector.

All tracks are continuous in the Information Zone. However, the grooves shall be interrupted in the Header and Mirror fields of each sector (see 15.1.1). The grooves shall be wobbled in the radial direction in such way that they are given a sinusoidal wave form.

The detailed shape of the tracks is determined by the requirements of Section 4.

14.2 Track path

The track path shall be a continuous spiral from the inside (beginning of the Lead-in Zone) to the outside (end of the Lead-out Zone) of the disk.

14.3 Track pitch

The track pitch is the distance between the centrelines of adjacent tracks, measured in a radial direction. It shall be $0,615 \mu\text{m} \pm 0,03 \mu\text{m}$ in the Rewritable area and $0,74 \mu\text{m} \pm 0,03 \mu\text{m}$ in the Embossed area. The track pitch averaged over the Rewritable area shall be $0,615 \mu\text{m} \pm 0,01 \mu\text{m}$ and the track pitch averaged over the Embossed area shall be $0,74 \mu\text{m} \pm 0,01 \mu\text{m}$. The tracks shall start in the Lead-in Zone at radius

$$22,6 \text{ mm.} \begin{matrix} +0,0 \text{ mm} \\ -0,2 \text{ mm} \end{matrix}$$

14.4 Track layout

Each track shall be divided into sectors.

The number of sectors per track in the Embossed Area of the Lead-in Zone shall be 18 (see table 3 and table 4). Each sector in the Embossed Area of the Lead-in Zone shall comprise 2 418 bytes where each byte is represented on the disk by 16 Channel bits. The sectors in the Embossed Area of the Lead-in Zone shall be equally spaced over a track. They shall have a size of 38 688 Channel bits.

The number of sectors per track in the Rewritable Area shall increase from Zone 0 to Zone 34 in case of 120 mm disk, or from Zone 0 to Zone 13 in case of 80 mm disk, when moving from the inner radius to the outer radius so as to keep the recording linear density practically constant in any Zone. Each sector shall comprise 2 697 bytes where each byte is represented on the disk by 16 Channel bits. The sectors in the Rewritable Area shall be equally spaced over a track. They shall have a size of 43 152 Channel bits.

14.5 Rotation speed

The nominal rotation speed is different in each Zone and is determined by the Zone number. These values are for reference only. The nominal rotation speed yielding a user data bit rate of 22,16 Mbit/s is obtained by using the formula:

$$\text{Rotation speed (Hz)} = 22\,160\,000 / (\text{Number of sectors per track} \times 2048 \times 8).$$

The disk shall rotate counter clockwise as viewed from the optical head.

The absolute rotation speed in the Embossed data zone shall be adjusted to that of Zone 0.

Table 3 - Nominal rotation speed for 120 mm disk

Zone		Rotation speed (Hz)	Number of sectors per track	Period of a Channel bit (ns)	Period of a Byte (ns)	Period of a Sector (µs)
Lead-in Zone	Embossed Area	54,10	18	26,54	425	1 027
	Rewritable Area	54,10	25	17,13	274	739
Data Zone Rewritable Area	Zone 0	54,10	25	17,13	274	739
	Zone 1	52,02	26	17,13	274	739
	Zone 2	50,09	27	17,13	274	739
	Zone 3	48,30	28	17,13	274	739
	Zone 4	46,64	29	17,13	274	739
	Zone 5	45,08	30	17,13	274	739
	Zone 6	43,63	31	17,13	274	739
	Zone 7	42,27	32	17,13	274	739
	Zone 8	40,99	33	17,13	274	739
	Zone 9	39,78	34	17,13	274	739
	Zone 10	38,64	35	17,13	274	739
	Zone 11	37,57	36	17,13	274	739
	Zone 12	36,56	37	17,13	274	739
	Zone 13	35,59	38	17,13	274	739
	Zone 14	34,68	39	17,13	274	739
	Zone 15	33,81	40	17,13	274	739
	Zone 16	32,99	41	17,13	274	739
	Zone 17	32,20	42	17,13	274	739
	Zone 18	31,45	43	17,13	274	739
	Zone 19	30,74	44	17,13	274	739
	Zone 20	30,06	45	17,13	274	739
	Zone 21	29,40	46	17,13	274	739
	Zone 22	28,78	47	17,13	274	739
	Zone 23	28,18	48	17,13	274	739
	Zone 24	27,60	49	17,13	274	739
	Zone 25	27,05	50	17,13	274	739
	Zone 26	26,52	51	17,13	274	739
	Zone 27	26,01	52	17,13	274	739
	Zone 28	25,52	53	17,13	274	739
	Zone 29	25,05	54	17,13	274	739
	Zone 30	24,59	55	17,13	274	739
	Zone 31	24,15	56	17,13	274	739
	Zone 32	23,73	57	17,13	274	739
	Zone 33	23,32	58	17,13	274	739
	Zone 34	22,92	59	17,13	274	739
Lead-out Zone Rewritable Area		22,92	59	17,13	274	739

Table 4 - Nominal rotation speed for 80 mm disk

Zone		Rotation speed (Hz)	Number of sectors per track	Period of a Channel bit (ns)	Period of a Byte (ns)	Period of a Sector (µs)
Lead-in Zone	Embossed Area	54,10	18	26,54	425	1 027
	Rewritable Area	54,10	25	17,13	274	739
Data Zone Rewritable Area	Zone 0	54,10	25	17,13	274	739
	Zone 1	52,02	26	17,13	274	739
	Zone 2	50,09	27	17,13	274	739
	Zone 3	48,30	28	17,13	274	739
	Zone 4	46,64	29	17,13	274	739
	Zone 5	45,08	30	17,13	274	739
	Zone 6	43,63	31	17,13	274	739
	Zone 7	42,27	32	17,13	274	739
	Zone 8	40,99	33	17,13	274	739
	Zone 9	39,78	34	17,13	274	739
	Zone 10	38,64	35	17,13	274	739
	Zone 11	37,57	36	17,13	274	739
	Zone 12	36,56	37	17,13	274	739
	Zone 13	35,59	38	17,13	274	739
Lead-out Zone Rewritable Area		35,59	38	17,13	274	739

14.6 Radial alignment

In the Lead-in Zone, the Data Zone and the Lead-out Zone, the sectors on adjacent tracks shall be radially aligned so that the angular distance between the first Channel bits of two sectors does not exceed 4 Channel bits, except for the sectors on the track along the boundary between Buffer Zone 2 and the Connection Zone (see 16.2.7), along the boundary between Guard Track Zone 1 and the Connection Zone, and along the 34 boundaries between the 35 Zones of the Data Zone in 120 mm disk, or along the 13 boundaries between the 14 Zones of the Data Zone in 80 mm disk.

In addition, the angular distance between the first Channel bits of any pair of non-adjacent tracks shall not exceed 256 Channel bits.

14.7 Sector number

Each sector shall be identified by a sector number.

Sector (030000) shall be the first sector of the Rewritable Area in the Lead-in Zone. It shall be located at a radius of

$$24,0 \text{ mm} \begin{matrix} +0,0 \text{ mm} \\ -0,2 \text{ mm} \end{matrix}$$

The sector numbers of the following sectors shall be increased by 1 for each sector. Sector (30000) shall be the first sector in a groove track.

15 Sector format

15.1 Sector layout

15.1.1 Sector layout in the Rewritable Area

A sector shall consist of 20 fields within a Header field, a Mirror field and 8 fields within a Recording field. The 4 PID fields, the 4 PED fields and the Data field contain data. Each byte of these fields shall be recorded as a 16-Channel bit pattern according to 13.5 and annex G. All other fields are defined in terms of Channel bits. The numbers below the identifier of each field in figure 17 indicate the number of 16-Channel bit patterns in each field. The Recording field may be either unrecorded or recorded with up to 2 048 user bytes. The Header field shall be embossed.

The nominal length of a sector shall be 43 152 Channel bits. The length of the Header field shall be 2 048 Channel bits and the length of the Mirror field shall be 32 Channel bits. The nominal length of the Recording field shall be 41 072 Channel bits. It shall consist of a Gap field, a Guard 1 field, a VFO 3 field, a PS field, a Data field, a PA 3 field, a Guard 2 field and a Buffer field.

The Header field shall consist of a Header 1 field, a Header 2 field, a Header 3 field and a Header 4 field.

The Header 1 field shall consist of a VFO 1, an Address Mark, a Physical ID 1, a PED 1 and a PA 1.

The Header 2 field shall consist of a VFO 2, an Address Mark, a Physical ID 2, a PED 2 and a PA 2.

The Header 3 field shall consist of a VFO 1, an Address Mark, a Physical ID 3, a PED 3 and a PA 1.

The Header 4 field shall consist of a VFO 2, an Address Mark, a Physical ID 4, a PED 4 and a PA 2.

The Header field shall consist of Complementary Allocated Pit Addresses. The Header 1 field and the Header 2 field shall be arranged on the boundary between the groove track and the outer adjacent land track. The Header 3 field and the Header 4 field shall be arranged on the boundary between the groove track and the inner adjacent land track.

A groove shall be 41 072 Channel bits in length from the beginning of the Gap field. The groove is wobbled, and one wobble cycle shall be 186 Channel bits in length. This wobbled groove shall be sinusoidal, and shall start with 0 degree of phase at the beginning of the Gap field in each sector. The first half cycle shall be wobbled in the outer radial direction. The groove shall end from 0 to 4 Channel bits before the following Header field.

The Mirror field shall be located between the Header 4 and the Gap field.

The layout of a sector in the Rewritable Area is shown in figure 17.

The layout of the Header field on a disk from the view of objective lens shall be as shown in figure 18.

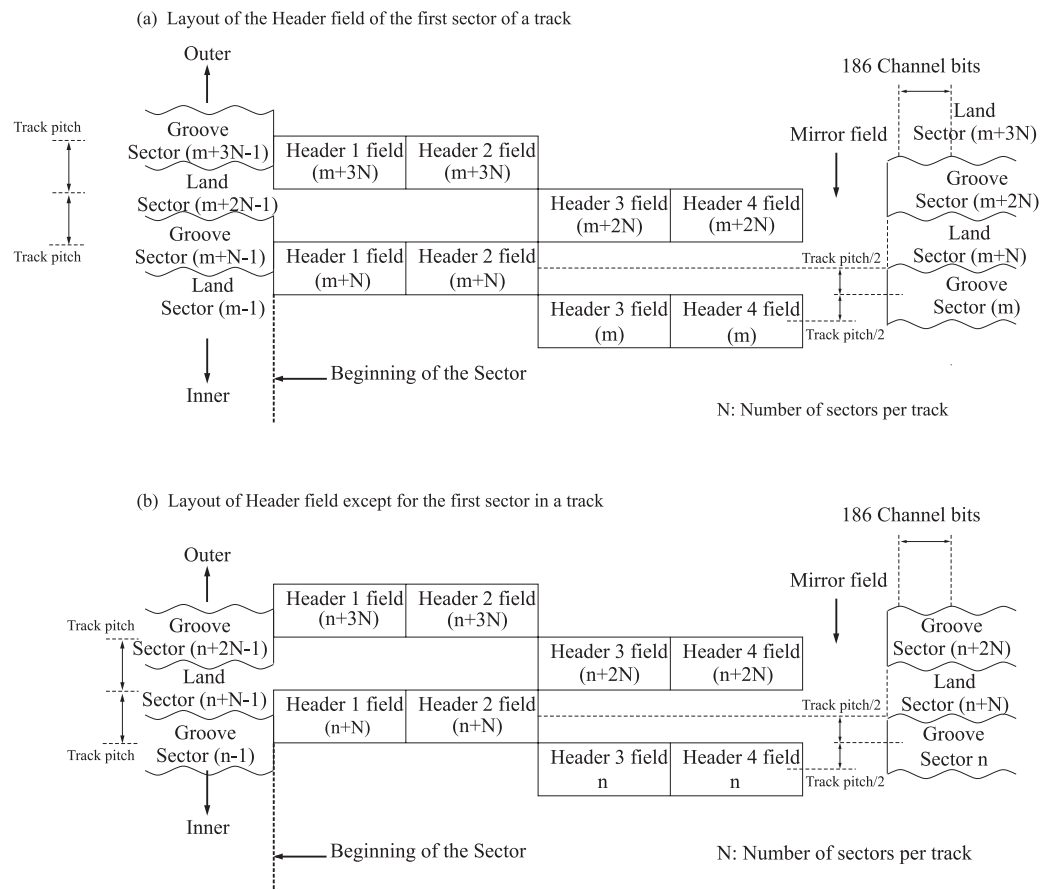
Recording field									
Header	Mirror	Gap	Guard 1	VFO 3	PS	Data	PA 3	Guard 2	Buffer
128	2	$10 + \frac{J}{16}$	$20 + K$	35	3	2 418	1	$55 - K$	$25 - \frac{J}{16}$
$0 \leq J \leq 15$				$0 \leq K \leq 7$					

a) Sector layout

Header 1					Header 2					Header 3					Header 4				
VFO 1	AM	PID 1	PED 1	PA 1	VFO 2	AM	PID 2	PED 2	PA 2	VFO 1	AM	PID 3	PED 3	PA 1	VFO 2	AM	PID 4	PED 4	PA 2
36	3	4	2	1	8	3	4	2	1	36	3	4	2	1	8	3	4	2	1

b) Header field layout

Figure 17 - Sector and Header field layout in the Rewritable Area



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Figure 18 - Layout of the Header field in the Rewritable Area**15.1.2 Sector layout in the Embossed Area**

A sector shall consist of the Data field formed by continuous embossed pits with a size of 38 688 Channel bits.

A sector on the track has no gap and is placed continuously from the beginning of the Embossed Area in the Lead-in Zone to the end of the Embossed Area in the Lead-in Zone.

15.2 VFO fields

There shall be two embossed VFO 1 fields and two embossed VFO 2 fields in the Header field and one VFO 3 field in the Recording field to give bit synchronization to the variable frequency oscillator of the phase-locked loop of the Read Channel. VFO 1 shall have a length of 576 Channel bits. VFO 2 shall have a length of 128 Channel bits. VFO 3 shall have a length of 560 Channel bits.

The continuous Channel bit pattern for the VFO fields shall be as shown in figure 19.

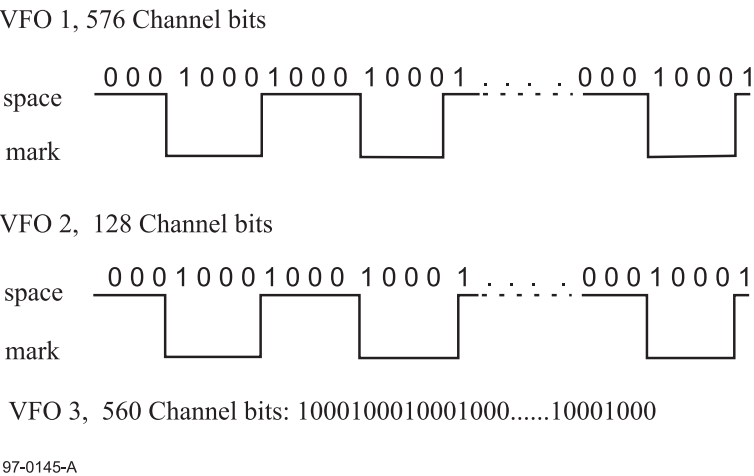


Figure 19 - VFO patterns

15.3 Address Mark (AM)

The Address Mark shall consist of an embossed pattern that does not occur in the 8-to-16 recording code. The field is intended to give the drive byte synchronization for the following PID field. It shall have a length of 48 Channel bits with the following pattern as shown in figure 20.

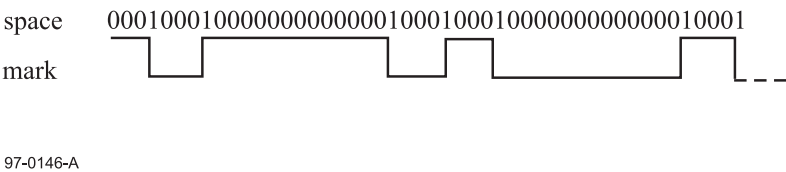


Figure 20 - Address Mark pattern

15.4 Physical ID (PID) fields

This field shall consist of four bytes the bits of which are numbered consecutively from b_0 (lsb) to b_{31} (msb), see figure 21.

b_{31}	b_{30}	b_{29}	b_{28}	b_{27}	b_{26}	b_{25}	b_{24}	b_{23}	b_0
Reserved		Physical ID Number		Sector Type		Layer Number		Sector Number	

Figure 21 - Physical ID field

The bits of the most significant byte, the Sector Information, shall be set as follows:

- Bits b_{31} to b_{30} shall be set to ZERO ZERO.
- Bits b_{29} to b_{28} shall be set to
- ZERO ZERO, indicating PID 1,
 - ZERO ONE, indicating PID 2,
 - ONE ZERO, indicating PID 3,
 - ONE ONE, indicating PID 4.

Bit b_{27} to b_{25} shall be set to

100	in the first rewritable sector in a track,
101	in the last rewritable sector in a track,
110	in the last but one rewritable sector in a track,
111	in other rewritable sectors in a track.

Bit b_{24} shall be set to ZERO, indicating Layer 0.

The least significant three bytes, bits b_0 to b_{23} , shall specify the sector number in binary notation.

In the Rewritable Area, the PID 1 and the PID 2 fields both specify the sector number of the following land sector, the PID 3 and the PID 4 fields both specify the sector number of the following groove sector.

15.5 PID Error Detection code (PED) fields

Each PID field and the following PED field constitute a matrix the bytes of which are identified by C_j for $j = 0$ to 5. The bytes of the PED are C_4 and C_5 .

$$PED(x) = \sum_{j=4}^5 C_j x^{5-j} = I(x) x^2 \mod G_E(x)$$

where:

$$I(x) = \sum_{j=0}^3 C_j x^{3-j}$$

$$G_E(x) = \prod_{k=0}^1 (x + \alpha^k)$$

α is the primitive root of the primitive polynomial $P(x) = x^8 + x^4 + x^3 + x^2 + 1$.

15.6 Postamble 1 and Postamble 2 (PA 1, PA 2) fields

The Postamble 1 and Postamble 2 fields shall have a length of 16 Channel bits. The PA 1 field and PA 2 field allow for the closure of the last byte of the preceding PED, figures 22 to 25.

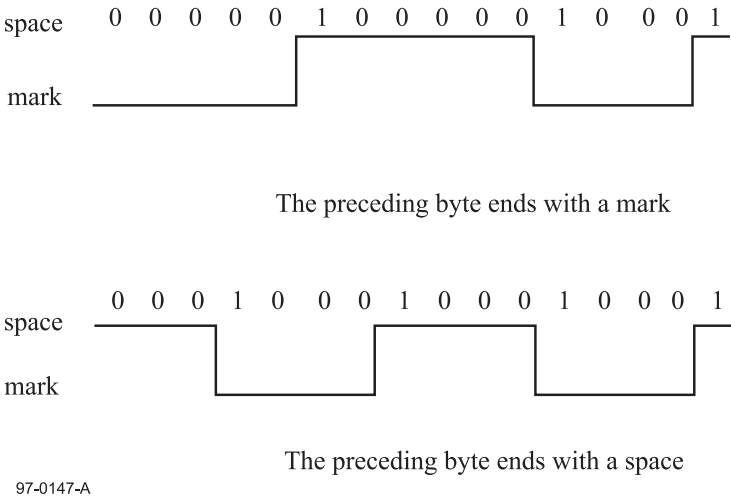
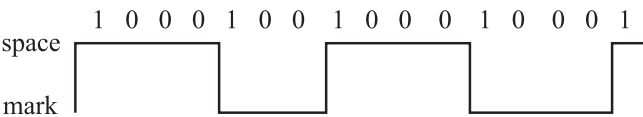
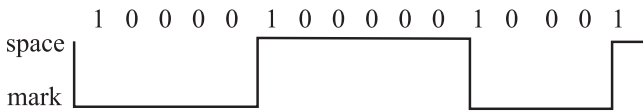


Figure 22 - PA 1 patterns in State 1 and State 2



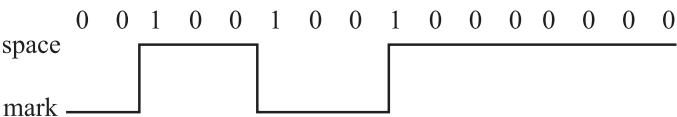
The preceding byte ends with a mark



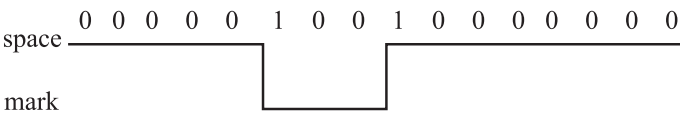
The preceding byte ends with a space

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Figure 23 - PA 1 patterns in State 3 and State 4



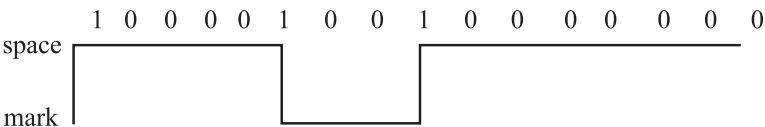
The preceding byte ends with a mark



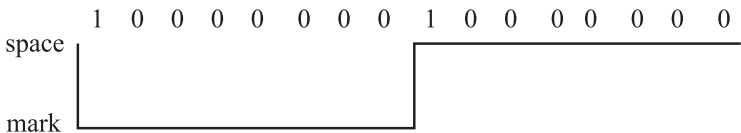
The preceding byte ends with a space

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Figure 24 - PA 2 patterns in State 1 and State 2



The preceding byte ends with a mark



The preceding byte ends with a space

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Figure 25 - PA 2 patterns in State 3 and State 4

15.7 Mirror field

This field shall have a nominal length of 32 Channel bits. This field shall have neither grooves nor embossed marks. There shall be no writing in this field.

15.8 Gap field

The Gap field shall have a nominal length of $(160 + J)$ Channel bits, where J shall be varied randomly from 0 to 15. The tolerance on the resulting nominal length shall be ± 20 Channel bits. The variation of the length of the Gap field shall be compensated by the length of the Buffer field. See annex K.

Its contents are not specified and shall be ignored on interchange, but shall not be embossed. It is the first field of the Recording field, and gives a drive time for processing after it has finished reading the Header field and before it has to write the Guard 1 field or read the VFO 3 field.

15.9 Guard 1 field

The Guard 1 field shall have a nominal length of $(20 + K)$ bytes, where K shall be varied randomly from 0 to 7 bytes to shift the position of the marks formed in the fields following from the VFO 3 field to the Guard 2 field of the Recording field. See annex K.

The first 20 bytes of the Guard 1 field protect the beginning of the VFO 3 field from signal degradation after overwriting many times. Their contents shall be ignored on reading.

The Guard 1 field shall contain $(20 + K)$ times the 16 Channel bit pattern

1000 1000 1000 1000

15.10 Pre-Synchronous code (PS) field

The PS field is intended to allow the drive to achieve byte synchronization for the following Data field.

It shall contain the 48-Channel bit pattern

0000 0100 0100 1000 0010 0001 0010 0000 1000 0010 0001 0000

15.11 Data field

This field shall be recorded with the format specified in clause 13.

15.12 Postamble 3 (PA 3) field

The PA 3 field shall be equal in length to 16 Channel bits. The PA 3 field allows closure of the last byte of the preceding Data field as required by the 8-to-16 recording code.

For State 1 and State 2, it shall be set to

0001 0010 0100 0100 / 0001 0010 0000 0100

State 3 and State 4, it shall be set to

1001 0010 0000 0100 / 1001 0010 0100 0100

In demodulating, PA 3 can be used as the first 16 Channel bits of SY0 in the next Data field.

15.13 Guard 2 field

The Guard 2 field shall have a nominal length of $(55-K)$ bytes, where K shall be varied from 0 to 7 so that the total length of Guard 1 field and Guard 2 field shall be equal to 75 bytes. The last 20 bytes of the Guard 2 field protect the end of the Data field from degradation after overwriting many times. The rest of the Guard 2 field takes up the variation of actual length of the written data. Its contents shall be ignored in interchange.

The Guard 2 field shall be set to $(55-K)$ times the 16-Channel bit pattern

1000 1000 1000 1000