INTERNATIONAL STANDARD

ISO/IEC 15486

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Information technology — Data interchange on 130 mm optical disk cartridges of type WORM (Write Once Read Many) using irreversible effects — Capacity: 2,6 Gbytes per cartridge

Technologies de l'information — Échange de données sur cartouches de disque optique de 130 mm *de type WORM utilisant des effets irréversibles — Capacité:* 2,6 Gbytes *par cartouche*

Reference number
ISO/IEC 15486:1998(E)

Contents

Foreword

ISO (the International Organization for Standardization) and IEC (the International Electrotechnical Commission) form the specialized system for worldwide standardization. National bodies that are members of ISO or IEC participate in the development of International Standards through technical committees established by the respective organization to deal with particular fields of technical activity. ISO and IEC technical committees collaborate in fields of mutual interest. Other international organizations, governmental and non-governmental, in liaison with ISO and IEC, also take part in the work.

In the field of information technology, ISO and IEC have established a joint technical committee, ISO/IEC JTC 1. Draft International Standards adopted by the joint technical committee are circulated to national bodies for voting. Publication as an International Standard requires approval by at least 75 % of the national bodies casting a vote.

International Standard ISO/IEC 15486 was prepared by ECMA (as ECMA-238) 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.

Annexes A to N form an integral part of this International Standard. Annexes P to W are for information only.

Information technology — Data interchange on 130 mm optical disk cartridges of type WORM (Write Once Read Many) using irreversible effects — Capacity: 2,6 Gbytes per cartridge

Section 1 - General

1 Scope

This International Standard specifies the characteristics of a 130 mm optical disk cartridge (ODC) of Type WORM (Write Once Read Many) with a capacity of 2,6 Gbytes. Type WORM ODCs use writing effects that are inherently irreversible. Written marks cannot be erased and attempted modification of the written marks are detectable.

This International Standard specifies

- the conditions for conformance testing and the Reference Drive;
- the environments in which the cartridges are to be operated and stored;
- the mechanical, physical and dimensional characteristics of the cartridge, so as to provide mechanical interchange ability between data processing systems;
- the format of the information on the disk, both embossed and user-written, including the physical disposition of the tracks and sectors, the error correction codes, the modulation methods used;
- the characteristics of the embossed information on the disk;
- the recording characteristics of the disk, enabling processing systems to write data onto the disk;
- the minimum quality of user-written data on the disk, enabling data processing systems to read data from the disk.

This International Standard provides for interchange between optical disk drives. Together with a standard for volume and file structure it provides for full data interchange between data processing systems.

2 Conformance

2.1 Optical Disk Cartridge (ODC)

An Optical Disk Cartridge shall be in conformance with this International Standard if it meets the mandatory requirements specified herein. A claim of conformance shall state that the ODC is of Type WORM.

2.2 Generating system

A generating system shall be in conformance with this International Standard if the ODC 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 an ODC according to 2.1

2.4 Compatibility statement

A claim of conformance by a generating or receiving system with this International Standard shall include a statement listing any other International Optical Disk Cartridge standard(s) supported by the system for which conformance is claimed. This statement shall specify the number of the standard(s), including, where appropriate, the ODC Type(s), or the Types of side, and whether support includes reading only or both reading and writing.

3 Normative reference

The following standard contains provisions which, through reference in this text, constitute provisions of this International Standard. At the time of publication, the edition indicated was valid. All standards are subject to revision, and parties to agreements based on this International Standard are encouraged to investigate the possibility of applying the most recent edition of the standard indicated below. Members of IEC and ISO maintain registers of currently valid International Standards.

IEC 950:1991, *Safety of information technology equipment.*

4 Definitions

For the purposes of this International Standard, the following definitions apply.

4.1 band: An annular area within the user zone on the disk having a constant clock frequency.

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

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

4.4 control track: A track containing the information on media parameters and format necessary for writing, reading and erasing (read/write disks only) the remaining tracks on the optical disk.

4.5 Cyclic Redundancy Check (CRC): A method for detecting errors in data.

4.6 defect management: A method for handling the defective areas on the disk.

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

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

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

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

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

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

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

4.14 logical track: 17 consecutive sectors in one or more physical tracks. The first sector of each logical track is assigned sector number 0.

4.15 mark: A feature of the recording layer which may take the form of a crystalline region a pit, or any other type or form that can be sensed as a reflectivity change by the optical system. The pattern of marks represents the data on the disk.

Note - Subdivisions of a sector which are named "mark" are not marks in the sense of this definition

4.16 mark edge: The transition between a region with a mark and one without a mark or vice versa, along the track.

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

4.18 optical disk: A disk that will accept and retain information in the form of marks in a recording layer, that can be read with an optical beam.

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

4.20 physical track: The path which is followed by the focus of the optical beam during one revolution of the disk. This path is not directly addressable.

4.21 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.

4.22 pre-recorded mark: An unalterable mark recorded or embossed onto the disk prior to customer use.

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

Note - It is specified as a maximum power that may be used without damage to the written data. Lower power may be used providing that the signal-to-noise ratio and other requirements of this International Standard are met.

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

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

4.26 **space:** The area between marks along the track.

4.27 **spindle:** The part of the disk drive which contacts the disk and/or hub.

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

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

4.30 **write-inhibit hole:** A hole in the case which, when detected by the drive to be open, inhibits write operations.

4.31 **zone:** An annular area of the disk.

5 Conventions and notations

5.1 Representation of numbers

- A measured value is rounded off to the least significant digit of the corresponding specified value. It implies that a specified value of 1,26 with a positive tolerance of +0,01, and a negative tolerance of -0,02 allows a range of measured values from 1,235 to 1,275.
- Letters and digits in parentheses represent numbers in hexadecimal notation.
- The setting of a bit is denoted by ZERO or ONE.
- Numbers in binary notation and bit combinations are represented by strings of digits 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 last, the most significant bit (numbered 7 in an 8-bit byte) is recorded first. This order of recording applies also to the data input of the Error Detection and Correction circuits and their output.

5.2 Names

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

6 List of acronyms

ALPC	Auto Laser Power Control
AM	Address Mark
CRC	Cyclic Redundancy Code
DMA	Defect Management Area
DMP	Defect Management Pointers
DST	Disk Structure Table
ECC	Error Correction Code
EDAC	Error Detection And Correction Code
ID	Identifier
LBA	Logical Block Address
LSB	Least Significant Byte
MO	Magneto-Optical
MSB	Most Significant Byte
ODC	Optical Disk Cartridge
PA	Postamble
PDL	Primary Defect List
PRA	Primary Reserved Area
PEP	Phase-Encoded Part of the Control Tracks
RLL(1,7)	Run Length Limited (code)
R-S	Reed-Solomon (code)
R/W	Rewritable
R-S/LDC	Reed-Solomon Long Distance Code
SCSI	Small Computer System Interface
SDL	Secondary Defect List
SFP	Standard Formatted Part of the Control Tracks

SM	Sector Mark
SRA	Secondary Reserved Area
TIA	Time Interval Analyzer
VFO	Variable Frequency Oscillator
WO	Write Once
WORM	Write Once Read Many
ZCAV	Zoned Constant Angular Velocity

7 General description of the optical disk cartridge

The optical disk cartridge which is the subject of this International Standard consists of a case containing an optical disk.

The case is a protective enclosure for the disk. It has access windows covered by a shutter. The windows are automatically uncovered by the drive when the cartridge is inserted into it.

The optical disk consists of two sides assembled together with their recording layers on the inside.

The optical disk is recordable on both sides. Data is written onto the disk with a focused optical beam as marks in the recording layer using irreversible effects, such that the marks cannot be erased or transformed back into an unrecorded state. The marks can be formed by either a phase transformation process, an ablative process, or any other irreversible process. The data are read by detecting the intensity modulation of the reflected beam caused by the difference of reflectivity of the recorded marks and the unrecorded regions. The beam accesses the recording layer through the transparent substrate of the disk.

8 General requirements

8.1 Environments

8.1.1 Test environment

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

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

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

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

8.1.2 Operating environment

This International Standard requires that an optical disk cartridge which meets all requirements of this International Standard in the specified test environment provides data interchange over the specified ranges of environmental parameters in the operating environment (See also annex Q).

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

temperature	: 5 °C to 55 °C
relative humidity	: 3 % to 85 %
absolute humidity	: 1 g/m^3 to 30 g/m^3
atmospheric pressure	: 60 kPa to 106 kPa
temperature gradient	: 10 °C/h max.
relative humidity gradient	: 10 %/h max.
air cleanliness	: office environment (see Q.1)

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

8.1.3 Storage environment

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

temperature	: -10 °C to 55 °C
relative humidity	: 3 % to 90 %
absolute humidity	: 1 g/m^3 to 30 g/m^3
atmospheric pressure	: 60 kPa to 106 kPa
temperature gradient	: 15 °C/h max.
relative humidity gradient	: 10 %/h max.
air cleanliness	: Office environment (see Q.1)

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

8.1.4 Transportation

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

8.2 Temperature shock

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

8.3 Safety requirements

The cartridge shall satisfy the safety requirements of IEC 950, when used in the intended manner or in any foreseeable use in an information processing system.

8.4 Flammability

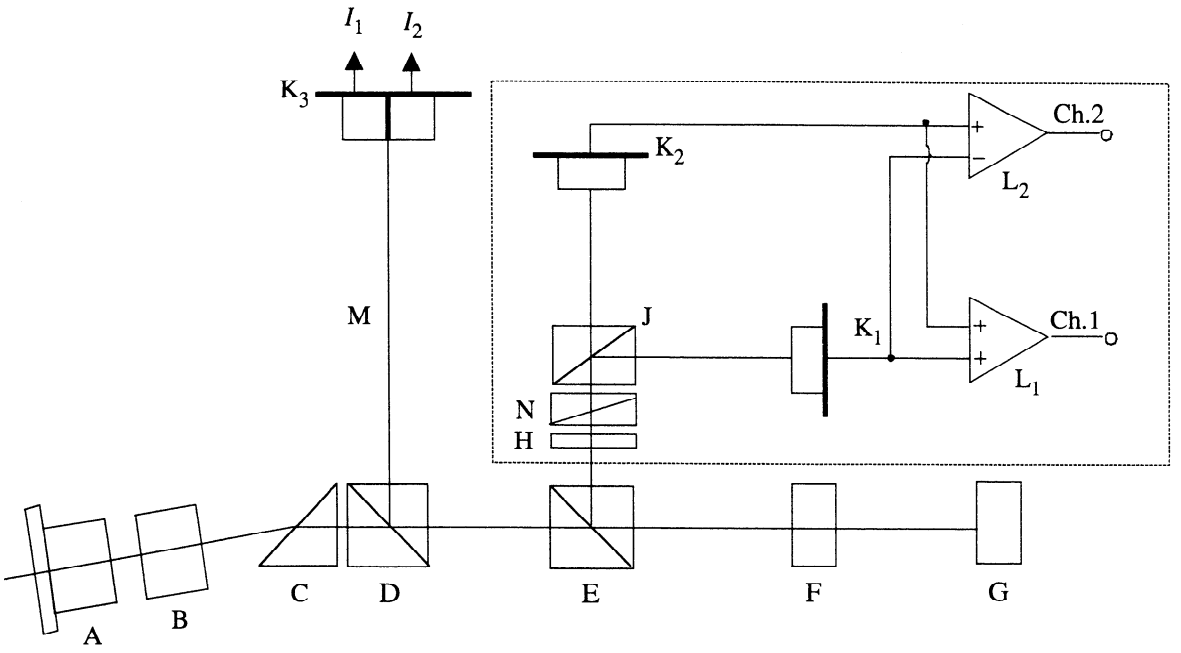
The cartridge and its components shall be made from materials that comply with the flammability class for HB materials, or better, as specified in IEC 950.

9 Reference Drive

The Reference Drive is a drive several critical components of which have well defined properties and which is used to test the write and read parameters of the disk for conformance to this International Standard. The critical components vary from test to test. This clause gives an outline of all components; components critical for tests in specific clauses are specified in those clauses.

9.1 Optical system

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



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A	Laser diode	H	Optional half-wave platc
B	Collimator lens	I_1,I_2	Tracking signals from photodiode K_3
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	d.c.-coupled amplifiers
E	Polarizing beam splitter	M	Tracking Channel (see 20.3)
F	Objective lens	N	Phase retarder
G	Optical disk		

Figure 1 - Optical system of the Reference Drive

In the absence of polarization changes in the disk, the polarizing beam splitter J shall be aligned to make the signal of detector K_1 equal to that of detector K_2. The direction of polarization in this case is called the neutral direction. The phase retarder N shall be adjusted such that the optical system does not have more than 2,5° phase retardation between the neutral polarization and the polarization perpendicular to it. This position of the retarder is called the neutral position.

The phase retarder can be used for the measurement of the narrow-band signal-to-noise ratio (see 27.2).

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

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

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

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

to make it correspond to the nominal beam splitter E.

The output of Channel 1 is the sum of the currents through photodiodes K_1 and K_2 , and is used for reading embossed marks and the user-written marks. The output of Channel 2 is the difference between photo-diode currents.

9.2 Optical beam

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

a) Wavelcngth (λ)	685 nm $^{+10\ nm}_{-10\ nm}$
b) Wavelength (λ) divided by the numerical aperture of the objective lens (NA)	λ / NA = 1,245 µm ± 0,018 µm
c) Filling D/W of the aperture of the objective lens	0,85 ± 0,05
d) Variance of the wavefront of the optical beam near the recording layer	0 to λ^2/ 330
e) Polarization	Linear - parallel to the groove
f) Extinction ratio	0,01 max.

g) The optical power and pulse width for writing and reading shall be as specified in later clauses of this International Standard.

D is the diameter of the lens aperture and W is the beam diameter of the Gaussian beam where the intensity is $1/e^2$ of the maximum intensity.

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

9.3 Read Channels

Channel 1 shall be provided to generate signals from the marks in the recording layer. Unless otherwise stated, the signal of Channel 1 is not equalized before detection. This Channel shall be used for reading the embossed marks using the diffraction of the optical beam by the marks, and shall be used for reading the written marks using the change in reflectivity of the marks. Channel 2 is used to obtain birefringence information of the disk from the signal imbalance of unwritten tracks. The read amplifiers after the photo-detectors in Channel 1 and Channel 2 shall have a flat response within 1 dB from d.c. to 28 MHz.

The signals from Channel 1 and 2 are not equalized before detection. The signals shall be low-pass filtered with a 3-pole Butterworth filter with a cut-off frequency of one half the Channel clock frequency.

9.4 Tracking

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

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

9.5 Rotation of the disk

The spindle shall position the disk as specified in 12.4. It shall rotate the disk at 50,0 Hz ± 0,5 Hz. The direction of rotation shall be counterclockwise when viewed from the objective lens.

Section 2 - Mechanical and physical characteristics

10 Dimensional and physical characteristics of the case

10.1 General description of the case

The case (see figure 3) is a rigid protective container of rectangular shape. It has spindle windows on both sides to allow the spindle of the drive to clamp the disk by its hub. Both sides of the case have a head window, one for the optical head of the drive, the other for the magnetic head of a multifunction drive that provides magnetic fields when using MO rewritable media.