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Information technology — Digitally recorded media for information interchange and storage — Data migration method for DVD-R, DVD-RW, DVD-RAM, +R, and +RW disks

Technologies de l'information — Supports enregistrés numériquement pour échange et stockage d'information — Méthode de migration de données pour disques DVD-R, DVD-RW, DVD-RAM, +R, et +RW

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ISO copyright office
Case postale 56 • CH-1211 Geneva 20
Tel. + 41 22 749 01 11
Fax + 41 22 749 09 47
E-mail copyright@iso.org
Web www.iso.org

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Contents

Page

Foreword iv

Introduction v

1 Scope 1

2 Normative references 1

3 Terms and definitions 2

4 Test methods 3
4.1 Test parameters 3
4.2 Test Drive 3
4.2.1 Test drive calibration 3
4.2.2 Test preparation 4
4.2.3 Test execution 4
4.3 Test area 4

5 Test result evaluation 4
5.1 Initial performance test result evaluation 4
5.2 Periodical performance test result evaluation 5

6 Test frequency 6

7 Prevention of deterioration 6

Annex A (informative) **Causes of deterioration for DVD-R, DVD-RW, DVD-RAM, +R, and +RW disks** 7
A.1 Deterioration 7
A.2 Disk structure 7
A.3 Causes of deterioration 7
A.4 Nature of deterioration 8
A.5 Effects of deterioration 8

Annex B (informative) **Recommendations on handling, storage and cleaning conditions for DVD-R, DVD-RW, DVD-RAM, +R, and +RW disks** 9
B.1 Handling 9
B.2 Storage 9
B.3 Cleaning 10

Annex C (informative) **Relation between BER and PIE SUM 8** 11

Annex D (informative) **Normalization of the time scales** 12

Annex E (informative) **Test area** 14

Bibliography 15

Foreword

ISO (the International Organization for Standardization) is a worldwide federation of national standards bodies (ISO member bodies). The work of preparing International Standards is normally carried out through ISO technical committees. Each member body interested in a subject for which a technical committee has been established has the right to be represented on that committee. International organizations, governmental and non-governmental, in liaison with ISO, also take part in the work. ISO collaborates closely with the International Electrotechnical Commission (IEC) on all matters of electrotechnical standardization.

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

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

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ISO/IEC 29121 was prepared by Joint Technical Committee ISO/IEC JTC 1, *Infomation technology*, Subcommittee SC 23, *Digitally Recorded Media for Information Interchange and Storage*.

Introduction

Many organizations now use optical disks for long-term storage of information. It is assumed that a disk selected for recording has already been qualified for that purpose. It is therefore important to be able to verify that data has been recorded correctly and remains readable for the required amount of time. Previous ISO standards clearly defined requirements for interchange, but did not contain requirements for longevity.

Longevity is limited both by disk degradation and by technology obsolescence. Interchange must be regularly verified to assure that information on existing recorded disks will continue to be recoverable. Users may have a maintenance policy that protects disks against unanticipated failure or use, such as by making one archival copy, another to function as a backup or master, and another for routine access. Hardware support life cycles typically vary between 5 to 10 years and technology lifecycles usually end after 20 years. Consequently, recordings that require a longer lifecycle may have to be transferred to upgraded platforms every 10 to 20 years.

Optical disks for long-term storage should be evaluated. Significant longevity differences may exist for disks from different manufacturers and also between disks from the same manufacturer. It is preferable that the disks for long-term preservation should have a long life expectancy, which can be estimated according to ISO/IEC 10995.

Disks with an initially poor quality do not offer sufficient headroom to avoid reaching the unrecoverable error threshold before the next scheduled inspection, which for archival disks is to be avoided. This means that a disk of high initial recorded quality that maintains this condition for life is expected to have superior longevity.

Because errors in read data are corrected at error correction decoder, it is impossible to detect degradation without detecting raw error rate or raw error number. The raw error can be detected with standard test drive. Quality of the disk can be specified by the number of erroneous inner parity with DVD-R, DVD-RW, +R, and +RW disks. That of DVD-RAM disk is defined by byte error rate. Deterioration can be monitored by checking the raw error numbers and must continue to be monitored. Methods described in this standard define a quality control policy that can non-destructively identify degradation, and thereby support timely and effective corrective action.

DVD-R, DVD-RW, DVD-RAM, +R, and +RW disks are based on the technology now widely known as DVD in the market; i.e. the use of red Laser Diode, the use of two 0,6 mm thick substrates bonded together by an adhesive layer to protect the disks from dust combined with Write Once recording layers (DVD-R, +R) or Phase Change recording layers (DVD-RW, DVD-RAM, +RW), the use of a 0,60 or 0,65 NA objective lens to ensure good spatial margins required for a professional data archive solution, and the use of dual recording layers with a spacer between them in addition to conventional single recording layer.

Information technology — Digitally recorded media for information interchange and storage — Data migration method for DVD-R, DVD-RW, DVD-RAM, +R, and +RW disks

1 Scope

This International Standard provides specifications of the data migration method for archival data storage which allow manufacturers storage systems that use DVD-R (ISO/IEC 23912:2005), DVD-RW (ISO/IEC 17342:2004), DVD-RAM (ISO/IEC 17592:2004), +R (ISO/IEC 17344:2006 and ISO/IEC 25434:2007), and +RW (ISO/IEC 17341:2006 and ISO/IEC 26925:2006) disks for information storage to classify disk longevity potential on the basis of initial performance requirements and to allow users to monitor continuing conformance with the error limits required for its class identified by the manufacturer of the drive/disk. Digital data can be migrated to a next new disk without loss from the present disk as far as the data errors are completely corrected before and during the migration and the copy of the data is allowed.

The methodology for data migration does not apply to disks with short archival storage time but to disks with long archival storage time. Disks with shorter archival storage time have more rapid degradation and require more frequent periodical tests. In addition, degradation of recorded data has a complex failure mechanism. Archival storage time, therefore, varies depending not only on temperature and humidity but also on many other effects, such as exposure to light, corrosive gases, contaminations, handling, and variation in playback subsystems. Consequently, severer storage environment requires more frequent periodical tests. Frequency of periodical tests is based on the quality of the disks for storing data and the storage environment.

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.

ISO/IEC 10995:2008 *Information technology — Digitally recorded media for information interchange and storage — Test method for the estimation of the archival lifetime of optical media*

ISO/IEC 16448:2002 *Information technology — 120 mm DVD — Read-only disk*

ISO/IEC 17592 *Information technology — 120 mm (4,7 Gbytes per side) and 80 mm (1,46 Gbytes per side) DVD rewritable disk (DVD-RAM)*

3 Terms and definitions

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

3.1
archival
having ability of a medium or system to maintain the retrievability of recorded information for a specified extended period of years

3.2
BER max
maximum byte error rate at any consecutive 32 ECC blocks on a disk as measured in the first pass of the decoder before correction

3.3
data migration
process to copy data from one storage device or medium to another

3.4
error correction code
ECC
mathematical computation yielding check bytes used for the detection and correction of errors in data

NOTE For DVD-R, DVD-RW, DVD-RAM, +R, and +RW disks, the Reed-Solomon product code defined in ISO/IEC 16448:2002 for DVD-ROM systems is applied.

3.5
error rate
rate of errors on the recorded disk measured before error correction is applied

3.6
initial performance test
test of the recording performance of data recorded on a disk before storing

3.7
life expectancy
estimated lifetime

3.8
lifetime
time that information is retrievable in a system

3.9
PIE SUM 8 max
maximum inner parity error at any consecutive 8 ECC blocks on a disk as measured in the first pass of the decoder before correction

NOTE See ISO/IEC 16448:2002, ISO/IEC 23912:2005, ISO/IEC 17341:2005, ISO/IEC 17342:2004 and ISO/IEC 17344:2006.

3.10
periodical performance test
periodical test of the recording performance of data recorded on a disk during the storage

3.11
retrievability
ability to recover physical information as recorded

3.12
stress
temperature and relative humidity variables to which the recorded disk is exposed for the duration of test intervals

3.13
storage time
time that a disk is being stored since data is recorded on the disk

3.14
substrate
transparent layer of the disk, provided for mechanical support of the recording or recorded layer, through which the optical beam accesses the recordable / recorded layer

3.15
system
combination of hardware, software, storage medium and documentation used to record, retrieve and reproduce information

3.16
uncorrectable error
error in the playback data that could not be corrected by the error correcting decoders

4 Test methods

4.1 Test parameters

For DVD-R, DVD-RW, +R, and +RW disks, the maximum inner parity error shall be measured at any consecutive 8 ECC blocks (PIE SUM 8 max) in the first pass of the decoder before correction.

For a DVD-RAM disk, the maximum Byte error rate (BER max) shall be measured (see Annex C).

The objective of this test method is to establish a practical estimation of the retrievability of the recorded data on a disk without producing uncorrectable errors, in response to time at controlled stress conditions to produce accelerated aging.

In this case, measuring the PIE SUM 8 max or the BER max is principal method to estimate actual retrievability of a disk instead of measuring other parameters to confirm the disk quality specified in each specifications.

4.2 Test Drive

Test drive shall comply with ISO/IEC 16448 for DVD-R, DVD-RW, +R, and +R disks and ISO/IEC 17592 for DVD-RAM disk or shall be equivalent. It shall have capability to measure the PIE SUM 8 max for DVD-R, DVD-RW, +R, and +RW disks and the BER max for a DVD-RAM disk, respectively.

4.2.1 Test drive calibration

The test drive shall be calibrated by using a calibration disk prepared by the test drive manufacturer based on the calibration procedure defined by the manufacturer. The calibration shall be done at the intervals recommended by the manufacturer.

4.2.2 Test preparation

Prior to conducting tests, the disks shall be visually examined to determine whether it contains dust, finger prints, or other contaminants. If appropriate, such contaminants shall be removed in accordance with the disk manufacturer's recommendations. Certain options are contained in Annex A. Microscopic examination may reveal physical deterioration, such as delamination and porosity of the protective coating.

4.2.3 Test execution

Before testing disks, the test drive shall be verified by checking the calibration disk supplied with the test drive or publicly verified. If the drive passes the calibration check, the disk to be checked shall be tested by the test drive.

Test results shall be judged by the PIE SUM 8 max for DVD-R, DVD-RW, +R, and +RW disks or the BER max for a DVD-RAM disk.

4.3 Test area

The entire recorded area of all the disks should be tested in order to confirm the readability of the data (see Annex E).

5 Test result evaluation

5.1 Initial performance test result evaluation

When data is recorded on disks, the initial recording performance on the whole recorded area shall be checked. The initial recording performance is categorized in Level 1, 2 and 3 by PIE SUM 8 max for DVD-R, DVD-RW, +R, and +RW disks and BER max for DVD-RAM as shown in Table 1 (see Annex C).

At least, the initial recording performance shall be within Level 1. Disks showing the initial recording performance of Level 2 should not be used for archival use and those of Level 3 are out of the specification and shall not be used.

If the initial recording performance is worse than Level 1, the performance of the disk and drive used for recording the data should be verified because PIE SUM 8 max and BER max depend both on the performance of disks and drives. If the drive is not good, the drive should be replaced. If the disk is not good, another lot of disks should be used.

Table 1 — Category of initial recording performance

Level	Status	DVD-R, DVD-RW, +R, +RW	DVD-RAM
1	Recommended	< 140	$< 5{,}0\text{X}10^{-4}$
2	Should not be used	140 – 280	$5{,}0\text{X}10^{-4} – 1{,}0\text{X}10^{-3}$
3	Shall not be used	> 280	$> 1{,}0\text{X}10^{-3}$
Recording performance indicator		PIE SUM 8 max	BER max

5.2 Periodical performance test result evaluation

Disks used for storing data should be periodically checked with the test frequency described in Clause 6. The recording performance at the periodical performance test is categorized in Level 4, 5 and 6 by PIE SUM 8 max for DVD-R, DVD-RW, +R, and +RW disks and BER max for DVD-RAM as shown in Table 2 (see Annex C).

If the recording performance is within Level 4, the performance of the disk is good enough to be continuously used.

If the recording performance is within Level 5, the data stored on the disk shall be migrated to another disk as soon as possible.

If the recording performance is in Level 6, the data stored on the disk shall be copied to another disk immediately as far as the data can be retrieved, Please note that PIE SUM 8 max and BER max higher in Level 6 may disable to retrieve the data due to uncorrectable errors.

Data migration flow for the initial performance test and periodical performance test is shown in Figure 1.

Table 2 — Category of recording performance at periodical performance test

Level	Status	DVD-R, DVD-RW, +R, +RW	DVD-RAM
4	Use as it is	< 200	< $7{,}1X10^{-4}$
5	Migrate data as soon as possible	200 – 280	$7{,}1X10^{-4}$ – $1{,}0X10^{-3}$
6	Migrate data immediately	> 280	> $1{,}0X10^{-3}$
Recording performance indicator		PIE SUM 8 max	BER max