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)

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AUDIO ARCHIVE SYSTEM –

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

FOREWORD

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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.

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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:

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

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.