IEC 62702-1-1

Edition 2.0 2022-06
REDLINE VERSION

INTERNATIONAL STANDARD

colour inside

Audio archive system –
Part 1-1: DVD disk and data migration for long-term audio data storage

IEC 62702-1-1:2022-06 RLV(en)

IEC Secretariat
3, rue de Varembé
CH-1211 Geneva 20
Switzerland

Tel.: +41 22 919 02 11
info@iec.ch
www.iec.ch

About the IEC
The International Electrotechnical Commission (IEC) is the leading global organization that prepares and publishes International Standards for all electrical, electronic and related technologies.

About IEC publications
The technical content of IEC publications is kept under constant review by the IEC. Please make sure that you have the latest edition, a corrigendum or an amendment might have been published.

IEC publications search - webstore.iec.ch/advsearchform
The advanced search enables to find IEC publications by a variety of criteria (reference number, text, technical committee, …). It also gives information on projects, replaced and withdrawn publications.

IEC Just Published - webstore.iec.ch/justpublished
Stay up to date on all new IEC publications. Just Published details all new publications released. Available online and once a month by email.

IEC Customer Service Centre - webstore.iec.ch/csc
If you wish to give us your feedback on this publication or need further assistance, please contact the Customer Service Centre: sales@iec.ch.

IEC Products & Services Portal - products.iec.ch
Discover our powerful search engine and read freely all the publications previews. With a subscription you will always have access to up to date content tailored to your needs.

Electropedia - www.electropedia.org
The world's leading online dictionary on electrotechnology, containing more than 22 300 terminological entries in English and French, with equivalent terms in 19 additional languages. Also known as the International Electrotechnical Vocabulary (IEV) online.

IEC 62702-1-1

Edition 2.0 2022-06
REDLINE VERSION

INTERNATIONAL STANDARD

colour inside

Audio archive system –
Part 1-1: DVD disk and data migration for long-term audio data storage

INTERNATIONAL
ELECTROTECHNICAL
COMMISSION

ICS 33.160.30; 35.220.30

ISBN 978-2-8322-3915-5

Warning! Make sure that you obtained this publication from an authorized distributor.

CONTENTS

INTERNATIONAL ELECTROTECHNICAL COMMISSION

_____

AUDIO ARCHIVE SYSTEM –

Part 1-1: DVD disk and data migration for long-term audio data storage

FOREWORD

1) The International Electrotechnical Commission (IEC) is a worldwide organization for standardization comprising all national electrotechnical committees (IEC National Committees). The object of IEC is to promote international co-operation on all questions concerning standardization in the electrical and electronic fields. To this end and in addition to other activities, IEC publishes International Standards, Technical Specifications, Technical Reports, Publicly Available Specifications (PAS) and Guides (hereafter referred to as "IEC Publication(s)"). Their preparation is entrusted to technical committees; any IEC National Committee interested in the subject dealt with may participate in this preparatory work. International, governmental and non-governmental organizations liaising with the IEC also participate in this preparation. IEC collaborates closely with the International Organization for Standardization (ISO) in accordance with conditions determined by agreement between the two organizations.
2) The formal decisions or agreements of IEC on technical matters express, as nearly as possible, an international consensus of opinion on the relevant subjects since each technical committee has representation from all interested IEC National Committees.
3) IEC Publications have the form of recommendations for international use and are accepted by IEC National Committees in that sense. While all reasonable efforts are made to ensure that the technical content of IEC Publications is accurate, IEC cannot be held responsible for the way in which they are used or for any misinterpretation by any end user.
4) In order to promote international uniformity, IEC National Committees undertake to apply IEC Publications transparently to the maximum extent possible in their national and regional publications. Any divergence between any IEC Publication and the corresponding national or regional publication shall be clearly indicated in the latter.
5) IEC itself does not provide any attestation of conformity. Independent certification bodies provide conformity assessment services and, in some areas, access to IEC marks of conformity. IEC is not responsible for any services carried out by independent certification bodies.
6) All users should ensure that they have the latest edition of this publication.
7) No liability shall attach to IEC or its directors, employees, servants or agents including individual experts and members of its technical committees and IEC National Committees for any personal injury, property damage or other damage of any nature whatsoever, whether direct or indirect, or for costs (including legal fees) and expenses arising out of the publication, use of, or reliance upon, this IEC Publication or any other IEC Publications.
8) Attention is drawn to the Normative references cited in this publication. Use of the referenced publications is indispensable for the correct application of this publication.
9) Attention is drawn to the possibility that some of the elements of this IEC Publication may be the subject of patent rights. IEC shall not be held responsible for identifying any or all such patent rights.

This redline version of the official IEC Standard allows the user to identify the changes made to the previous edition IEC 62702-1-1:2016. A vertical bar appears in the margin wherever a change has been made. Additions are in green text, deletions are in strikethrough red text.

IEC 62702-1-1 has been prepared by technical area 6: Storage media, storage data structures, storage systems and equipment, of IEC technical committee 100: Audio, video and multimedia systems and equipment. It is an International Standard.

This second edition cancels and replaces the first edition published in 2016. This edition constitutes a technical revision.

In order to reflect the updates to ISO/IEC 29121:2021, this edition includes the following significant technical changes with respect to the previous edition:

a) ISO/IEC 16963 has been identified as the referee test method for the estimation of lifetime;
b) the ambient conditions for the measurement of maximum data error have been added;
c) the requirements for test drives have been changed considering the use condition of users;
d) the requirements for the estimated lifetime have been defined more clearly;
e) the requirements for the periodic performance test have been defined more clearly.

The text of this International Standard is based on the following documents:

Draft	Report on voting
100/3670/CDV	100/3742/RVC

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

The language used for the development of this International Standard is English.

A list of all parts in the IEC 62702 series, published under the general title *Audio archive system*, can be found on the IEC website.

This document was drafted in accordance with ISO/IEC Directives, Part 2, and developed in accordance with ISO/IEC Directives, Part 1 and ISO/IEC Directives, IEC Supplement, available at www.iec.ch/members_experts/refdocs. The main document types developed by IEC are described in greater detail at www.iec.ch/standardsdev/publications.

The committee has decided that the contents of this document will remain unchanged until the stability date indicated on the IEC website under webstore.iec.ch in the data related to the specific document. At this date, the document will be

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

IMPORTANT – The "colour inside" logo on the cover page of this document indicates that it contains colours which are considered to be useful for the correct understanding of its contents. Users should therefore print this document using a colour printer.

INTRODUCTION

Sound recordings such as music, speech, and storytelling are an important human heritage and should be preserved for as long as possible. However, we were not able to record sounds in order to preserve them in the past. The first recording system, the phonautograph, was invented by Édouard-Léon Scott de Martinville in 1860 and, after that, Thomas Alva Edison invented the recording and playback system known as the phonograph in 1877.

Although various technologies were invented later, most of them have limitations for audio archives because storage lifetime is limited, and the sound quality deteriorates when it is transferred to the next generation of storage device.

The progress of LSI (Large-Scale Integrated Circuit) technology made digital recording of recorded sound possible. Digital recording is very suitable for audio archiving because the migration is performed by copying digital data.

For this purpose, various recording materials exist, such as optical disks, magnetic disks, magnetic tape, and non-volatile memory (such as phase-change memory).

This International Standard specifies physical and logical aspects for standards of audio archives of various storage types which are typically used for audio archives on the market.

The IEC 62702 series currently consists of:

- Part 1 specifies the minimum requirements on physical aspects of optical disks for digital sound recordings. Part 1-1 specifies DVD optical disks, and Part 1-2 specifies BD optical disks.

  NOTE DVD optical disks include DVD-R disk, DVD-RW disk, DVD-RAM disk and +R format disk, +RW format disk. BD optical disks include BD recordable disk and BD rewritable disk.

- Part 2 specifies the minimum requirements for digitization of content, format of digitised content, content information and media inspection.

AUDIO ARCHIVE SYSTEM –

Part 1-1: DVD disk and data migration for long-term audio data storage

1 Scope

This part of IEC 62702 specifies a method of data-quality assurance for writable DVD disks (hereafter referred to as "disks") which are specified for long-term data storage, and a data migration method which can sustain the recorded data on disks for long-term audio data preservation. The writable disks include recordable disks such as DVD-R, and +R format, and rewritable disks such as DVD-RW, +RW format and DVD-RAM.

2 Normative references

The following documents are referred to in the text in such a way that some or all of their content constitutes requirements 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 16448:2002, *Information technology – 120 mm DVD – Read-only disk*~~

ISO/IEC 16963:2017, *Information technology – Digitally recorded media for information interchange and storage – Test method for the estimation of lifetime of optical ~~media~~ disks for long-term data storage*

ISO/IEC 29121:~~2013~~2021, *Information technology – Digitally recorded media for information interchange and storage – Data migration method for ~~DVD-R, DVD-RW, DVD-RM, +R, and +RW disks~~ optical disks for long-term data storage*

3 Terms and definitions

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

ISO and IEC maintain terminological databases for use in standardization at the following addresses:

- IEC Electropedia: available at http://www.electropedia.org/
- ISO Online browsing platform: available at https://www.iso.org/obp

3.1
B_{mig} life
lifetime (3.10) for use of *data migration* (3.6) and identical to $B_{0,000\ 1}$ life, which is 0,000 001 quantile of the lifetime distribution (i.e. 0,000 1 % failure time) or 99,999 9 % survival lifetime

[SOURCE: ISO/IEC 29121:2021, 3.1]

3.2
B_5 life
5 percentile of the *lifetime* (3.10) distribution (i.e. 5 % failure time) or 95 % survival lifetime

[SOURCE: ISO/IEC 16963:2017, 3.4]

3.3
(B_5 life)$_L$
95 % lower confidence bound of B_5 *life* (3.2)

[SOURCE: ISO/IEC 16963:2017, 3.5]

3.4
B_{50} life
50 percentile of the *lifetime* (3.10) distribution (i.e. 50 % failure time) or 50 % survival lifetime

[SOURCE: ISO/IEC 16963:2017, 3.6]

3.5
controlled storage condition
well-controlled storage conditions with full-time air conditioning (25 °C and 50 % relative humidity) in which the *lifetime* (3.10) of data stored on optical ~~media may be extended~~ disks

~~Note 1 to entry: Refer ISO/IEC 16963.~~

[SOURCE: ISO/IEC 16963:2017, 3.7]

3.6
data migration
process to copy data from one storage device or medium to another

[SOURCE: ISO/IEC 29121:2021, 3.5]

3.7
error correction code
ECC
mathematical computation yielding check bytes used for the detection and correction of errors in data

Note 1 to entry: For DVD-R, DVD-RW, DVD-RAM, +R format, and +RW format disks, the Reed-Solomon product code defined in ISO/IEC 16448:2002 for DVD-ROM systems is applied.

Note 2 to entry: This note applies to the French language only.

[SOURCE: ISO/IEC 29121:2021, 3.6 modified — Note 1 to entry has been shortened to apply only to DVDs.]

3.8
error rate
rate of errors or error count ~~on the recorded disk~~ measured ~~before~~ on the signal at the input of error-correction decoder ~~is applied~~, which represents raw-error rate of data recorded on a disk

[SOURCE: ISO/IEC 29121:2021, 3.7]

3.9
initial performance test
first test of the ~~recording performance~~ *error rate* (3.8) of data recorded on a disk before storing

[SOURCE: ISO/IEC 29121:2021, 3.8]

3.10
lifetime
time that information is retrievable in a *system* (3.17)

[SOURCE: ISO/IEC 29121:2021, 3.9]

3.11
maximum byte-error rate
~~**BER max**~~ **BER_{max}**
~~maximum~~ greatest level of byte error rate at any consecutive 32 *error correction code* (3.7) blocks ~~on a~~ in one of relevant area of the disk as measured in the first pass of the decoder before correction

Note 1 to entry: ~~BER max~~ BER_{max} is applied to DVD-RAM disks.

Note 2 to entry: This note applies to the French language only.

[SOURCE: ISO/IEC 29121:2021, 3.10]

3.12
maximum data error
greatest level of *error rate* (3.8) anywhere in one of the relevant areas on the disk

[SOURCE: ISO/IEC 16963:2017, 3.13, modified — Note 1 to entry has been deleted.]

3.13
maximum parity inner sum 8
~~**PIE SUM 8 max**~~ **$PI_{sum\ 8,max}$**
~~maximum inner parity~~ greatest level of parity (of the) inner code error count at any consecutive 8 *error correction code* (3.7) blocks ~~on a~~ in one of the relevant areas of the disk as measured in the first pass of the decoder before correction

~~Note 1 to entry: PIE SUM 8 max is applied to DVD-R, DVD-RW, +R, and +RW disks.~~

~~Note 2 to entry: This note applies to the French language only.~~

Note 1 to entry: See ISO/IEC 16448, ISO/IEC 23912, ISO/IEC 17341, ISO/IEC 17342 and ISO/IEC 17344.

[SOURCE: ISO/IEC 29121:2021, 3.13]

3.14
periodic performance test
periodic test of the ~~recording performance~~ *error rate* (3.8) of data recorded on a disk during the storage

[SOURCE: ISO/IEC 29121:2021, 3.15]

3.15
retrievability
ability to recover physical information as recorded

[SOURCE: ISO/IEC 16963:2017, 3.14]

3.16
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

[SOURCE: ISO/IEC 16448:2002, 4.18]

3.17
system
combination of hardware, software, storage medium and documentation used to record, retrieve and reproduce information

[SOURCE: ISO/IEC 16963:2017, 3.20]

3.18
uncorrectable error
error in the ~~playback~~ read-out data that could not be corrected by the error correcting decoders

[SOURCE: ISO/IEC 29121:2021, 3.18]

3.19
X_{mig} ~~Life~~ interval
migration interval (year) which is determined by user

[SOURCE: ISO/IEC 29121:2021, 3.19 modified — Note 1 to entry has been deleted.]

4 Disk and lifetime for long-term audio data storage

4.1 Disk for long-term audio data storage

A disk with a specified lifetime should be used for long-term audio data storage. A disk with an unspecified lifetime should not be used.

4.2 Lifetime estimation

For the purposes of this document, the lifetime of a disk shall be derived from the measurements specified in ISO/IEC 16963. The Eyring method is used for lifetime estimation under controlled storage conditions (25 °C and 50 % relative humidity).

In ISO/IEC 16963, the estimated lifetime can be defined variously as B_{50} life, B_5 life and the 95 % lower confidence bound of B_5 life [equals $(B_5 \text{ life})_L$], and described as follows.

$$B_{50\ \text{life}} = \exp\left(\ln\hat{B}_{50}\right) = \exp\left(\hat{\beta}_0 + \hat{\beta}_1 x_{10} + \hat{\beta}_2 x_{20}\right)$$

$$B_{5\ \text{life}} = \exp\left(\ln\hat{B}_5\right) = \exp\left(\hat{\beta}_0 + \hat{\beta}_1 x_{10} + \hat{\beta}_2 x_{20} - 1{,}64\hat{\sigma}\right)$$

Where

$B_{50\ \text{life}}$ is the variable for B_{50} life;

$B_{5\ \text{life}}$ is the variable for B_5 life;

x_{10} and x_{20} are the temperature-dependent factor and the relative-humidity-dependent factor at the controlled storage conditions (25 °C/50 % relative humidity), respectively.

Also, the 95 % lower confidence bound of B_5 life becomes:

~~$$(B_5 \text{ Life})_L \cong \exp(\ln \hat{B}_5 - 1{,}64\hat{\sigma}).$$~~

$$B_{(5\ \text{life})L} = \exp\left[\left(\ln \hat{B}_5\right)_L\right] = \exp\left[\ln \hat{B}_5 - 1{,}64\sqrt{\text{var}\left(\ln \hat{B}_5\right)}\right]$$

where

$B_{(5\ \text{life})L}$ is the variable for $(B_5\ \text{life})_L$;

$\hat{\beta}_0, \hat{\beta}_1, \hat{\beta}_2$ and estimated variance of residual errors $\hat{\sigma}_2$ $\hat{\sigma}$ are obtained using regression analysis of time-to-failure data.

4.3 B_{mig} life for long-term audio data storage

The estimated lifetime of B_5 life means 5 % of the products reach failure. It is widely used in other contexts. However, from the viewpoint of the reliability of long-term audio storage to retain the integrity of the original data, it is not appropriate to use B_5 life as the estimated lifetime when determining a test interval and deciding on data migration.

In the case of audio data migration, it is necessary to have a sufficiently low failure probability. The time at which one millionth of the products reach failure shall define, in this document, the estimated lifetime to determine test intervals and the migration interval. $B_{0{,}000\ 1}$ life is 0,000 001 quantile of the lifetime distribution (i.e. 0,000 1% failure time) and expressed as B_{mig} life in this document. B_{mig} life can be calculated using B_{50} life and B_5 life as follows (see also ISO/IEC 29121:~~2013~~2021, Annex E).

~~$$B_{0{,}000\ 1}\text{Life} = \exp\left(\ln \hat{B}_{50} - 4{,}75\hat{\sigma}\right) = \exp\left(\ln \hat{B}_{50} - 4{,}75\,\frac{\ln \hat{B}_{50} - \ln \hat{B}_5}{1{,}64}\right)$$~~

$$B_{0{,}000\ 1\ \text{life}} = \exp\left(\ln \hat{B}_{0{,}0001}\right) = \exp\left(\ln \hat{B}_{50} - 4{,}75\hat{\sigma}\right) = \exp\left(\ln \hat{B}_{50} - 4{,}75\,\frac{\ln \hat{B}_{50} - \ln \hat{B}_5}{1{,}64}\right) =$$

$$\exp\left(2{,}9\ln \hat{B}_5 - 1{,}9\ln \hat{B}_{50}\right)$$

where

$B_{0{,}000\ 1\ \text{life}}$ is the variable for $B_{0{,}000\ 1}$ life;

Thus

~~B_{mig} Life = $B_{0,000\ 1}$ Life = $\exp\left(2{,}9 \ln \hat{B}_5 - 1{,}9 \ln \hat{B}_{50}\right)$~~

$$B_{\text{mig life}} \times 24 \times 365 = B_{0,000\ 1\ \text{life}} = \exp\left(2{,}9 \ln \hat{B}_5 - 1{,}9 \ln \hat{B}_{50}\right)$$

where

$B_{\text{mig life}}$ is the variable for B_{mig} life in years.

In actual storage conditions, the temperature and relative humidity ~~may~~ can deviate from the controlled storage condition of 25 °C and 50 % relative humidity, which changes the estimated lifetime. In this case, the estimated lifetime should be adjusted according to the estimated lifetime at the actual storage conditions, as specified in ISO/IEC 29121:~~2013~~2021, Annex D.

4.4 Estimated-lifetime rank and display colour

4.4.1 Estimated-lifetime rank and display colour identification

For audio data migration, rank of B_{mig} life and its identifying display colour are defined as follows.

B_{mig} life is over 30 years, the display colour is red.

B_{mig} life is over 60 years, the display colour is green.

B_{mig} life is over 100 years, the display colour is gold.

Guidelines for use of the ranks of B_{mig} life and their display colours are shown in Annex A.

4.4.2 B_{mig} life and display colour indication on disks and packages

The rank of B_{mig} life, its display colour and the reference-controlled storage condition shall be indicated on both the disk and the packaging, excluding a two-sided disk. Indication examples for ranks and their colours are shown in Annex A.

5 Test condition, test methods and disks for audio data ~~migration~~

5.1 Ambient conditions ~~for testing~~ of maximum data error measurement

~~When performing recordings or playbacks, the air immediately surrounding the disk should have the following properties:~~

~~Recording condition 20 °C to 45 °C~~

~~Playback condition 20 °C to 45 °C~~

The ambient condition is the surrounding condition in a room where a test drive is located. The ambient conditions for the $PI_{\text{sum 8,max}}$ and BER_{max} measurements are as follows:

Temperature 15 °C to 30 °C

Relative humidity 20 % to 75%

5.2 Test methods

5.2.1 Playback test drive

For DVD-R disks, DVD-RW disks, +R format disks, and +RW format disks, the test drive shall have the capability to measure $PI_{sum\ 8,max}$.

For DVD-RAM disks, the test drive shall have capability to measure BER_{max}.

The test drive shall have the capability to evaluate the error rate level specified in the initial performance test and the periodic performance test.

The playback speed of the test drive should be:

for DVD-R, DVD-RW, +R format, and +RW format disks	4 × CLV (constant linear velocity), or 6 × CLV
for DVD-RAM disk	2 × CAV (constant angular velocity), 3 × CAV, or 5 × CAV

5.2.2 Test area ~~of recorded~~ and sample disk

The test area is the recorded area to be tested in a disk.

The whole recorded area of all disks shall be tested for the initial performance test.

The whole recorded ~~data~~ area of all disks should be tested for the periodic performance test. Although the integrity of the data becomes lower, the user may reduce the test area and/or the number of sample disks based on a certain sampling method, considering the value of the information (see ISO/IEC 29121:2021, Annex G). For the reduction of test area, see ISO/IEC 16963:2017, 7.5 for additional information. The number of sample disks should be enough to guarantee statistical effectiveness. If the sample disks have different attributes such as disk standards, recording conditions or storage conditions, the disks should be divided into groups of disks considering the attributes so that the sampling can be applied on each group with statistical effectiveness.

In case of a DVD-RAM disk, the replaced data in the defect management area, instead of the defect data in the user area, should be tested.

5.2.3 Recording test drive

There are two cases for the test drive. The first is that the drive serves as both a test drive and a recorder that records the data on the disk. The second is that the test drive is different from the recorder. For both cases, the data recorded on the disk by the recorder shall fulfil the error rate level specified in the initial performance test and the periodic performance test.

The recording speed of the test drive should be:

For DVD-R, DVD-RW, +R format and +RW format disks	4 × CLV or 6 × CLV
For a DVD-RAM disk	2 × CAV, 3 × CAV or 5 × CAV

The test drive should implement the multi-session and multi-border method for the DVD-R and +R format recordable disks and the DVD-RW rewritable disk. Archive data shall be recorded in the first session or border. The history information can be recorded on the second or subsequent session or border.

The test drive should implement the incremental write method for the DVD-RAM and +RW format rewritable disks. Data can be written to the formatted disk by simply recording files. The history information can be recorded on the disk as an additional file record.

5.2.4 Test drive ~~calibration~~ check

~~The playback and recording test drive(s) shall be calibrated by using a calibration disk prepared by the test drive manufacturer and using the calibration procedure specified by the manufacturer. The calibration shall be done at the intervals recommended by the manufacturer.~~

The test drive shall be checked by using a reference disk prepared by the test drive manufacturer or the disk prepared by the user, so that it fulfils the requirements in 5.2.1, 5.2.2 and 5.2.3. When using a reference disk prepared by the test drive manufacturer, the check of the test drive shall be done at the intervals recommended by the manufacturer. When using a disk prepared by the user, it is recommended for the user to set an appropriate interval and to check the test drive at the interval.

6 Test result evaluation

6.1 Initial performance test result evaluation

~~When data are recorded on disks, the initial recording performance on the whole recorded area shall be checked.~~ The initial recording performance shall be categorized as Levels 1, 2 ~~and~~ or 3 using ~~PIE SUM $_{8max}$~~ $PI_{sum\ 8,max}$ for DVD-R, DVD-RW, +R format, and +RW format disks, and ~~BER max~~ BER_{max} for DVD-RAM as shown in Table 1.

At the least, the initial recording performance shall be within the limits of Level 1. Disks showing the initial recording performance of Level 2 should not be used for long-term audio data storage, 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 drive used for recording the data should be verified because ~~PIE SUM 8$_{max}$~~ $PI_{sum8,max}$ and ~~BER max~~ BER_{max} depend on the performance of both disks and drives. If the drive is not good, the drive should be replaced. If the disk is not good, another batch of disks should be used.

Table 1 – Category of initial recording performance

Level	Status	DVD-R, DVD-RW, +R format, +RW format ~~PIE SUM 8 max~~	DVD-RAM ~~BER max~~
1	Recommended	< 140	$< 5{,}0 \times 10^{-4}$
2	Should not be used	140 to 280	$5{,}0 \times 10^{-4}$ to $1{,}0 \times 10^{-3}$
3	Shall not be used	> 280	$> 1{,}0 \times 10^{-3}$
Maximum data error		$PI_{sum\ 8,max}$	BER_{max}

6.2 Periodic performance test result evaluation

Disks used for storing data should be periodically checked with the test interval described in 6.5. The recording performance at the periodic performance test is categorized in Levels 4, 5 and 6 using ~~PIE SUM $_{8\ max}$~~ $PI_{sum\ 8,\ max}$ for DVD-R, DVD-RW, +R format, and +RW format disks, and ~~BER max~~ BER_{max} for DVD-RAM disk as shown in Table 2.

If the recording performance is within Level 4, the disk is good enough to continue to be stored.

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. In Level 6, ~~PIE SUM 8 max~~ $PI_{sum\ 8,\ max}$ and ~~BER max~~ BER_{max} are high enough that the retrieved data ~~may~~ can contain uncorrectable errors.

Table 2 – Category of recording performance at periodic performance test

Level	Status	DVD-R, DVD-RW, R format, RW format ~~PIE SUM 8 max~~	DVD-RAM ~~BER max~~
4	Use as it is	< 200	< $7{,}1 \times 10^{-4}$
5	Migrate data as soon as possible	200 to 280	$7{,}1 \times 10^{-4}$ to $1{,}0 \times 10^{-3}$
6	Migrate data immediately	> 280	> $1{,}0 \times 10^{-3}$
Maximum data error		$PI_{sum\ 8,max}$	BER_{max}

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

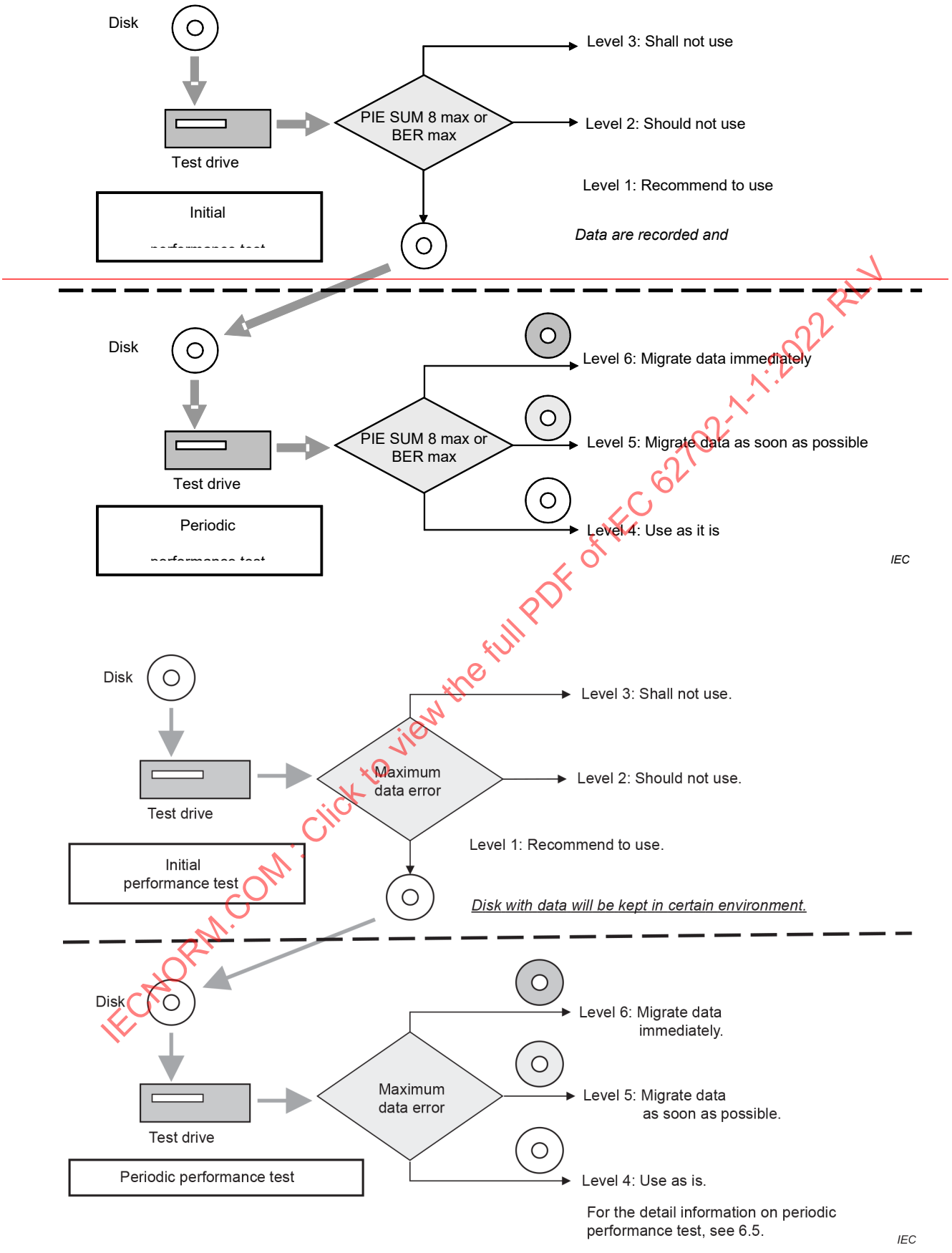


Figure 1 – Data migration flow for DVD-R, DVD-RW, DVD-RAM, +R format, and +RW format disks

6.3 Report items

6.3.1 Initial performance test result

The date and year of the initial test, the measured errors result, and the evaluation result shall be reported as part of the history of this disk. The disk type and manufacturer name, the specified rank of disk, and the next testing year and date should be reported. Moreover, the test drive manufacturer, model name and serial number should be reported.

6.3.2 Periodic performance test result

At each periodic test, the date and year of the test, the measured errors result, and history of evaluation results shall be reported. The disk type and manufacturer name, and the specified rank of the disk should be reported. Moreover, the test drive manufacturer, model name and serial number should be reported.

6.4 Management of report item

Report items shall be reported to the host computer.

Report items should be recorded on the disk, which can then be used (see Annex C).

6.5 Test and migration intervals

In this document, the test interval between periodic performance tests ~~shall be~~ is set at half of B_{mig} life. Therefore, the test interval for each rank of disk with display colour red, green and gold will be 15 years, 30 years, and 50 years, respectively.

~~If a disk with an unspecified lifetime is used, it should be tested every three years or less.~~

If B_{mig} life is not available as shown below, the test interval should be three years or less. A greater test interval causes the risk of data loss and failure in the data migration. If such a risk is unacceptable, a test interval of three years or less is strongly recommended.

– The estimated lifetime data is not provided.

– The estimated lifetime data is provided but lacks the statistical accuracy.

Generational changes of the system, including reading devices, file structures and applications, which occur during the normal migration interval, ~~may~~ can affect readability in addition to the quality of the disk itself. For safety, or if the stored data has high value, the user may choose shorter intervals for testing and migration.

In consideration of these factors, the migration interval is defined as X_{mig} ~~(years)~~ interval and this value shall be determined by the user of this part (see ISO/IEC 29121:2021, Annex F).

X_{mig} is the variable for X_{mig} interval, and $B_{mig\ life}$ is the variable for B_{mig} life in years.

Actual test interval and data migration using $B_{mig\ life}$ ~~(herein after B_{mig})~~ and X_{mig} are as follows.

a) If $X_{mig} - B_{mig\ life}/2$ is larger than 0, then the test interval of the first periodic performance test is $B_{mig\ life}/2$ years, and the storage is continued. ~~(See Annex F in ISO/IEC 29121:2013.)~~

b) If $X_{mig} - B_{mig\ life}/2$ is less than or equal to 0, then the test interval of the first periodic performance test is X_{mig} ~~(years)~~, and the data migration is carried out regardless of the test result.

If the test interval is very long, for instance over ten years, a sampling check of the stored disks should be carried out at shorter intervals. The occurrence of retrievability problems or long read times ~~may~~ can indicate an immediate need for detailed testing.

When tests indicate deterioration of one disk, additional tests may be performed on other disks of the same type, age, or batch to ascertain their condition. Replacement of all similarly affected disks should be considered if such additional tests indicate significant problems.

7 Prevention of deterioration

Necessary precautions shall be taken to reduce the possibility of deterioration in order to ensure the integrity of the disks during their use, storage, handling, or transportation. ~~Causes of deterioration and their effects are indicated in Annex B.~~ For long-term audio storage, the recommendations in Annex B should be implemented.

Annex A
(informative)

Guidelines for usage and indication

A.1 Usage of lifetime rank

This annex describes how to choose the disk rank which is most desirable as audio information storage.

a) Display colour: red, (indicated B_{mig} life is over 30 years)

   A disk of this rank may be used for general purpose storage of audio information.

b) Display colour: green, (indicated B_{mig} life is over 60 years)

   A disk of this rank may be used for long-term audio information storage or important audio information.

c) Display colour: gold, (indicated B_{mig} life is over 100 years)

   A disk of this rank may be used for especially important audio information or historically valuable audio information.

A.2 Lifetime rank indication and place

A.2.1 Lifetime rank indication

Disk and/or disk packages should display the specified lifetime rank and display colour. Two-sided disks should display the specified lifetime rank and display colour on the packaging only.

A.2.2 Indication example

Figure A.1 shows typical indication examples together with B_{mig} life, display colour and storage condition for reference.

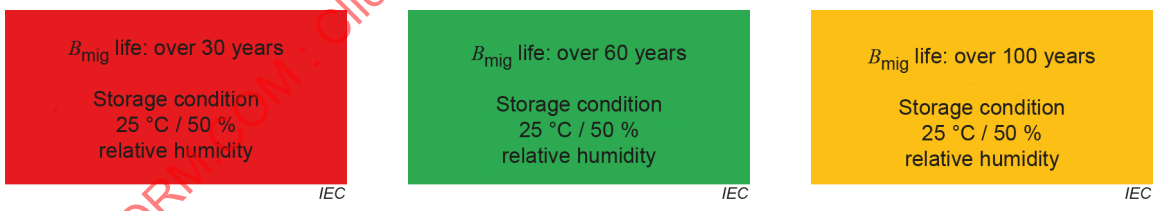


Figure A.1 – Indication example

Annex B
(informative)

Recommendations on handling, storage and cleaning conditions for DVD-R, DVD-RW, DVD-RAM, +R format, and +RW format disks

B.1 Handling

Disks intended for long-term audio storage should not be left in readers, nor remain exposed to light, corrosive atmospheres or solvents, or to extremes of temperature or humidity.

The fragile protective coating on the label surface is vulnerable to damage and should be protected together with the readout surface. Carefully handle the disk, touching only the outer edge and inner hole. Never touch the readout surface.

Disks should not be subjected to mechanical stresses that might tend to distort the disk.

Disks should be protected from dust and debris. This is especially important for recordable and rewritable disks during the recording process. The use of a deionizing environment is recommended to neutralize static charges on the disk that can attract and retain loose contaminants.

B.2 Storage

For temporary storage such as in an office environment, the storage environment should be limited to the ranges given in Table B.1.

Table B.1 – Recommended conditions for general storage

Ambient condition	Recommended range
Temperature	5 °C to 30 °C
Relative humidity	15 % to 80 %
Absolute humidity	1 g/m^3 to 24 g/m^3
Atmospheric pressure	75 kPa to 106 kPa
Temperature gradient	10 °C per hour maximum
Relative humidity gradient	10 % per hour maximum

For long-term storage, conditions should be more tightly controlled, and the storage environment should be limited to the ranges given in Table B.2.

Table B.2 – Recommended conditions for controlled storage

Ambient condition	Recommended range
Temperature	10 °C to 25 °C
Relative humidity	30 % to 50 %
Absolute humidity	3 g/m^3 to 12 g/m^3
Atmospheric pressure	75 kPa to 106 kPa
Temperature gradient	10 °C per hour maximum
Relative humidity gradient	10 % per hour maximum

Conditions that could form condensation of moisture on the disk should be avoided. Cool and dry storage conditions are preferred. To maintain the desirable temperature and humidity fluctuation tolerance levels, and to protect against high intensity light and pollutants, DVD-R, DVD-RW, DVD-RAM, +R format, and +RW format disks should be stored vertically in clean insulated containers. Dust or debris in operational or storage locations should be minimized by appropriate maintenance and monitoring procedures, especially when recording disks.

B.3 Cleaning

Prior to performing cleaning operations of disks containing useful data, tests should be carried out on disks of the same type and from the same supplier that do not contain any useful data, in order to ensure that no adverse reaction will occur.

Loose contaminants ~~may~~ can be removed by short, one-second bursts of clean, dry air, avoiding expulsion of cold propellants. If the manufacturer has not supplied any cleaning information, organic polymer substrate disks can be cleaned using a lint-free cloth of a non-woven fabric and either clean or soapy water. ~~Do~~ It is recommended not use detergents or solvents such as alcohol. All wiping actions should be in a radial direction, taking care not to exert isolated pressure or to scratch the disks. ~~Never~~ It is strongly recommended not to use abrasives. ~~Do~~ It is recommended not to use acrylic liquids, waxes, or other coatings on either surface.

Annex C
(informative)

Guidelines for disk history record

With writable disks such as DVD-R, +R format and +R DL format, and the rewritable disk such as DVD-RW, the disk history information should be recorded with the multi-session/multi-border write method.

Archive data should be preserved in the first session or border. The first history information at the preservation of the archive data should be recorded in the second session or border. This information is saved as a file named $$HIST$$.000. The size of this file should be 128 sectors (256 kB = 8ECC). The detail of this file is described later.

The second and the subsequent history information of the periodic inspection results should be recorded in the third and following session or border as a file named $$HIST$$.n, where n is greater than or equal to 001 and is a 3-digit decimal number. These disk history files are described in detail later.

The host software is required to appropriately take the archive data out of the first session even when the multi-session/multi-border write has failed. If the host software cannot implement such a process, the recording of history information is prohibited.

When the disk free space is less than 100 MB, no history information should be saved to the disk.

When no more data can be recorded, the disk should be finalized so that no more additional record can be implemented.

With rewritable disks such as DVD-RAM and DVD+RW, disk history information should be recorded with an incremental write method. In this case, it is recommended that the archive file and a file named $$HIST$$.000 with the size of 128-sector (256 kB = 8ECC) are sequentially and successively recorded without a separating space. The files recorded to the disk should be write-protected, if possible.

Similar to the case for the multi-session/multi-border write method, the history information should be recorded as the file named $$HIST$$.xxx, where xxx is a 3-digit decimal number indicating the number of the inspecting operation.

The history files should not be recorded unless all risk to the archive file can be suppressed when the history information is added to the disk. The history files should also not be recorded if the free space of the disk is less than 2 MB. In this case, the disk should be write-protected to prevent more files from being added to the disk, if possible.

The history files should be stored in the folder with the name of disk ID, which is explained below:

0 disk ID\$$HIST$$.000 at the archive file preservation

1 disk ID\$$HIST$$.001 for the first inspection right after the archive file preservation

2 disk ID\$$HIST$$.002 for the second inspection

3 disk ID\$$HIST$$.003 for the third inspection:

- m disk ID\$$HIST$$.m for the m^{th} inspection (m is a 3-digit decimal number);
- n disk ID\$$HIST$$.MIG at the archive file migration.

With the multi-session/multi-border method, the disk should be finalized after this file is recorded to inhibit additional recording.

With the incremental write method, the disk should be write-protected if possible, after recording of this file.

The disk ID should be renamed on the disk to which the archive file is migrated, and the 3-digit decimal of the file extension should be reset to 000, that is, new disk ID\$$HIST$$.000 after migration.

$$HIST$$.000 consists of the first 8 sectors of disk history file shown in Table C.1 as sector 0 to 7 and pad data, composing 128 sectors (256 kB = 8ECC). The main data of the 120-sector pad data is all 00h.

$$HIST$$.MIG consists of the first 8 sectors of the disk history file shown in Table C.1 (sectors 0 to 7) with padding data composing 1ECC. The main data of the padding data is all 00h.

The disk history should be recorded as the file ($$HIST$$.n, where n is a 3-digit decimal number equal to, or more than 0, or MIG) at the time of the archive file preservation, error rate inspection and the archive file migration. Those files are composed of the following sectors.

In the following tables, PSN_{LBA0} is the value of the physical sector number (PSN) where the user area starts. At the address of PSN_{LBA0}, LBA (Logical Block Address) is equal to 0. PSN_{LBA0} is 31 000 h for DVD-RAM, and 30 000 h for DVD-R, DVD-RW, +R format and +RW format.

Table C.1 – Sectors of the disk history file

Sector	Byte	Description
0 to 7	0 to 16 383	Information related to disk, drive, and software. These sectors always exist in all $$HIST$$.n, where n is from 000 to 999 or MIG. Refer to Table C.2 for the byte format of these sectors.
8 to 15	16 384 to 32 767	Error rate inspection results of the disk's inner area with the physical sector number (PSN) less than PSN_{LBA0}. The size of this field is fixed to 16 384 B. The unused field should be filled with 00h. These sectors are present in the history files $$HIST.001 to 999 which represent the error rate inspection result. However, they are not in the files $$HIST$$.000 and $$HIST$$.MIG. Refer to Table C.3 for the byte format of these sectors.
16 to maximum 527	32 768 to maximum 1 081 343	Error rate inspection results of disk user area with the PSN more than or equal to PSN_{LBA0}. The maximum size of this field is 510 sectors. These sectors are present in the history files $$HIST.001 to 999 which represent the error rate inspection result. However, these are not in the files $$HIST$$.000 and $$HIST$$.MIG. Refer to Table C.3 for the byte format of these sectors.
		Padding sectors in the order to form a multiple of ECCs. The padding data should all be 00h. If no padding is necessary, this field is absent.

The content of these sectors is explained below in Table C.2 and Table C.3. All the parameters are MSB first (little endian). Insufficient data should be padded with 00h.

Table C.2 – Byte content of sector 0 to 7 of the disk history file

Byte	Parameters	Byte size	Description
0	Disk ID	32	Unique ID for a single disk If the volume label, SDCB in the lead-in of DVD+R and DVD+R DL, and disk ID in the RMD field of DVD-R are recorded, all these disk IDs should be identical. The history files should be stored in the folder named with this disk ID. Even when the size of the folder name is restricted to less than 32 B by old operating systems, this disk ID should be unique under the usage environment.
32	Archive data information	992	This field can be utilized to distinguish the song titles, album titles and so on. The data definition is vendor-specific. When this field is unnecessary, all the data should be 00h. When this field is insufficient, the additional archive data information field may also be assigned for the title information.
1 024	Inspection year	4	Inspection year with ASCII character format (example 2013 = 32h 30h 31h 33h)
1 028	Inspection month	2	Inspection month with ASCII character format (example June = 30h 36h)
1 030	Inspection day	2	Inspection day with ASCII character format (example 12 = 31h 32h)
1 032	Next inspection year	4	The next planned inspection year with ASCII character format (example 2028 = 32h 30h 32h 38h)
1 036	Next inspection month	2	The next planned inspection month with ASCII character format (example June = 30h 36h)
1 038	RESERVED	1	00h
1 039	Disk condition	1	This field implies the inspection result which is determined by the all over error rate measurement. The values less than 40h shown below are the error rate inspection result. 00h: good (use as it is) 1xh: archive data should be migrated (refer to ISO/IEC 29121) 2xh: error rate measurement was failed 40h: first archive data preservation 41h: archive data has been migrated from a disk X 42h: archive data has been migrated to a disk Y 80h to FFh: vendor specific When x is 0, the definition is as specified in the above. When x takes another value, the information is supplemental for each result and vendor-specific. The value of 40h and 41h are information for $$HIST$$.000. The value of 42h is information for $$HIST$$.MIG. The values between 43h and 4Fh are information about the archive data migration and are vendor-specific.
1 040	Migrated to/from disk ID	32	When the disk condition takes the value of 41h, this field specifies the disk ID from which the archive data are migrated. When the disk condition takes the value of 42h, this field describes the disk ID of the disk to which the archive file is migrated. When the disk condition takes another value, this field is filled with 00h.
1 072	Error rate measuring device vendor ID	8	This field can be obtained by INQUIRY command (MMC6, SFF8090-v8)

Byte	Parameters	Byte size	Description
1 080	Error rate measuring device product ID	16	This field can be obtained by INQUIRY command (MMC6, SFF8090-v8)
1 096	Error rate measuring device product revision level	8	This field can be obtained by INQUIRY command (MMC6, SFF8090-v8) IDENTIFY PACKET command (ATA8-ACS)
1 104	Error rate measuring device serial number	20	This field can be obtained by GET CONFIGURATION command with feature of 0108h (MMC6, SFF8090-v8) IDENTIFY PACKET command (ATA8-ACS) The serial number is mandatory.
1 124	Error rate measuring device profile	88	This field can be obtained by GET CONFIGURATION command with feature of 0000h (MMC6, SFF8090-v8). This field describes the error rate measuring device profile such as DVD-ROM, DVD-R, DVD-RW, +R format, +RW format or DVD-RAM.
1 212	RESERVED	3	This field is filled with 00h.
1 215	Error rate measuring software information validity	1	Bit 0: validity of error rate measuring software vendor ID field (1 if valid, 0 if invalid). Bit 1: validity of error rate measuring software name field (1 if valid, 0 if invalid). Bit 2: validity of error rate measuring software version field (1 if valid, 0 if invalid). Else: all 0.
1 216	Error rate measuring software vendor ID	384	If bit 0 of error rate measuring software information validity field is 1, then this field is valid when specifying the software vendor ID. ASCII characters comprise this field. This field should be filled with 00h when the error rate measuring software vendor ID is unnecessary or invalid.
1 600	Error rate measuring software name	384	If bit 1 of error rate measuring software information validity field is 1, then this field is valid when specifying the software name. ASCII characters comprise this field. This field should be filled with 00h when the error rate measuring software name is unnecessary or invalid.
1 984	Error rate measuring software version	64	If bit 2 of error rate measuring software information validity field is 1, then this field is valid when specifying the software version. ASCII characters comprise this field. This field should be filled with 00h when the error rate measuring software version is unnecessary or invalid.
2 048	Additional archive data information	14 336	Archive data information is complemented with this field. When this field is unnecessary, it should be filled with 00h. This field is also allowed to complement the information about error rate measuring software. When this field is used for additional software information, the data definition is vendor-specific.

Table C.3 shows the common format for the error rate measuring results which are sectors 8 to 15 and 16 to the following sectors (maximum 527) of the disk history file.

The first byte offset (start offset in Table C.3) of disk inner error rate inspection is 16 384. The size of disk inner error rate inspection is fixed to 16 384 B (= 32 767 − 16 384 + 1).

The error rate inspection is not performed in the initial zone and OPC (optimum power control) area of the disk inner area.

The first byte offset (start offset in Table C.3) of the disk user area error rate inspection is 32 768. The disk user area size varies, but the maximum size is 1 048 576 B (= 1 081 343 − 32 768 + 1).

Table C.3 – Byte format of sector 8 to 15 and 9 to the following of the disk history file

Byte offset	Parameters	Byte size	Description
Start offset + n × 32 + 0	Error rate measuring start address	4	For the disk inner area with PSN less than PSN_{LBA0}, this field specifies the error rate measuring start PSN. For the disk user area with PSN more than or equal to PSN_{LBA0}, this field specifies the error rate measuring start LBA. The LBA may not be allocated for some areas with PSN more than ~~PS_{LBA0}~~PSN_{LBA0} such as the middle zone. In this case, this field specifies the error rate measuring start PSN. This condition can be distinguished with the user area error rate measuring address mode field. This field and the error rate measuring end address specify, per unit, the number of recorded sectors of the error rate measuring operation.
Start offset + n × 32 + 4	Error rate measuring end address	4	For the disk inner area with PSN less than PSN_{LBA0}, this field specifies the error rate measuring end PSN. For the disk user area with PSN more than or equal to PSN_{LBA0}, this field specifies the error rate measuring end LBA. The LBA may not be allocated for some areas with PSN more than PSN_{LBA0} such as the middle zone. In this case, this field specifies the error rate measuring end PSN. This condition can be distinguished with the user area error rate measuring address mode field.
Start offset + n × 32 + 8	PI error counts	4	This field specifies the number of PI errors within the area between the error rate measuring start and end addresses. When the error rate measuring fails, this field takes the value of FFh-*XXXXXX*h where *XXXXXX*h is the address where the failure is detected.
Start offset + n × 32 + 12	PO error counts	4	This field specifies the number of PO errors within the area between the error rate measuring start and end addresses. When the error rate measuring fails, this field takes the value of FFh-*XXXXXX*h where *XXXXXX*h is the address where the failure is detected. The failure information can be revealed with this field ~~as well as the error rate measuring result field~~.

Byte offset	Parameters	Byte size	Description
Start offset + n × 32 + 16	Error rate measuring result	4	After the successful error rate measuring, this field is determined by the PI and PO error counts within the error rate measuring start and end addresses. When the MSB takes the value of FFh, the error rate measuring is failed. The following values indicate the failure causes. FFh-03h-02h-00: The seek error causes the error rate measuring failure. FFh-03h-11h-00h: The decode error causes the error rate measuring failure. FFh-*xx-xx-xx*: vendor-specific error causes other than the above causes. When MSB takes the value of 00h, the error rate measuring is successfully completed. 00h-00h-00h-00h: The disk is fine. 00h-FFh-FFh-FFh: The archive file should be migrated even though the error rate measuring is successfully performed.
Start offset + n × 32 + 20	Temperature around the error rate measuring device at the start address	4	This field is optional. The temperature should be monitored 30 mm away from the centre of the spindle motor, toward the tray open direction, on the top cover of the device. The format of this field is *xx.yy* degrees Celsius, where *xx* are the upper 2 B and *yy* are the lower 2 B. The value of *yy* is the number after the decimal point.
Start offset + n × 32 + 24	Temperature in the error rate measuring device at the start address	4	This field is optional. The position to monitor the temperature in the device is vendor-specific. The format of this field is *xx.yy* degrees Celsius, where *xx* are the upper 2 B and *yy* are lower 2 B. The value of *yy* is the number after the decimal point.
Start offset + n × 32 + 28	User area error rate measuring address mode	1	When the error rate measuring start and end addresses are specified by the LBA for the user area with a PSN more than PSN_{LBA0}, this field is 00h. When the error rate measuring start and end addresses are specified by the PSN for the user area with a PSN more than ~~PS_{LBA0}~~ PSN_{LBA0}, this field is 01h. When the error rate measuring is performed in the disk inner area with PSN less than PSN_{LBA0}, this field is 00h as this field is "don't care". An LBA may not be allocated to an area with a PSN more than PSN_{LBA0} such as the middle zone. Therefore, if the error rate measuring of such an area is necessary, the error rate measuring needs to be carried out with the addresses specified by the PSN. In the area (such as border in/out or intro/closure) where an LBA can be theoretically allocated even though the normal read/write command ~~may not be able~~ can be unable to access with addresses specified by LBA, this field should be 00h and the error rate measuring should be performed with LBA.
Start offset+ n × 32 + 29	RESERVED	3	All 00h

n is an integer greater than or equal to 0, depending on the number of error rate measurement records.

All the above 32 B are parameters for per unit of error rate measuring results.

The error rate resulting from measuring the disk inner area and the user area should be recorded. The number of PI or PO errors here will represent errors in the archive data and indicate the necessity for data migration. Nonetheless, any error rate measuring results even without PI and PO errors can be recorded, in a vendor-specific manner.

For the inspection history, a file named $$HIST$$.*n* should be recorded even when there is no implication for data migration. This file should include the error rate measurement result with zero or a sufficiently small number of PI and PO errors, and padding data to satisfy at least 1ECC.

Bibliography

ISO/IEC 12862:2011, *Information technology – 120 mm (8,54 Gbytes per side) and 80 mm (2,66 Gbytes per side) DVD recordable disk for dual layer (DVD-R for DL)*

ISO/IEC 13170:2009, *Information technology – 120 mm (8,54 Gbytes per side) and 80 mm (2,66 Gbytes per side) DVD re-recordable disk for dual layer (DVD-RW for DL)*

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

ISO/IEC 16449:2002, *Information technology – 80 mm DVD – Read-only disk*

ISO/IEC 17341:2009, *Information technology – Data interchange on 120 mm and 80 mm optical disk using +RW format – Capacity: 4,7 Gbytes and 1,46 Gbytes per side (recording speed up to 4x)*

ISO/IEC 17342:2004, *Information technology – 80 mm (1,46 Gbytes per side) and 120 mm (4,70 Gbytes per side) DVD re-recordable disk (DVD-RW)*

ISO/IEC 17344:2009, *Information technology – Data interchange on 120 mm and 80 mm optical disk using +R format – Capacity: 4,7 Gbytes and 1,46 Gbytes per side (recording speed up to 16x)*

ISO/IEC 17592:2004, *Information technology – 120 mm (4,7 Gbytes per side) and 80 mm (1,46 Gbytes per side) DVD rewritable disk (DVD-RAM)*

ISO/IEC 23912:2005, *Information technology – 80 mm (1,46 Gbytes per side) and 120 mm (4,70 Gbytes per side) DVD Recordable Disk (DVD-R)*

ISO/IEC 25434:2008, *Information technology – Data interchange on 120 mm and 80 mm optical disk using +R DL format – Capacity: 8,55 Gbytes and 2,66 Gbytes per side (recording speed up to 16x)*

ISO/IEC 26925:2009, *Information technology – Data interchange on 120 mm and 80 mm optical disk using +RW HS format – Capacity: 4,7 and 1,46 Gbytes per side (recording speed 8x)*

ISO/IEC 29642:2009, *Information technology – Data interchange on 120 mm and 80 mm optical disk using +RW DL format – Capacity: 8,55 Gbytes and 2,66 Gbytes per side (recording speed 2,4X)*

ANSI INCITS 452 (D1699), *AT Attachment 8 – ATA/ATAPI Command Set (ATA8-ACS)*

ANSI INCITS 468, *Information technology – Multi-media Commands – 6 (MMC-6)*

INF-8090i v9, *Mt.Fuji Commands for Multimedia Devices Version 9*, available at https://www.snia.org/node/4783

IEC 62702-1-1

Edition 2.0 2022-06

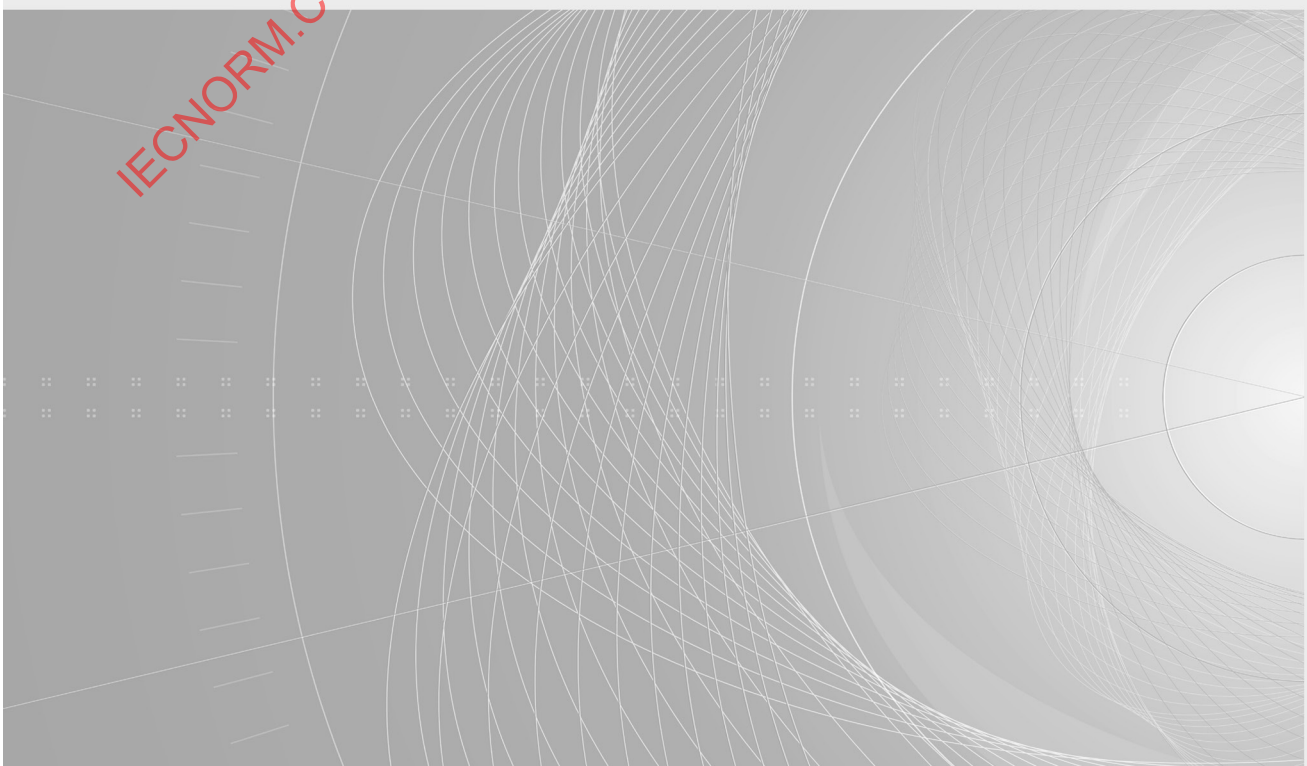
INTERNATIONAL STANDARD

NORME INTERNATIONALE

colour inside

Audio archive system –
Part 1-1: DVD disk and data migration for long-term audio data storage

Système d'archivage audio –
Partie 1-1: Disque DVD et migration de données pour le stockage à long terme des données audio



IEC 62702-1-1:2022-06(en-fr)

CONTENTS

INTERNATIONAL ELECTROTECHNICAL COMMISSION

_____

AUDIO ARCHIVE SYSTEM –

Part 1-1: DVD disk and data migration for long-term audio data storage

FOREWORD

1) The International Electrotechnical Commission (IEC) is a worldwide organization for standardization comprising all national electrotechnical committees (IEC National Committees). The object of IEC is to promote international co-operation on all questions concerning standardization in the electrical and electronic fields. To this end and in addition to other activities, IEC publishes International Standards, Technical Specifications, Technical Reports, Publicly Available Specifications (PAS) and Guides (hereafter referred to as "IEC Publication(s)"). Their preparation is entrusted to technical committees; any IEC National Committee interested in the subject dealt with may participate in this preparatory work. International, governmental and non-governmental organizations liaising with the IEC also participate in this preparation. IEC collaborates closely with the International Organization for Standardization (ISO) in accordance with conditions determined by agreement between the two organizations.
2) The formal decisions or agreements of IEC on technical matters express, as nearly as possible, an international consensus of opinion on the relevant subjects since each technical committee has representation from all interested IEC National Committees.
3) IEC Publications have the form of recommendations for international use and are accepted by IEC National Committees in that sense. While all reasonable efforts are made to ensure that the technical content of IEC Publications is accurate, IEC cannot be held responsible for the way in which they are used or for any misinterpretation by any end user.
4) In order to promote international uniformity, IEC National Committees undertake to apply IEC Publications transparently to the maximum extent possible in their national and regional publications. Any divergence between any IEC Publication and the corresponding national or regional publication shall be clearly indicated in the latter.
5) IEC itself does not provide any attestation of conformity. Independent certification bodies provide conformity assessment services and, in some areas, access to IEC marks of conformity. IEC is not responsible for any services carried out by independent certification bodies.
6) All users should ensure that they have the latest edition of this publication.
7) No liability shall attach to IEC or its directors, employees, servants or agents including individual experts and members of its technical committees and IEC National Committees for any personal injury, property damage or other damage of any nature whatsoever, whether direct or indirect, or for costs (including legal fees) and expenses arising out of the publication, use of, or reliance upon, this IEC Publication or any other IEC Publications.
8) Attention is drawn to the Normative references cited in this publication. Use of the referenced publications is indispensable for the correct application of this publication.
9) Attention is drawn to the possibility that some of the elements of this IEC Publication may be the subject of patent rights. IEC shall not be held responsible for identifying any or all such patent rights.

IEC 62702-1-1 has been prepared by technical area 6: Storage media, storage data structures, storage systems and equipment, of IEC technical committee 100: Audio, video and multimedia systems and equipment. It is an International Standard.

This second edition cancels and replaces the first edition published in 2016. This edition constitutes a technical revision.

In order to reflect the updates to ISO/IEC 29121:2021, this edition includes the following significant technical changes with respect to the previous edition:

a) ISO/IEC 16963 has been identified as the referee test method for the estimation of lifetime;
b) the ambient conditions for the measurement of maximum data error have been added;
c) the requirements for test drives have been changed considering the use condition of users;
d) the requirements for the estimated lifetime have been defined more clearly;
e) the requirements for the periodic performance test have been defined more clearly.

The text of this International Standard is based on the following documents:

Draft	Report on voting
100/3670/CDV	100/3742/RVC

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

The language used for the development of this International Standard is English.

A list of all parts in the IEC 62702 series, published under the general title *Audio archive system*, can be found on the IEC website.

This document was drafted in accordance with ISO/IEC Directives, Part 2, and developed in accordance with ISO/IEC Directives, Part 1 and ISO/IEC Directives, IEC Supplement, available at www.iec.ch/members_experts/refdocs. The main document types developed by IEC are described in greater detail at www.iec.ch/standardsdev/publications.

The committee has decided that the contents of this document will remain unchanged until the stability date indicated on the IEC website under webstore.iec.ch in the data related to the specific document. At this date, the document will be

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

IMPORTANT – The "colour inside" logo on the cover page of this document indicates that it contains colours which are considered to be useful for the correct understanding of its contents. Users should therefore print this document using a colour printer.

INTRODUCTION

Sound recordings such as music, speech, and storytelling are an important human heritage and should be preserved for as long as possible. However, we were not able to record sounds in order to preserve them in the past. The first recording system, the phonautograph, was invented by Édouard-Léon Scott de Martinville in 1860 and, after that, Thomas Alva Edison invented the recording and playback system known as the phonograph in 1877.

Although various technologies were invented later, most of them have limitations for audio archives because storage lifetime is limited, and the sound quality deteriorates when it is transferred to the next generation of storage device.

The progress of LSI (Large-Scale Integrated Circuit) technology made digital recording of recorded sound possible. Digital recording is very suitable for audio archiving because the migration is performed by copying digital data.

For this purpose, various recording materials exist, such as optical disks, magnetic disks, magnetic tape, and non-volatile memory (such as phase-change memory).

This International Standard specifies physical and logical aspects for standards of audio archives of various storage types which are typically used for audio archives on the market.

The IEC 62702 series currently consists of:

- Part 1 specifies the minimum requirements on physical aspects of optical disks for digital sound recordings. Part 1-1 specifies DVD optical disks, and Part 1-2 specifies BD optical disks.

  NOTE DVD optical disks include DVD-R disk, DVD-RW disk, DVD-RAM disk and +R format disk, +RW format disk. BD optical disks include BD recordable disk and BD rewritable disk.

- Part 2 specifies the minimum requirements for digitization of content, format of digitised content, content information and media inspection.

AUDIO ARCHIVE SYSTEM –

Part 1-1: DVD disk and data migration for long-term audio data storage

1 Scope

This part of IEC 62702 specifies a method of data-quality assurance for writable DVD disks (hereafter referred to as "disks") which are specified for long-term data storage, and a data migration method which can sustain the recorded data on disks for long-term audio data preservation. The writable disks include recordable disks such as DVD-R, and +R format, and rewritable disks such as DVD-RW, +RW format and DVD-RAM.

2 Normative references

The following documents are referred to in the text in such a way that some or all of their content constitutes requirements 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 16963:2017, *Information technology – Digitally recorded media for information interchange and storage – Test method for the estimation of lifetime of optical disks for long-term data storage*

ISO/IEC 29121:2021, *Information technology – Digitally recorded media for information interchange and storage – Data migration method for optical disks for long-term data storage*

3 Terms and definitions

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

ISO and IEC maintain terminological databases for use in standardization at the following addresses:

- IEC Electropedia: available at http://www.electropedia.org/
- ISO Online browsing platform: available at https://www.iso.org/obp

3.1
B_{mig} life
lifetime (3.10) for use of *data migration* (3.6) and identical to $B_{0,000\ 1}$ life, which is 0,000 001 quantile of the lifetime distribution (i.e. 0,000 1 % failure time) or 99,999 9 % survival lifetime

[SOURCE: ISO/IEC 29121:2021, 3.1]

3.2
B_5 life
5 percentile of the *lifetime* (3.10) distribution (i.e. 5 % failure time) or 95 % survival lifetime

[SOURCE: ISO/IEC 16963:2017, 3.4]

3.3
(B_5 life)$_L$
95 % lower confidence bound of B_5 *life* (3.2)

[SOURCE: ISO/IEC 16963:2017, 3.5]

3.4
B_{50} life
50 percentile of the *lifetime* (3.10) distribution (i.e. 50 % failure time) or 50 % survival lifetime

[SOURCE: ISO/IEC 16963:2017, 3.6]

3.5
controlled storage condition
well-controlled storage conditions with full-time air conditioning (25 °C and 50 % relative humidity) in which the *lifetime* (3.10) of data stored on optical disks

[SOURCE: ISO/IEC 16963:2017, 3.7]

3.6
data migration
process to copy data from one storage device or medium to another

[SOURCE: ISO/IEC 29121:2021, 3.5]

3.7
error correction code
ECC
mathematical computation yielding check bytes used for the detection and correction of errors in data

Note 1 to entry: For DVD-R, DVD-RW, DVD-RAM, +R format, and +RW format disks, the Reed-Solomon product code defined in ISO/IEC 16448:2002 for DVD-ROM systems is applied.

Note 2 to entry: This note applies to the French language only.

[SOURCE: ISO/IEC 29121:2021, 3.6 modified — Note 1 to entry has been shortened to apply only to DVDs.]

3.8
error rate
rate of errors or error count measured on the signal at the input of error-correction decoder, which represents raw-error rate of data recorded on a disk

[SOURCE: ISO/IEC 29121:2021, 3.7]

3.9
initial performance test
first test of the *error rate* (3.8) of data recorded on a disk before storing

[SOURCE: ISO/IEC 29121:2021, 3.8]

3.10
lifetime
time that information is retrievable in a *system* (3.17)

[SOURCE: ISO/IEC 29121:2021, 3.9]

3.11
maximum byte-error rate
BER_{max}
greatest level of byte error rate at any consecutive 32 *error correction code* (3.7) blocks in one of relevant area of the disk as measured in the first pass of the decoder before correction

Note 1 to entry: BER_{max} is applied to DVD-RAM disks.

Note 2 to entry: This note applies to the French language only.

[SOURCE: ISO/IEC 29121:2021, 3.10]

3.12
maximum data error
greatest level of *error rate* (3.8) anywhere in one of the relevant areas on the disk

[SOURCE: ISO/IEC 16963:2017, 3.13, modified — Note 1 to entry has been deleted.]

3.13
maximum parity inner sum 8
$PI_{sum\ 8,max}$
greatest level of parity (of the) inner code error count at any consecutive 8 *error correction code* (3.7) blocks in one of the relevant areas of the disk as measured in the first pass of the decoder before correction

Note 1 to entry: See ISO/IEC 16448, ISO/IEC 23912, ISO/IEC 17341, ISO/IEC 17342 and ISO/IEC 17344.

[SOURCE: ISO/IEC 29121:2021, 3.13]

3.14
periodic performance test
periodic test of the *error rate* (3.8) of data recorded on a disk during the storage

[SOURCE: ISO/IEC 29121:2021, 3.15]

3.15
retrievability
ability to recover physical information as recorded

[SOURCE: ISO/IEC 16963:2017, 3.14]

3.16
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

[SOURCE: ISO/IEC 16448:2002, 4.18]

3.17
system
combination of hardware, software, storage medium and documentation used to record, retrieve and reproduce information

[SOURCE: ISO/IEC 16963:2017, 3.20]

3.18
uncorrectable error
error in the read-out data that could not be corrected by the error correcting decoders

[SOURCE: ISO/IEC 29121:2021, 3.18]

3.19
X_{mig} interval
migration interval (year) which is determined by user

[SOURCE: ISO/IEC 29121:2021, 3.19 modified — Note 1 to entry has been deleted.]

4 Disk and lifetime for long-term audio data storage

4.1 Disk for long-term audio data storage

A disk with a specified lifetime should be used for long-term audio data storage. A disk with an unspecified lifetime should not be used.

4.2 Lifetime estimation

For the purposes of this document, the lifetime of a disk shall be derived from the measurements specified in ISO/IEC 16963. The Eyring method is used for lifetime estimation under controlled storage conditions (25 °C and 50 % relative humidity).

In ISO/IEC 16963, the estimated lifetime can be defined variously as B_{50} life, B_5 life and the 95 % lower confidence bound of B_5 life [equals $(B_5 \text{ life})_L$], and described as follows.

$$B_{50\ \text{life}} = \exp\left(\ln\hat{B}_{50}\right) = \exp\left(\hat{\beta}_0 + \hat{\beta}_1 x_{10} + \hat{\beta}_2 x_{20}\right)$$

$$B_{5\ \text{life}} = \exp\left(\ln\hat{B}_5\right) = \exp\left(\hat{\beta}_0 + \hat{\beta}_1 x_{10} + \hat{\beta}_2 x_{20} - 1{,}64\hat{\sigma}\right)$$

where

$B_{50\ \text{life}}$ is the variable for B_{50} life;

$B_{5\ \text{life}}$ is the variable for B_5 life;

x_{10} and x_{20} are the temperature-dependent factor and the relative-humidity-dependent factor at the controlled storage conditions (25 °C/50 % relative humidity), respectively.

Also, the 95 % lower confidence bound of B_5 life becomes:

$$B_{(5\ \text{life})\text{L}} = \exp\left[\left(\ln\hat{B}_5\right)_L\right] = \exp\left[\ln\hat{B}_5 - 1{,}64\sqrt{\text{var}\left(\ln\hat{B}_5\right)}\right]$$

where

$B_{(5\ \text{life})\text{L}}$ is the variable for $(B_5 \text{ life})_L$;

$\hat{\beta}_0, \hat{\beta}_1, \hat{\beta}_2$ and estimated variance of residual errors $\hat{\sigma}$ are obtained using regression analysis of time-to-failure data.

4.3 B_{mig} life for long-term audio data storage

The estimated lifetime of B_5 life means 5 % of the products reach failure. It is widely used in other contexts. However, from the viewpoint of the reliability of long-term audio storage to retain the integrity of the original data, it is not appropriate to use B_5 life as the estimated lifetime when determining a test interval and deciding on data migration.

In the case of audio data migration, it is necessary to have a sufficiently low failure probability. The time at which one millionth of the products reach failure shall define, in this document, the estimated lifetime to determine test intervals and the migration interval. $B_{0,000\ 1}$ life is 0,000 001 quantile of the lifetime distribution (i.e. 0,000 1% failure time) and expressed as B_{mig} life in this document. B_{mig} life can be calculated using B_{50} life and B_5 life as follows (see also ISO/IEC 29121:2021, Annex E).

$$B_{0,000\ 1\ \text{life}} = \exp\left(\ln\hat{B}_{0,0001}\right) = \exp\left(\ln\hat{B}_{50} - 4{,}75\hat{\sigma}\right) = \exp\left(\ln\hat{B}_{50} - 4{,}75\frac{\ln\hat{B}_{50} - \ln\hat{B}_5}{1{,}64}\right) =$$

$$\exp\left(2{,}9\ln\hat{B}_5 - 1{,}9\ln\hat{B}_{50}\right)$$

where

$B_{0,000\ 1\ \text{life}}$ is the variable for $B_{0,000\ 1}$ life;

Thus

$$B_{\text{mig life}} \times 24 \times 365 = B_{0,000\ 1\ \text{life}} = \exp\left(2{,}9\ln\hat{B}_5 - 1{,}9\ln\hat{B}_{50}\right)$$

where

$B_{\text{mig life}}$ is the variable for B_{mig} life in years.

In actual storage conditions, the temperature and relative humidity can deviate from the controlled storage condition of 25 °C and 50 % relative humidity, which changes the estimated lifetime. In this case, the estimated lifetime should be adjusted according to the estimated lifetime at the actual storage conditions, as specified in ISO/IEC 29121:2021, Annex D.

4.4 Estimated-lifetime rank and display colour

4.4.1 Estimated-lifetime rank and display colour identification

For audio data migration, rank of B_{mig} life and its identifying display colour are defined as follows.

B_{mig} life is over 30 years, the display colour is red.

B_{mig} life is over 60 years, the display colour is green.

B_{mig} life is over 100 years, the display colour is gold.

Guidelines for use of the ranks of B_{mig} life and their display colours are shown in Annex A.

4.4.2 B_{mig} life and display colour indication on disks and packages

The rank of B_{mig} life, its display colour and the reference-controlled storage condition shall be indicated on both the disk and the packaging, excluding a two-sided disk. Indication examples for ranks and their colours are shown in Annex A.

5 Test condition, test methods and disks for audio data

5.1 Ambient conditions of maximum data error measurement

The ambient condition is the surrounding condition in a room where a test drive is located. The ambient conditions for the $PI_{sum\ 8,max}$ and BER_{max} measurements are as follows:

Temperature	15 °C to 30 °C
Relative humidity	20 % to 75%

5.2 Test methods

5.2.1 Playback test drive

For DVD-R disks, DVD-RW disks, +R format disks, and +RW format disks, the test drive shall have the capability to measure $PI_{sum\ 8,max}$.

For DVD-RAM disks, the test drive shall have capability to measure BER_{max}.

The test drive shall have the capability to evaluate the error rate level specified in the initial performance test and the periodic performance test.

The playback speed of the test drive should be:

for DVD-R, DVD-RW, +R format, and +RW format disks	4 × CLV (constant linear velocity), or 6 × CLV
for DVD-RAM disk	2 × CAV (constant angular velocity), 3 × CAV, or 5 × CAV

5.2.2 Test area and sample disk

The test area is the recorded area to be tested in a disk.

The whole recorded area of all disks shall be tested for the initial performance test.

The whole recorded area of all disks should be tested for the periodic performance test. Although the integrity of the data becomes lower, the user may reduce the test area and/or the number of sample disks based on a certain sampling method, considering the value of the information (see ISO/IEC 29121:2021, Annex G). For the reduction of test area, see ISO/IEC 16963:2017, 7.5 for additional information. The number of sample disks should be enough to guarantee statistical effectiveness. If the sample disks have different attributes such as disk standards, recording conditions or storage conditions, the disks should be divided into groups of disks considering the attributes so that the sampling can be applied on each group with statistical effectiveness.

In case of a DVD-RAM disk, the replaced data in the defect management area, instead of the defect data in the user area, should be tested.

5.2.3 Recording test drive

There are two cases for the test drive. The first is that the drive serves as both a test drive and a recorder that records the data on the disk. The second is that the test drive is different from the recorder. For both cases, the data recorded on the disk by the recorder shall fulfil the error rate level specified in the initial performance test and the periodic performance test.

The recording speed of the test drive should be:

For DVD-R, DVD-RW, +R format and +RW format disks	4 × CLV or 6 × CLV
For a DVD-RAM disk	2 × CAV, 3 × CAV or 5 × CAV

The test drive should implement the multi-session and multi-border method for the DVD-R and +R format recordable disks and the DVD-RW rewritable disk. Archive data shall be recorded in the first session or border. The history information can be recorded on the second or subsequent session or border.

The test drive should implement the incremental write method for the DVD-RAM and +RW format rewritable disks. Data can be written to the formatted disk by simply recording files. The history information can be recorded on the disk as an additional file record.

5.2.4 Test drive check

The test drive shall be checked by using a reference disk prepared by the test drive manufacturer or the disk prepared by the user, so that it fulfils the requirements in 5.2.1, 5.2.2 and 5.2.3. When using a reference disk prepared by the test drive manufacturer, the check of the test drive shall be done at the intervals recommended by the manufacturer. When using a disk prepared by the user, it is recommended for the user to set an appropriate interval and to check the test drive at the interval.

6 Test result evaluation

6.1 Initial performance test result evaluation

The initial recording performance shall be categorized as Levels 1, 2 or 3 using $PI_{sum\ 8,max}$ for DVD-R, DVD-RW, +R format, and +RW format disks, and BER_{max} for DVD-RAM as shown in Table 1.

At the least, the initial recording performance shall be within the limits of Level 1. Disks showing the initial recording performance of Level 2 should not be used for long-term audio data storage, 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 drive used for recording the data should be verified because $PI_{sum8,max}$ and BER_{max} depend on the performance of both disks and drives. If the drive is not good, the drive should be replaced. If the disk is not good, another batch of disks should be used.

Table 1 – Category of initial recording performance

Level	Status	DVD-R, DVD-RW, +R format, +RW format	DVD-RAM
1	Recommended	< 140	$< 5{,}0 \times 10^{-4}$
2	Should not be used	140 to 280	$5{,}0 \times 10^{-4}$ to $1{,}0 \times 10^{-3}$
3	Shall not be used	> 280	$> 1{,}0 \times 10^{-3}$
Maximum data error		$PI_{sum\ 8,max}$	BER_{max}

6.2 Periodic performance test result evaluation

Disks used for storing data should be periodically checked with the test interval described in 6.5. The recording performance at the periodic performance test is categorized in Levels 4, 5 and 6 using $PI_{sum\ 8,\ max}$ for DVD-R, DVD-RW, +R format, and +RW format disks, and BER_{max} for DVD-RAM disk as shown in Table 2.

If the recording performance is within Level 4, the disk is good enough to continue to be stored.

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. In Level 6, $PI_{sum\ 8,\ max}$ and BER_{max} are high enough that the retrieved data can contain uncorrectable errors.

Table 2 – Category of recording performance at periodic performance test

Level	Status	DVD-R, DVD-RW, R format, RW format	DVD-RAM
4	Use as is	< 200	$< 7{,}1 \times 10^{-4}$
5	Migrate data as soon as possible	200 to 280	$7{,}1 \times 10^{-4}$ to $1{,}0 \times 10^{-3}$
6	Migrate data immediately	> 280	$> 1{,}0 \times 10^{-3}$
Maximum data error		$PI_{sum\ 8,max}$	BER_{max}

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

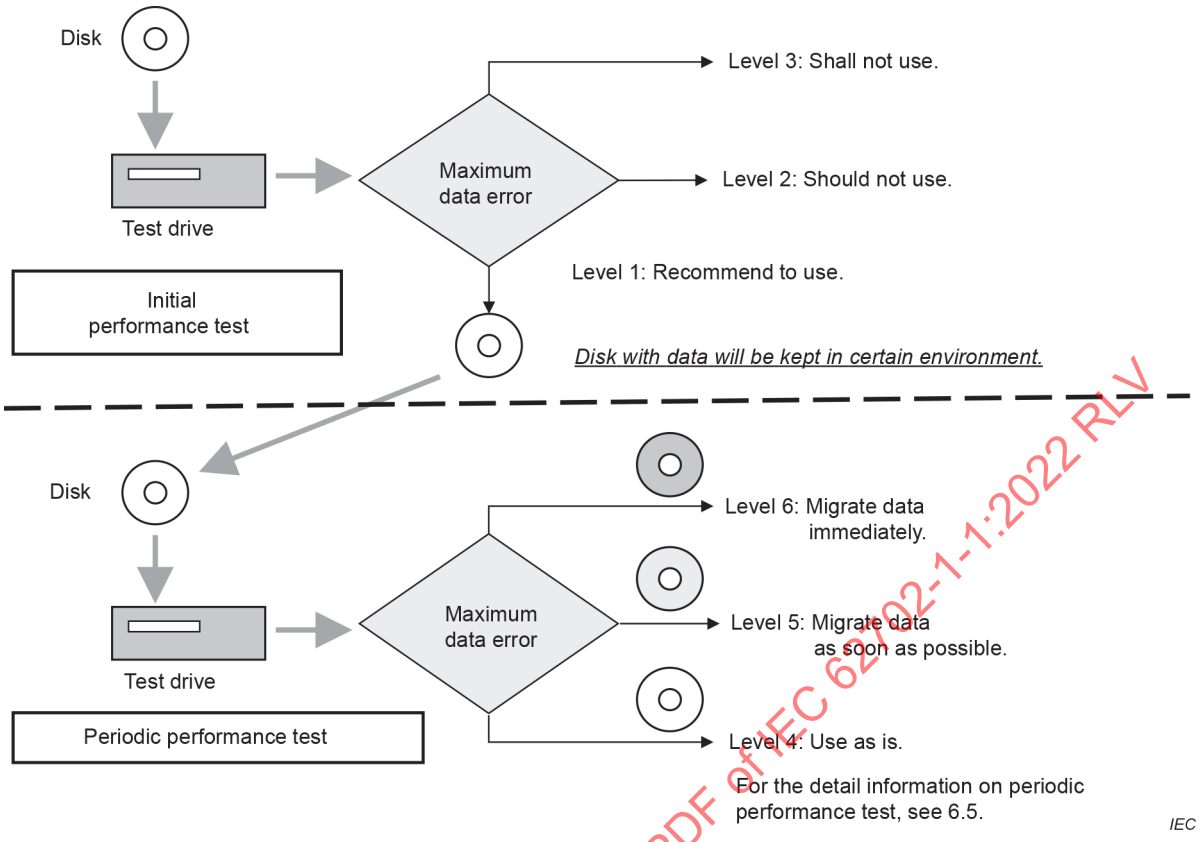


Figure 1 – Data migration flow for DVD-R, DVD-RW, DVD-RAM, +R format, and +RW format disks

6.3 Report items

6.3.1 Initial performance test result

The date and year of the initial test, the measured errors result, and the evaluation result shall be reported as part of the history of this disk. The disk type and manufacturer name, the specified rank of disk, and the next testing year and date should be reported. Moreover, the test drive manufacturer, model name and serial number should be reported.

6.3.2 Periodic performance test result

At each periodic test, the date and year of the test, the measured errors result, and history of evaluation results shall be reported. The disk type and manufacturer name, and the specified rank of the disk should be reported. Moreover, the test drive manufacturer, model name and serial number should be reported.

6.4 Management of report item

Report items shall be reported to the host computer.

Report items should be recorded on the disk, which can then be used (see Annex C).

6.5 Test and migration intervals

In this document, the test interval between periodic performance tests is set at half of B_{mig} life. Therefore, the test interval for each rank of disk with display colour red, green and gold will be 15 years, 30 years, and 50 years, respectively.

If B_{mig} life is not available as shown below, the test interval should be three years or less. A greater test interval causes the risk of data loss and failure in the data migration. If such a risk is unacceptable, a test interval of three years or less is strongly recommended.

– The estimated lifetime data is not provided.

– The estimated lifetime data is provided but lacks the statistical accuracy.

Generational changes of the system, including reading devices, file structures and applications, which occur during the normal migration interval, can affect readability in addition to the quality of the disk itself. For safety, or if the stored data has high value, the user may choose shorter intervals for testing and migration.

In consideration of these factors, the migration interval is defined as X_{mig} interval and this value shall be determined by the user of this part (see ISO/IEC 29121:2021, Annex F).

X_{mig} is the variable for X_{mig} interval, and $B_{mig\ life}$ is the variable for B_{mig} life in years.

Actual test interval and data migration using $B_{mig\ life}$ and X_{mig} are as follows.

a) If $X_{mig} - B_{mig\ life}/2$ is larger than 0, then the test interval of the first periodic performance test is $B_{mig\ life}/2$ years, and the storage is continued.

b) If $X_{mig} - B_{mig\ life}/2$ is less than or equal to 0, then the test interval of the first periodic performance test is X_{mig}, and the data migration is carried out regardless of the test result.

If the test interval is very long, for instance over ten years, a sampling check of the stored disks should be carried out at shorter intervals. The occurrence of retrievability problems or long read times can indicate an immediate need for detailed testing.

When tests indicate deterioration of one disk, additional tests may be performed on other disks of the same type, age, or batch to ascertain their condition. Replacement of all similarly affected disks should be considered if such additional tests indicate significant problems.

7 Prevention of deterioration

Necessary precautions shall be taken to reduce the possibility of deterioration in order to ensure the integrity of the disks during their use, storage, handling, or transportation. For long-term audio storage, the recommendations in Annex B should be implemented.

Annex A
(informative)

Guidelines for usage and indication

A.1 Usage of lifetime rank

This annex describes how to choose the disk rank which is most desirable as audio information storage.

a) Display colour: red, (indicated B_{mig} life is over 30 years)

   A disk of this rank may be used for general purpose storage of audio information.

b) Display colour: green, (indicated B_{mig} life is over 60 years)

   A disk of this rank may be used for long-term audio information storage or important audio information.

c) Display colour: gold, (indicated B_{mig} life is over 100 years)

   A disk of this rank may be used for especially important audio information or historically valuable audio information.

A.2 Lifetime rank indication and place

A.2.1 Lifetime rank indication

Disk and/or disk packages should display the specified lifetime rank and display colour. Two-sided disks should display the specified lifetime rank and display colour on the packaging only.

A.2.2 Indication example

Figure A.1 shows typical indication examples together with B_{mig} life, display colour and storage condition for reference.

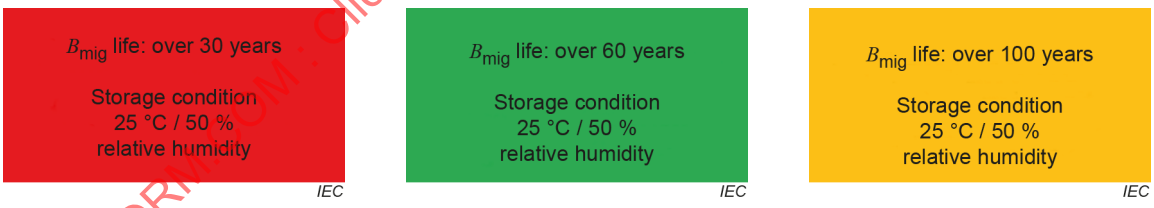


Figure A.1 – Indication example

Annex B
(informative)

Recommendations on handling, storage and cleaning conditions for DVD-R, DVD-RW, DVD-RAM, +R format, and +RW format disks

B.1 Handling

Disks intended for long-term audio storage should not be left in readers, nor remain exposed to light, corrosive atmospheres or solvents, or to extremes of temperature or humidity.

The fragile protective coating on the label surface is vulnerable to damage and should be protected together with the readout surface. Carefully handle the disk, touching only the outer edge and inner hole. Never touch the readout surface.

Disks should not be subjected to mechanical stresses that might tend to distort the disk.

Disks should be protected from dust and debris. This is especially important for recordable and rewritable disks during the recording process. The use of a deionizing environment is recommended to neutralize static charges on the disk that can attract and retain loose contaminants.

B.2 Storage

For temporary storage such as in an office environment, the storage environment should be limited to the ranges given in Table B.1.

Table B.1 – Recommended conditions for general storage

Ambient condition	Recommended range
Temperature	5 °C to 30 °C
Relative humidity	15 % to 80 %
Absolute humidity	1 g/m^3 to 24 g/m^3
Atmospheric pressure	75 kPa to 106 kPa
Temperature gradient	10 °C per hour maximum
Relative humidity gradient	10 % per hour maximum

For long-term storage, conditions should be more tightly controlled, and the storage environment should be limited to the ranges given in Table B.2.

Table B.2 – Recommended conditions for controlled storage

Ambient condition	Recommended range
Temperature	10 °C to 25 °C
Relative humidity	30 % to 50 %
Absolute humidity	3 g/m^3 to 12 g/m^3
Atmospheric pressure	75 kPa to 106 kPa
Temperature gradient	10 °C per hour maximum
Relative humidity gradient	10 % per hour maximum

Conditions that could form condensation of moisture on the disk should be avoided. Cool and dry storage conditions are preferred. To maintain the desirable temperature and humidity fluctuation tolerance levels, and to protect against high intensity light and pollutants, DVD-R, DVD-RW, DVD-RAM, +R format, and +RW format disks should be stored vertically in clean insulated containers. Dust or debris in operational or storage locations should be minimized by appropriate maintenance and monitoring procedures, especially when recording disks.

B.3 Cleaning

Prior to performing cleaning operations of disks containing useful data, tests should be carried out on disks of the same type and from the same supplier that do not contain any useful data, in order to ensure that no adverse reaction will occur.

Loose contaminants can be removed by short, one-second bursts of clean, dry air, avoiding expulsion of cold propellants. If the manufacturer has not supplied any cleaning information, organic polymer substrate disks can be cleaned using a lint-free cloth of a non-woven fabric and either clean or soapy water. It is recommended not use detergents or solvents such as alcohol. All wiping actions should be in a radial direction, taking care not to exert isolated pressure or to scratch the disks. It is strongly recommended not to use abrasives. It is recommended not to use acrylic liquids, waxes, or other coatings on either surface.

Annex C
(informative)

Guidelines for disk history record

With writable disks such as DVD-R, +R format and +R DL format, and the rewritable disk such as DVD-RW, the disk history information should be recorded with the multi-session/multi-border write method.

Archive data should be preserved in the first session or border. The first history information at the preservation of the archive data should be recorded in the second session or border. This information is saved as a file named $$HIST$$.000. The size of this file should be 128 sectors (256 kB = 8ECC). The detail of this file is described later.

The second and the subsequent history information of the periodic inspection results should be recorded in the third and following session or border as a file named $$HIST$$.n, where n is greater than or equal to 001 and is a 3-digit decimal number. These disk history files are described in detail later.

The host software is required to appropriately take the archive data out of the first session even when the multi-session/multi-border write has failed. If the host software cannot implement such a process, the recording of history information is prohibited.

When the disk free space is less than 100 MB, no history information should be saved to the disk.

When no more data can be recorded, the disk should be finalized so that no more additional record can be implemented.

With rewritable disks such as DVD-RAM and DVD+RW, disk history information should be recorded with an incremental write method. In this case, it is recommended that the archive file and a file named $$HIST$$.000 with the size of 128-sector (256 kB = 8ECC) are sequentially and successively recorded without a separating space. The files recorded to the disk should be write-protected, if possible.

Similar to the case for the multi-session/multi-border write method, the history information should be recorded as the file named $$HIST$$.xxx, where xxx is a 3-digit decimal number indicating the number of the inspecting operation.

The history files should not be recorded unless all risk to the archive file can be suppressed when the history information is added to the disk. The history files should also not be recorded if the free space of the disk is less than 2 MB. In this case, the disk should be write-protected to prevent more files from being added to the disk, if possible.

The history files should be stored in the folder with the name of disk ID, which is explained below:

0 disk ID\$$HIST$$.000 at the archive file preservation

1 disk ID\$$HIST$$.001 for the first inspection right after the archive file preservation

2 disk ID\$$HIST$$.002 for the second inspection

3 disk ID\$$HIST$$.003 for the third inspection:

- m disk ID\$$HIST$$.m for the m^{th} inspection (m is a 3-digit decimal number);
- n disk ID\$$HIST$$.MIG at the archive file migration.

With the multi-session/multi-border method, the disk should be finalized after this file is recorded to inhibit additional recording.

With the incremental write method, the disk should be write-protected if possible, after recording of this file.

The disk ID should be renamed on the disk to which the archive file is migrated, and the 3-digit decimal of the file extension should be reset to 000, that is, new disk ID\$$HIST$$.000 after migration.

$$HIST$$.000 consists of the first 8 sectors of disk history file shown in Table C.1 as sector 0 to 7 and pad data, composing 128 sectors (256 kB = 8ECC). The main data of the 120-sector pad data is all 00h.

$$HIST$$.MIG consists of the first 8 sectors of the disk history file shown in Table C.1 (sectors 0 to 7) with padding data composing 1ECC. The main data of the padding data is all 00h.

The disk history should be recorded as the file ($$HIST$$.n, where n is a 3-digit decimal number equal to, or more than 0, or MIG) at the time of the archive file preservation, error rate inspection and the archive file migration. Those files are composed of the following sectors.

In the following tables, PSN_{LBA0} is the value of the physical sector number (PSN) where the user area starts. At the address of PSN_{LBA0}, LBA (Logical Block Address) is equal to 0. PSN_{LBA0} is 31 000 h for DVD-RAM, and 30 000 h for DVD-R, DVD-RW, +R format and +RW format.

Table C.1 – Sectors of the disk history file

Sector	Byte	Description
0 to 7	0 to 16 383	Information related to disk, drive, and software. These sectors always exist in all $$HIST$$.n, where n is from 000 to 999 or MIG. Refer to Table C.2 for the byte format of these sectors.
8 to 15	16 384 to 32 767	Error rate inspection results of the disk's inner area with the physical sector number (PSN) less than PSN_{LBA0}. The size of this field is fixed to 16 384 B. The unused field should be filled with 00h. These sectors are present in the history files $$HIST.001 to 999 which represent the error rate inspection result. However, they are not in the files $$HIST$$.000 and $$HIST$$.MIG. Refer to Table C.3 for the byte format of these sectors.
16 to maximum 527	32 768 to maximum 1 081 343	Error rate inspection results of disk user area with the PSN more than or equal to PSN_{LBA0}. The maximum size of this field is 510 sectors. These sectors are present in the history files $$HIST.001 to 999 which represent the error rate inspection result. However, these are not in the files $$HIST$$.000 and $$HIST$$.MIG. Refer to Table C.3 for the byte format of these sectors.
		Padding sectors in the order to form a multiple of ECCs. The padding data should all be 00h. If no padding is necessary, this field is absent.

The content of these sectors is explained below in Table C.2 and Table C.3. All the parameters are MSB first (little endian). Insufficient data should be padded with 00h.

Table C.2 – Byte content of sector 0 to 7 of the disk history file

Byte	Parameters	Byte size	Description
0	Disk ID	32	Unique ID for a single disk If the volume label, SDCB in the lead-in of DVD+R and DVD+R DL, and disk ID in the RMD field of DVD-R are recorded, all these disk IDs should be identical. The history files should be stored in the folder named with this disk ID. Even when the size of the folder name is restricted to less than 32 B by old operating systems, this disk ID should be unique under the usage environment.
32	Archive data information	992	This field can be utilized to distinguish the song titles, album titles and so on. The data definition is vendor-specific. When this field is unnecessary, all the data should be 00h. When this field is insufficient, the additional archive data information field may also be assigned for the title information.
1 024	Inspection year	4	Inspection year with ASCII character format (example 2013 = 32h 30h 31h 33h)
1 028	Inspection month	2	Inspection month with ASCII character format (example June = 30h 36h)
1 030	Inspection day	2	Inspection day with ASCII character format (example 12 = 31h 32h)
1 032	Next inspection year	4	The next planned inspection year with ASCII character format (example 2028 = 32h 30h 32h 38h)
1 036	Next inspection month	2	The next planned inspection month with ASCII character format (example June = 30h 36h)
1 038	RESERVED	1	00h
1 039	Disk condition	1	This field implies the inspection result which is determined by the all over error rate measurement. The values less than 40h shown below are the error rate inspection result. 00h: good (use as it is) 1xh: archive data should be migrated (refer to ISO/IEC 29121) 2xh: error rate measurement was failed 40h: first archive data preservation 41h: archive data has been migrated from a disk X 42h: archive data has been migrated to a disk Y 80h to FFh: vendor specific When x is 0, the definition is as specified in the above. When x takes another value, the information is supplemental for each result and vendor-specific. The value of 40h and 41h are information for $$HIST$$.000. The value of 42h is information for $$HIST$$.MIG. The values between 43h and 4Fh are information about the archive data migration and are vendor-specific.
1 040	Migrated to/from disk ID	32	When the disk condition takes the value of 41h, this field specifies the disk ID from which the archive data are migrated. When the disk condition takes the value of 42h, this field describes the disk ID of the disk to which the archive file is migrated. When the disk condition takes another value, this field is filled with 00h.
1 072	Error rate measuring device vendor ID	8	This field can be obtained by INQUIRY command (MMC6, SFF8090-v8)

Byte	Parameters	Byte size	Description
1 080	Error rate measuring device product ID	16	This field can be obtained by INQUIRY command (MMC6, SFF8090-v8)
1 096	Error rate measuring device product revision level	8	This field can be obtained by INQUIRY command (MMC6, SFF8090-v8) IDENTIFY PACKET command (ATA8-ACS)
1 104	Error rate measuring device serial number	20	This field can be obtained by GET CONFIGURATION command with feature of 0108h (MMC6, SFF8090-v8) IDENTIFY PACKET command (ATA8-ACS) The serial number is mandatory.
1 124	Error rate measuring device profile	88	This field can be obtained by GET CONFIGURATION command with feature of 0000h (MMC6, SFF8090-v8). This field describes the error rate measuring device profile such as DVD-ROM, DVD-R, DVD-RW, +R format, +RW format or DVD-RAM.
1 212	RESERVED	3	This field is filled with 00h.
1 215	Error rate measuring software information validity	1	Bit 0: validity of error rate measuring software vendor ID field (1 if valid, 0 if invalid). Bit 1: validity of error rate measuring software name field (1 if valid, 0 if invalid). Bit 2: validity of error rate measuring software version field (1 if valid, 0 if invalid). Else: all 0.
1 216	Error rate measuring software vendor ID	384	If bit 0 of error rate measuring software information validity field is 1, then this field is valid when specifying the software vendor ID. ASCII characters comprise this field. This field should be filled with 00h when the error rate measuring software vendor ID is unnecessary or invalid.
1 600	Error rate measuring software name	384	If bit 1 of error rate measuring software information validity field is 1, then this field is valid when specifying the software name. ASCII characters comprise this field. This field should be filled with 00h when the error rate measuring software name is unnecessary or invalid.
1 984	Error rate measuring software version	64	If bit 2 of error rate measuring software information validity field is 1, then this field is valid when specifying the software version. ASCII characters comprise this field. This field should be filled with 00h when the error rate measuring software version is unnecessary or invalid.
2 048	Additional archive data information	14 336	Archive data information is complemented with this field. When this field is unnecessary, it should be filled with 00h. This field is also allowed to complement the information about error rate measuring software. When this field is used for additional software information, the data definition is vendor-specific.

Table C.3 shows the common format for the error rate measuring results which are sectors 8 to 15 and 16 to the following sectors (maximum 527) of the disk history file.

The first byte offset (start offset in Table C.3) of disk inner error rate inspection is 16 384. The size of disk inner error rate inspection is fixed to 16 384 B (= 32 767 − 16 384 + 1).

The error rate inspection is not performed in the initial zone and OPC (optimum power control) area of the disk inner area.

The first byte offset (start offset in Table C.3) of the disk user area error rate inspection is 32 768. The disk user area size varies, but the maximum size is 1 048 576 B (= 1 081 343 − 32 768 + 1).

Table C.3 – Byte format of sector 8 to 15 and 9 to the following of the disk history file

Byte offset	Parameters	Byte size	Description
Start offset + n × 32 + 0	Error rate measuring start address	4	For the disk inner area with PSN less than PSN_{LBA0}, this field specifies the error rate measuring start PSN. For the disk user area with PSN more than or equal to PSN_{LBA0}, this field specifies the error rate measuring start LBA. The LBA may not be allocated for some areas with PSN more than PSN_{LBA0} such as the middle zone. In this case, this field specifies the error rate measuring start PSN. This condition can be distinguished with the user area error rate measuring address mode field. This field and the error rate measuring end address specify, per unit, the number of recorded sectors of the error rate measuring operation.
Start offset + n × 32 + 4	Error rate measuring end address	4	For the disk inner area with PSN less than PSN_{LBA0}, this field specifies the error rate measuring end PSN. For the disk user area with PSN more than or equal to PSN_{LBA0}, this field specifies the error rate measuring end LBA. The LBA may not be allocated for some areas with PSN more than PSN_{LBA0} such as the middle zone. In this case, this field specifies the error rate measuring end PSN. This condition can be distinguished with the user area error rate measuring address mode field.
Start offset + n × 32 + 8	PI error counts	4	This field specifies the number of PI errors within the area between the error rate measuring start and end addresses. When the error rate measuring fails, this field takes the value of FFh-*XXXXXX*h where *XXXXXX*h is the address where the failure is detected.
Start offset + n × 32 + 12	PO error counts	4	This field specifies the number of PO errors within the area between the error rate measuring start and end addresses. When the error rate measuring fails, this field takes the value of FFh-*XXXXXX*h where *XXXXXX*h is the address where the failure is detected. The failure information can be revealed with this field.
Start offset + n × 32 + 16	Error rate measuring result	4	After the successful error rate measuring, this field is determined by the PI and PO error counts within the error rate measuring start and end addresses. When the MSB takes the value of FFh, the error rate measuring is failed. The following values indicate the failure causes. FFh-03h-02h-00: The seek error causes the error rate measuring failure. FFh-03h-11h-00h: The decode error causes the error rate measuring failure. FFh-*xx-xx-xx*: vendor-specific error causes other than the above causes. When MSB takes the value of 00h, the error rate measuring is successfully completed. 00h-00h-00h-00h: The disk is fine. 00h-FFh-FFh-FFh: The archive file should be migrated even though the error rate measuring is successfully performed.

Byte offset	Parameters	Byte size	Description
Start offset + n × 32 + 20	Temperature around the error rate measuring device at the start address	4	This field is optional. The temperature should be monitored 30 mm away from the centre of the spindle motor, toward the tray open direction, on the top cover of the device. The format of this field is $xx.yy$ degrees Celsius, where xx are the upper 2 B and yy are the lower 2 B. The value of yy is the number after the decimal point.
Start offset + n × 32 + 24	Temperature in the error rate measuring device at the start address	4	This field is optional. The position to monitor the temperature in the device is vendor-specific. The format of this field is $xx.yy$ degrees Celsius, where xx are the upper 2 B and yy are lower 2 B. The value of yy is the number after the decimal point.
Start offset + n × 32 + 28	User area error rate measuring address mode	1	When the error rate measuring start and end addresses are specified by the LBA for the user area with a PSN more than PSN_{LBA0}, this field is 00h. When the error rate measuring start and end addresses are specified by the PSN for the user area with a PSN more than PSN_{LBA0}, this field is 01h. When the error rate measuring is performed in the disk inner area with PSN less than PSN_{LBA0}, this field is 00h as this field is "don't care". An LBA may not be allocated to an area with a PSN more than PSN_{LBA0} such as the middle zone. Therefore, if the error rate measuring of such an area is necessary, the error rate measuring needs to be carried out with the addresses specified by the PSN. In the area (such as border in/out or intro/closure) where an LBA can be theoretically allocated even though the normal read/write command can be unable to access with addresses specified by LBA, this field should be 00h and the error rate measuring should be performed with LBA.
Start offset+ n × 32 + 29	RESERVED	3	All 00h

n is an integer greater than or equal to 0, depending on the number of error rate measurement records.

All the above 32 B are parameters for per unit of error rate measuring results.

The error rate resulting from measuring the disk inner area and the user area should be recorded. The number of PI or PO errors here will represent errors in the archive data and indicate the necessity for data migration. Nonetheless, any error rate measuring results even without PI and PO errors can be recorded, in a vendor-specific manner.

For the inspection history, a file named $$HIST$$.n should be recorded even when there is no implication for data migration. This file should include the error rate measurement result with zero or a sufficiently small number of PI and PO errors, and padding data to satisfy at least 1ECC.

Bibliography

ISO/IEC 12862:2011, *Information technology – 120 mm (8,54 Gbytes per side) and 80 mm (2,66 Gbytes per side) DVD recordable disk for dual layer (DVD-R for DL)*

ISO/IEC 13170:2009, *Information technology – 120 mm (8,54 Gbytes per side) and 80 mm (2,66 Gbytes per side) DVD re-recordable disk for dual layer (DVD-RW for DL)*

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

ISO/IEC 16449:2002, *Information technology – 80 mm DVD – Read-only disk*

ISO/IEC 17341:2009, *Information technology – Data interchange on 120 mm and 80 mm optical disk using +RW format – Capacity: 4,7 Gbytes and 1,46 Gbytes per side (recording speed up to 4x)*

ISO/IEC 17342:2004, *Information technology – 80 mm (1,46 Gbytes per side) and 120 mm (4,70 Gbytes per side) DVD re-recordable disk (DVD-RW)*

ISO/IEC 17344:2009, *Information technology – Data interchange on 120 mm and 80 mm optical disk using +R format – Capacity: 4,7 Gbytes and 1,46 Gbytes per side (recording speed up to 16x)*

ISO/IEC 17592:2004, *Information technology – 120 mm (4,7 Gbytes per side) and 80 mm (1,46 Gbytes per side) DVD rewritable disk (DVD-RAM)*

ISO/IEC 23912:2005, *Information technology – 80 mm (1,46 Gbytes per side) and 120 mm (4,70 Gbytes per side) DVD Recordable Disk (DVD-R)*

ISO/IEC 25434:2008, *Information technology – Data interchange on 120 mm and 80 mm optical disk using +R DL format – Capacity: 8,55 Gbytes and 2,66 Gbytes per side (recording speed up to 16x)*

ISO/IEC 26925:2009, *Information technology – Data interchange on 120 mm and 80 mm optical disk using +RW HS format – Capacity: 4,7 and 1,46 Gbytes per side (recording speed 8x)*

ISO/IEC 29642:2009, *Information technology – Data interchange on 120 mm and 80 mm optical disk using +RW DL format – Capacity: 8,55 Gbytes and 2,66 Gbytes per side (recording speed 2,4X)*

ANSI INCITS 452 (D1699), *AT Attachment 8 – ATA/ATAPI Command Set (ATA8-ACS)*

ANSI INCITS 468, *Information technology – Multi-media Commands – 6 (MMC-6)*

INF-8090i v9, *Mt.Fuji Commands for Multimedia Devices Version 9*, available at https://www.snia.org/node/4783

SOMMAIRE

COMMISSION ÉLECTROTECHNIQUE INTERNATIONALE

_____

SYSTÈME D'ARCHIVAGE AUDIO –

Partie 1-1: Disque DVD et migration de données pour le stockage à long terme des données audio

AVANT-PROPOS

1) La Commission Electrotechnique Internationale (IEC) est une organisation mondiale de normalisation composée de l'ensemble des comités électrotechniques nationaux (Comités nationaux de l'IEC). L'IEC a pour objet de favoriser la coopération internationale pour toutes les questions de normalisation dans les domaines de l'électricité et de l'électronique. A cet effet, l'IEC – entre autres activités – publie des Normes internationales, des Spécifications techniques, des Rapports techniques, des Spécifications accessibles au public (PAS) et des Guides (ci-après dénommés "Publication(s) de l'IEC"). Leur élaboration est confiée à des comités d'études, aux travaux desquels tout Comité national intéressé par le sujet traité peut participer. Les organisations internationales, gouvernementales et non gouvernementales, en liaison avec l'IEC, participent également aux travaux. L'IEC collabore étroitement avec l'Organisation Internationale de Normalisation (ISO), selon des conditions fixées par accord entre les deux organisations.
2) Les décisions ou accords officiels de l'IEC concernant les questions techniques représentent, dans la mesure du possible, un accord international sur les sujets étudiés, étant donné que les Comités nationaux de l'IEC intéressés sont représentés dans chaque comité d'études.
3) Les Publications de l'IEC se présentent sous la forme de recommandations internationales et sont agréées comme telles par les Comités nationaux de l'IEC. Tous les efforts raisonnables sont entrepris afin que l'IEC s'assure de l'exactitude du contenu technique de ses publications; l'IEC ne peut pas être tenue responsable de l'éventuelle mauvaise utilisation ou interprétation qui en est faite par un quelconque utilisateur final.
4) Dans le but d'encourager l'uniformité internationale, les Comités nationaux de l'IEC s'engagent, dans toute la mesure possible, à appliquer de façon transparente les Publications de l'IEC dans leurs publications nationales et régionales. Toutes divergences entre toutes Publications de l'IEC et toutes publications nationales ou régionales correspondantes doivent être indiquées en termes clairs dans ces dernières.
5) L'IEC elle-même ne fournit aucune attestation de conformité. Des organismes de certification indépendants fournissent des services d'évaluation de conformité et, dans certains secteurs, accèdent aux marques de conformité de l'IEC. L'IEC n'est responsable d'aucun des services effectués par les organismes de certification indépendants.
6) Tous les utilisateurs doivent s'assurer qu'ils sont en possession de la dernière édition de cette publication.
7) Aucune responsabilité ne doit être imputée à l'IEC, à ses administrateurs, employés, auxiliaires ou mandataires, y compris ses experts particuliers et les membres de ses comités d'études et des Comités nationaux de l'IEC, pour tout préjudice causé en cas de dommages corporels et matériels, ou de tout autre dommage de quelque nature que ce soit, directe ou indirecte, ou pour supporter les coûts (y compris les frais de justice) et les dépenses découlant de la publication ou de l'utilisation de cette Publication de l'IEC ou de toute autre Publication de l'IEC, ou au crédit qui lui est accordé.
8) L'attention est attirée sur les références normatives citées dans cette publication. L'utilisation de publications référencées est obligatoire pour une application correcte de la présente publication.
9) L'attention est attirée sur le fait que certains des éléments de la présente Publication de l'IEC peuvent faire l'objet de droits de brevet. L'IEC ne saurait être tenue pour responsable de ne pas avoir identifié de tels droits de brevets.

L'IEC 62702-1-1 a été établie par le domaine technique 6: Média de stockage, structures des données, équipements et systèmes, du comité d'études 100 de l'IEC: Systèmes et équipements audio, vidéo et services de données. Il s'agit d'une Norme internationale.

Cette deuxième édition annule et remplace la première édition parue en 2016. Cette édition constitue une révision technique.

Afin de refléter les mises à jour apportées à l'ISO/IEC 29121:2021, cette édition inclut les modifications techniques majeures suivantes par rapport à l'édition précédente:

a) l'ISO/IEC 16963 a été identifiée comme méthode d'essai de référence pour l'estimation de la durée de vie;

b) des conditions ambiantes ont été ajoutées pour le mesurage de l'erreur de données maximale;

c) les exigences relatives aux unités d'essai ont été modifiées en fonction des conditions d'utilisation des utilisateurs;

d) les exigences relatives à la durée de vie estimée ont été définies de manière plus précise;

e) les exigences relatives à l'essai périodique de performances ont été définies de manière plus précise.

Le texte de cette Norme internationale est issu des documents suivants:

Projet	Rapport de vote
100/3670/CDV	100/3742/RVC

Le rapport de vote indiqué dans le tableau ci-dessus donne toute information sur le vote ayant abouti à son approbation.

La langue employée pour l'élaboration de cette Norme internationale est l'anglais.

Une liste de toutes les parties de la série IEC 62702, publiées sous le titre général *Système d'archivage audio*, se trouve sur le site web de l'IEC.

Ce document a été rédigé selon les Directives ISO/IEC, Partie 2, il a été développé selon les Directives ISO/IEC, Partie 1 et les Directives ISO/IEC, Supplément IEC, disponibles sous www.iec.ch/members_experts/refdocs. Les principaux types de documents développés par l'IEC sont décrits plus en détail sous www.iec.ch/standardsdev/publications.

Le comité a décidé que le contenu de ce document ne sera pas modifié avant la date de stabilité indiquée sur le site web de l'IEC sous webstore.iec.ch dans les données relatives au document recherché. A cette date, le document sera

- reconduit,
- supprimé,
- remplacé par une édition révisée, ou
- amendé.

IMPORTANT – Le logo "colour inside" qui se trouve sur la page de couverture de cette publication indique qu'elle contient des couleurs qui sont considérées comme utiles à une bonne compréhension de son contenu. Les utilisateurs devraient, par conséquent, imprimer cette publication en utilisant une imprimante couleur.

INTRODUCTION

Les enregistrements sonores tels que la musique, la parole et les récits constituent un héritage humain important qu'il convient de préserver le plus longtemps possible. Toutefois, par le passé, les sons ne pouvaient pas être enregistrés à des fins de préservation. Inventé par Édouard-Léon Scott de Martinville en 1860, le phonautographe est le premier système conçu pour enregistrer les sons. Le premier système d'enregistrement et de lecture, le phonographe, a été inventé en 1877 par Thomas Alva Edison.

Même si différentes technologies ont été inventées par la suite, la plupart d'entre elles ont leurs limites en ce qui concerne l'archivage audio; la durée de vie du stockage est limitée, et la qualité du son se détériore lors de son transfert sur les dispositifs de stockage de nouvelle génération.

Les progrès de la technologie d'intégration à grande échelle (LSI, *Large-Scale Integrated*) ont rendu possible l'enregistrement numérique du son. L'enregistrement numérique est parfaitement adapté à l'archivage audio, car la migration est réalisée en copiant les données numériques.

À cette fin, il existe différents supports d'enregistrement tels que les disques optiques, les disques magnétiques, les bandes magnétiques et la mémoire non volatile (comme la mémoire à variation de phase).

La présente Norme internationale spécifie les aspects physiques et logiques des normes relatives aux archivages audio de différents types de stockages, habituellement utilisés pour les archivages audio sur le marché.

La série IEC 62702 se compose actuellement des parties suivantes:

- La Partie 1 spécifie les exigences minimales relatives aux aspects physiques des disques optiques pour les enregistrements sonores numériques. La Partie 1-1 spécifie les disques optiques DVD (Digital Versatile Disc), tandis que la Partie 1-2 spécifie les disques optiques BD (Blu-ray Disc).

  NOTE Les disques optiques DVD incluent les disques DVD-R, DVD-RW, DVD-RAM, le format +R et le format +RW. Les disques optiques BD incluent les disques enregistrables BD et les disques réenregistrables BD.

- La Partie 2 spécifie les exigences minimales relatives à la numérisation du contenu, au format du contenu numérisé, aux informations du contenu et à l'inspection du support.

SYSTÈME D'ARCHIVAGE AUDIO –

Partie 1-1: Disque DVD et migration de données pour le stockage à long terme des données audio

1 Domaine d'application

La présente partie de l'IEC 62702 spécifie une méthode d'assurance de la qualité des données pour les disques DVD inscriptibles (ci-après dénommés "disques") qui sont spécifiés pour le stockage à long terme des données, ainsi qu'une méthode de migration des données capable de conserver les données enregistrées sur les disques de manière à assurer la conservation à long terme des données audio. Les disques inscriptibles incluent les disques enregistrables comme le DVD-R (Digital Versatile Disc-Recordable), le format +R, ainsi que les disques réenregistrables comme le DVD-RW (Digital Versatile Disc-Rewritable), le format +RW et le DVD-RAM (Digital Versatile Disc-Random Access Memory).

2 Références normatives

Les documents suivants sont cités dans le texte de sorte qu'ils constituent, pour tout ou partie de leur contenu, des exigences du présent document. Pour les références datées, seule l'édition citée s'applique. Pour les références non datées, la dernière édition du document de référence s'applique (y compris les éventuels amendements).

ISO/IEC 16963:2017, *Information technology – Digitally recorded media for information interchange and storage – Test method for the estimation of lifetime of optical disks for long-term data storage* (disponible en anglais seulement)

ISO/IEC 29121:2021, *Information technology – Digitally recorded media for information interchange and storage – Data migration method for optical disks for long-term data storage* (disponible en anglais seulement)

3 Termes et définitions

Pour les besoins du présent document, les termes et définitions suivants s'appliquent.

L'ISO et l'IEC tiennent à jour des bases de données terminologiques destinées à être utilisées en normalisation, consultables aux adresses suivantes:

- IEC Electropedia: disponible à l'adresse http://www.electropedia.org/
- ISO Online browsing platform: disponible à l'adresse https://www.iso.org/obp

3.1
durée de vie B_{mig}
durée de vie (3.10) d'utilisation de la *migration de données* (3.6) identique à la durée de vie $B_{0,000\ 1}$, qui correspond à 0,000 001 quantile de la répartition des durées de vie (soit 0,000 1 % de temps de défaillance) ou 99,999 9 % de temps de survie

[SOURCE: ISO/IEC 29121:2021, 3.1]

3.2
durée de vie B_5
5 centiles de la répartition des *durées de vie* (3.10) (soit 5 % de temps de défaillance) ou 95 % de temps de survie

[SOURCE: ISO/IEC 16963:2017, 3.4]

3.3
(durée de vie $B_5)_L$
limite de confiance inférieure de 95 % de la *durée de vie* B_5 (3.2)

[SOURCE: ISO/IEC 16963:2017, 3.5]

3.4
durée de vie B_{50}
50 centiles de la répartition des *durées de vie* (3.10) (soit 50 % de temps de défaillance) ou 50 % de temps de survie

[SOURCE: ISO/IEC 16963:2017, 3.6]

3.5
condition de stockage contrôlée
conditions de stockage bien contrôlées avec une climatisation permanente (25 °C et 50 % d'humidité relative) pour la *durée de vie* (3.10) des données stockées sur les disques optiques

[SOURCE: ISO/IEC 16963:2017, 3.7]

3.6
migration de données
processus de copie des données d'un dispositif ou d'un support de stockage sur un autre

[SOURCE: ISO/IEC 29121:2021, 3.5]

3.7
code de correction d'erreur
ECC
calcul mathématique qui donne les octets de contrôle utilisés pour la détection et la correction d'erreurs dans les données

Note 1 à l'article: Pour les disques DVD-R, DVD-RW, DVD-RAM, le format +R et le format +RW, le code de produit de Reed-Solomon défini dans l'ISO/IEC 16448:2002 pour les systèmes DVD-ROM s'applique.

Note 2 à l'article: Le terme abrégé "ECC" est dérivé du terme anglais développé correspondant "error correction code".

[SOURCE: ISO IEC 29121:2021, 3.6, modifié — La Note 1 à l'article a été raccourcie pour ne s'appliquer qu'aux DVD.]

3.8
taux d'erreurs
taux d'erreurs ou nombre d'erreurs mesuré sur le signal à l'entrée du décodeur de correction d'erreurs, qui représente le taux d'erreurs brutes des données enregistrées sur un disque

[SOURCE: ISO/IEC 29121:2021, 3.7]

3.9
essai initial de performances
premier essai du *taux d'erreurs* (3.8) des données enregistrées sur un disque avant le stockage

[SOURCE: ISO/IEC 29121:2021, 3.8]

3.10
durée de vie
durée pendant laquelle les informations sont récupérables à partir d'un *système* (3.17)

[SOURCE: ISO/IEC 29121:2021, 3.9]

3.11
taux d'erreurs d'octet maximal
BER_{max}
plus haut niveau de taux d'erreurs d'octet sur chacun des 32 blocs consécutifs du *code de correction d'erreur* (3.7) dans l'une des zones pertinentes du disque, mesuré au premier passage du décodeur avant la correction

Note 1 à l'article: Le BER_{max} s'applique aux disques DVD-RAM.

Note 2 à l'article: Le terme abrégé "BER" est dérivé du terme anglais développé correspondant "byte error rate".

[SOURCE: ISO/IEC 29121:2021, 3.10]

3.12
erreur de données maximale
plus haut niveau de *taux d'erreurs* (3.8) à un emplacement donné dans l'une des zones pertinentes du disque

[SOURCE: ISO IEC 16963:2017, 3.13, modifié — La Note 1 à l'article a été supprimée.]

3.13
somme interne de parité maximale 8
$PI_{sum\ 8,max}$
plus haut niveau de parité du décompte d'erreurs de code interne sur chacun des 8 blocs consécutifs du *code de correction d'erreur* (3.7) dans l'une des zones pertinentes du disque, mesuré au premier passage du décodeur avant la correction

Note 1 à l'article: Voir l'ISO/IEC 16448, l'ISO/IEC 23912, l'ISO/IEC 17341, l'ISO/IEC 17342 et l'ISO/IEC 17344.

[SOURCE: ISO IEC 29121:2021, 3.13]

3.14
essai périodique de performances
essai périodique du *taux d'erreurs* (3.8) des données enregistrées sur un disque pendant le stockage

[SOURCE: ISO/IEC 29121:2021, 3.15]

3.15
récupérabilité
aptitude à récupérer des informations physiques enregistrées

[SOURCE: ISO/IEC 16963:2017, 3.14]

3.16
substrat
couche transparente du disque, fournie pour assurer le support mécanique de la couche d'enregistrement ou de la couche enregistrée, à travers laquelle le faisceau optique accède à la couche enregistrable/enregistrée

[SOURCE: ISO/IEC 16448:2002, 4.18]

3.17
système
combinaison de matériel, de logiciel, de support de stockage et de documentation, utilisée pour l'enregistrement, la récupération et la reproduction d'informations

[SOURCE: ISO/IEC 16963:2017, 3.20]

3.18
erreur non corrigeable
erreur dans les données de lecture qui ne peut pas être corrigée par les décodeurs de correction d'erreurs

[SOURCE: ISO/IEC 29121:2021, 3.18]

3.19
intervalle X_{mig}
intervalle (année) de migration déterminé par l'utilisateur

[SOURCE: ISO IEC 29121:2021, 3.19, modifié — La Note 1 à l'article a été supprimée.]

4 Disque et durée de vie pour le stockage à long terme des données audio

4.1 Disque pour le stockage à long terme des données audio

Il convient d'utiliser un disque d'une durée de vie spécifiée pour le stockage à long terme des données audio. Il convient de ne pas utiliser un disque dont la durée de vie n'est pas spécifiée.

4.2 Estimation de la durée de vie

Pour les besoins du présent document, la durée de vie d'un disque doit être déduite des mesurages spécifiés dans l'ISO/IEC 16963. La méthode d'Eyring est utilisée pour estimer la durée de vie dans les conditions de stockage contrôlées (25 °C et 50 % d'humidité relative).

Dans l'ISO/IEC 16963, la durée de vie estimée peut être définie de différentes manières comme la durée de vie B_{50}, la durée de vie B_5 et la limite de confiance inférieure de 95 % de la durée de vie B_5 [qui équivaut à (durée de vie $B_5)_L$]; celle-ci est décrite ci-dessous.

$$B_{50\ \text{life}} = \exp\left(\ln\hat{B}_{50}\right) = \exp\left(\hat{\beta}_0 + \hat{\beta}_1 x_{10} + \hat{\beta}_2 x_{20}\right)$$

$$B_{5\ \text{life}} = \exp\left(\ln\hat{B}_5\right) = \exp\left(\hat{\beta}_0 + \hat{\beta}_1 x_{10} + \hat{\beta}_2 x_{20} - 1{,}64\hat{\sigma}\right)$$

où

$B_{50\ \text{life}}$ est la variable pour la durée de vie B_{50};

$B_{5\ life}$ est la variable pour la durée de vie B_5;

x_{10} et x_{20} sont le facteur dépendant de la température et le facteur dépendant de l'humidité relative dans les conditions de stockage contrôlées (25 °C et 50 % d'humidité relative), respectivement.

De même, la limite de confiance inférieure de 95 % de la durée de vie B_5 devient

$$B_{(5\ life)L} = \exp\left[\left(\ln\hat{B}_5\right)_L\right] = \exp\left[\ln\hat{B}_5 - 1{,}64\sqrt{\mathrm{var}\left(\ln\hat{B}_5\right)}\right]$$

où

$B_{(5\ life)L}$ est la variable pour (durée de vie $B_5)_L$.

$\hat{\beta}_0, \hat{\beta}_1, \hat{\beta}_2$ et la variance estimée des erreurs résiduelles $\hat{\sigma}$ sont obtenus par l'analyse de régression des données de durée de fonctionnement avant défaillance.

4.3 Durée de vie B_{mig} pour le stockage à long terme des données audio

La durée de vie estimée de B_5 signifie que 5 % des produits sont défaillants. Elle est largement utilisée dans d'autres contextes. Toutefois, du point de vue de la fiabilité du stockage audio à long terme pour le maintien de l'intégrité des données d'origine, il n'est pas pertinent d'utiliser la durée de vie B_5 comme durée de vie estimée pour déterminer un intervalle d'essai et prendre une décision concernant la migration de données.

En cas de migration de données audio, il est nécessaire que la probabilité de défaillance soit suffisamment faible. Le moment où un millionième des produits est défaillant doit définir, dans le présent document, la durée de vie estimée pour déterminer les intervalles d'essai et l'intervalle de migration. La durée de vie $B_{0{,}000\ 1}$ correspond à 0,000 001 quantile de la répartition des durées de vie (soit 0,000 1 % de temps de défaillance) et est exprimé par la durée de vie B_{mig} dans le présent document. La durée de vie B_{mig} peut être calculée à l'aide de la durée de vie B_{50} et de la durée de vie B_5 comme suit (voir également l'ISO/IEC 29121:2021, Annexe E).

$$B_{0{,}000\ 1\ life} = \exp\left(\ln\hat{B}_{0{,}0001}\right) = \exp\left(\ln\hat{B}_{50} - 4{,}75\hat{\sigma}\right) = \exp\left(\ln\hat{B}_{50} - 4{,}75\frac{\ln\hat{B}_{50} - \ln\hat{B}_5}{1{,}64}\right) =$$

$$\exp\left(2{,}9\ln\hat{B}_5 - 1{,}9\ln\hat{B}_{50}\right)$$

où

$B_{0{,}000\ 1\ life}$ est la variable pour la durée de vie $B_{0{,}000\ 1}$;

Ainsi

$$B_{mig\ life} \times 24 \times 365 = B_{0{,}000\ 1\ life} = \exp\left(2{,}9\ln\hat{B}_5 - 1{,}9\ln\hat{B}_{50}\right)$$

où

$B_{mig\ life}$ est la variable pour la durée de vie B_{mig}, en années.

Dans les conditions de stockage réelles, la température et l'humidité relative peuvent s'écarter des conditions de stockage contrôlées (25 °C et 50 % d'humidité relative), ce qui modifie la durée de vie estimée. Dans ce cas, il convient d'ajuster la durée de vie estimée en fonction de la durée de vie estimée aux conditions de stockage réelles, comme cela est spécifié dans l'ISO/IEC 29121:2021, Annexe D.

4.4 Rang de durée de vie estimée et couleur d'affichage

4.4.1 Rang de durée de vie estimée et identification de la couleur d'affichage

Pour la migration de données audio, le rang de la durée de vie B_{mig} et sa couleur d'affichage d'identification sont définis comme suit.

La durée de de vie B_{mig} est supérieure à 30 ans, la couleur d'affichage est le rouge.

La durée de de vie B_{mig} est supérieure à 60 ans, la couleur d'affichage est le vert.

La durée de de vie B_{mig} est supérieure à 100 ans, la couleur d'affichage est le doré.

Les lignes directrices relatives à l'utilisation et aux couleurs d'affichage des rangs de la durée de vie B_{mig} sont fournies à l'Annex A.

4.4.2 Durée de vie B_{mig} et indication de la couleur d'affichage sur les disques et les boîtiers

Le rang de la durée de vie B_{mig}, sa couleur d'affichage et la condition de stockage contrôlée de référence doivent être indiquées sur le disque et l'emballage, à l'exception des disques double face. Des exemples d'indication des rangs et de leurs couleurs sont donnés à l'Annex A.

5 Condition d'essai, méthodes d'essai et disques pour les données audio

5.1 Conditions ambiantes pour le mesurage de l'erreur de données maximale

La condition ambiante est la condition environnante dans une pièce, où se trouve une unité d'essai. Les conditions ambiantes suivantes s'appliquent pour les mesurages de la $PI_{sum\ 8,max}$ et du BER_{max}:

Température 15 °C à 30 °C

Humidité relative 20 % à 75 %

5.2 Méthodes d'essai

5.2.1 Unité d'essai de lecture

Pour les disques DVD-R, DVD-RW, le format +R et le format +RW, l'unité d'essai doit être capable de mesurer la $PI_{sum\ 8,max}$.

Pour les disques DVD-RAM, l'unité d'essai doit être capable de mesurer le BER_{max}.

L'unité d'essai doit être capable d'évaluer le niveau de taux d'erreurs spécifié lors de l'essai initial de performances et de l'essai périodique de performances.

Il convient que l'unité d'essai ait la vitesse de lecture suivante:

pour les disques DVD-R, DVD-RW, le format +R et le format +RW	4 × VLC (vitesse linéaire constante) ou 6 × VLC
pour un disque DVD-RAM	2 × VAC (vitesse angulaire constante), 3 × VAC ou 5 × VAC

5.2.2 Zone d'essai et disque échantillon

La zone d'essai est la zone enregistrée à soumettre à l'essai sur un disque.

La zone enregistrée totale de l'ensemble des disques doit être soumise à l'essai initial de performances.

Il convient de soumettre la zone enregistrée totale de l'ensemble des disques à l'essai périodique de performances. Même si l'intégrité des données diminue, l'utilisateur peut réduire la zone d'essai et/ou le nombre de disques échantillons en appliquant une méthode d'échantillonnage spécifique, en tenant compte de la valeur des informations (voir l'ISO/IEC 29121:2021, Annexe G). Pour plus d'informations sur la réduction de la zone d'essai, se reporter à l'ISO/IEC 16963:2017, 7.5. Il convient que le nombre de disques échantillons soit suffisamment élevé pour assurer l'exactitude statistique. Si les disques échantillons présentent différents attributs (normes de disque, conditions d'enregistrement ou conditions de stockage, par exemple), il convient de les diviser en groupes de disques en tenant compte de leurs attributs, afin de pouvoir appliquer l'échantillonnage à chaque groupe en assurant l'efficacité statistique.

Dans le cas d'un disque DVD-RAM, il convient de soumettre à l'essai les données remplacées dans la zone de gestion des défauts, et non les données de défaut de la zone utilisateur.

5.2.3 Unité d'essai d'enregistrement

Il existe deux cas pour l'unité d'essai. Dans le premier cas, le disque sert à la fois d'unité d'essai et d'enregistreur pour l'enregistrement des données sur le disque. Dans le second cas, l'unité d'essai est différente de l'enregistreur. Dans les deux cas, les données enregistrées sur le disque par l'enregistreur doivent respecter le niveau de taux d'erreurs spécifié lors de l'essai initial de performances et de l'essai périodique de performances.

Il convient que l'unité d'essai ait la vitesse d'enregistrement suivante:

pour les disques DVD-R, DVD-RW, le format +R et le format +RW	4 × VLC ou 6 × VLC
pour un disque DVD-RAM	2 × VAC, 3 × VAC ou 5 × VAC

Il convient que l'unité d'essai mette en œuvre la méthode multisession et multibordure pour les disques enregistrables DVD-R et le format +R, et les disques réenregistrables DVD-RW. Les données d'archive doivent être enregistrées dans la première session ou bordure. Les informations d'historique peuvent être enregistrées dans la deuxième session ou bordure, ou les suivantes.

Il convient que l'unité d'essai mette en œuvre la méthode d'écriture incrémentale pour les disques réenregistrables DVD-RAM et le format +RW. Les données peuvent être écrites sur le disque formaté par simple enregistrement des fichiers. Les informations d'historique peuvent être enregistrées sur le disque comme un enregistrement de fichier supplémentaire.

5.2.4 Contrôle de l'unité d'essai

L'unité d'essai doit être contrôlée à l'aide d'un disque de référence préparé par le fabricant de l'unité d'essai ou d'un disque préparé par l'utilisateur, de manière qu'il respecte les exigences des 5.2.1, 5.2.2 et 5.2.3. Dans le cas d'un disque de référence préparé par le fabricant de l'unité

d'essai, l'unité d'essai doit être contrôlée selon les intervalles recommandés par le fabricant. Dans le cas d'un disque préparé par l'utilisateur, il est recommandé que l'utilisateur définisse un intervalle adéquat et que l'unité d'essai soit contrôlée selon cet intervalle.

6 Évaluation des résultats d'essai

6.1 Évaluation des résultats de l'essai initial de performances

Les performances d'enregistrement initiales doivent être classées par Niveau 1, Niveau 2 et Niveau 3 en fonction de la $PI_{sum\ 8,max}$ pour les disques DVD-R, DVD-RW, le format +R et le format +RW, ou en fonction du BER_{max} pour les disques DVD-RAM, comme cela est indiqué dans le Tableau 1.

Les performances d'enregistrement initiales doivent être dans les limites du Niveau 1 au minimum. Il convient de ne pas utiliser les disques dont les performances d'enregistrement initiales sont de Niveau 2 pour le stockage à long terme des données audio, les disques dont les performances d'enregistrement initiales sont de Niveau 3 ne relèvent pas de la spécification et ne doivent pas être utilisés.

Si les performances d'enregistrement initiales sont plus défavorables que le Niveau 1, il convient de vérifier les performances de l'unité utilisée pour l'enregistrement des données, car la $PI_{sum\ 8,max}$ et le BER_{max} dépendent des performances des disques et des unités. Si les performances de l'unité ne sont pas correctes, il convient de la remplacer. Si les performances du disque ne sont pas correctes, il convient d'utiliser un autre lot de disques.

Tableau 1 – Catégorie de performances d'enregistrement initiales

Niveau	Statut	DVD-R, DVD-RW, format +R, format +RW	DVD-RAM
1	Utilisation recommandée	< 140	$< 5{,}0 \times 10^{-4}$
2	Utilisation non recommandée	140 à 280	$5{,}0 \times 10^{-4}$ à $1{,}0 \times 10^{-3}$
3	Ne doit pas être utilisé	> 280	$> 1{,}0 \times 10^{-3}$
Erreur de données maximale		$PI_{sum\ 8,max}$	BER_{max}

6.2 Évaluation des résultats de l'essai périodique de performances

Il convient de contrôler régulièrement les disques utilisés pour le stockage des données selon l'intervalle d'essai décrit en 6.5. Les performances d'enregistrement lors de l'essai périodique de performances sont classées par Niveau 4, Niveau 5 et Niveau 6 en fonction de la $PI_{sum\ 8,max}$ pour les disques DVD-R, DVD-RW, le format +R et le format +RW, et en fonction du BER_{max} pour les disques DVD-RAM, comme cela est indiqué dans le Tableau 2.

Si les performances d'enregistrement sont au Niveau 4, le disque est suffisamment performant pour poursuivre le stockage.

Si les performances d'enregistrement sont au Niveau 5, les données stockées sur le disque doivent être migrées vers un autre disque dès que possible.

Si les performances d'enregistrement sont au Niveau 6, les données stockées sur le disque doivent être copiées sur un autre disque immédiatement, sous réserve que les données puissent être récupérées. Au Niveau 6, la $PI_{sum\ 8,max}$ et le BER_{max} sont suffisamment élevés pour que les données récupérées puissent contenir des erreurs non corrigeables.