BS ISO/IEC 30192:2021

BSI Standards Publication

Information technology — Digitally recorded media for information interchange and storage — 120 mm Single Layer (25,0 Gbytes per disk) and Dual Layer (50,0 Gbytes per disk) BD Rewritable disk

Documents
Document Sharing Hub

Full document details: BS ISO/IEC 30192:2021

National foreword

This British Standard is the UK implementation of ISO/IEC 30192:2021. It supersedes BS ISO/IEC 30192:2016, which is withdrawn.

The UK participation in its preparation was entrusted to Technical Committee IDT/2/17, Archives/records management.

A list of organizations represented on this committee can be obtained on request to its committee manager.

This publication does not purport to include all the necessary provisions of a contract. Users are responsible for its correct application.

© The British Standards Institution 2021
Published by BSI Standards Limited 2021

ISBN 978 0 539 13153 6

ICS 35.220.30

Compliance with a British Standard cannot confer immunity from legal obligations.

This British Standard was published under the authority of the Standards Policy and Strategy Committee on 28 February 2021.

Amendments/corrigenda issued since publication

Date	Text affected

Documents
Document Sharing Hub

Full document details: BS ISO/IEC 30192:2021

INTERNATIONAL STANDARD

ISO/IEC 30192

Third edition
2021-01

Information technology — Digitally recorded media for information interchange and storage — 120 mm Single Layer (25,0 Gbytes per disk) and Dual Layer (50,0 Gbytes per disk) BD Rewritable disk

Technologies de l'information — Supports enregistrés numériquement pour échange et stockage d'information — Disques BD réinscriptibles de 120 mm simple couche (25,0 Go par disque) et double couche (50,0 Go par disque)

Reference number
ISO/IEC 30192:2021(E)

Documents
Document Sharing Hub

© ISO/IEC 2021

Full document details: BS ISO/IEC 30192:2021

COPYRIGHT PROTECTED DOCUMENT

© ISO/IEC 2021

All rights reserved. Unless otherwise specified, or required in the context of its implementation, no part of this publication may be reproduced or utilized otherwise in any form or by any means, electronic or mechanical, including photocopying, or posting on the internet or an intranet, without prior written permission. Permission can be requested from either ISO at the address below or ISO's member body in the country of the requester.

ISO copyright office
CP 401 • Ch. de Blandonnet 8
CH-1214 Vernier, Geneva
Phone: +41 22 749 01 11
Email: copyright@iso.org
Website: www.iso.org

Published in Switzerland

© ISO/IEC 2021 – All rights reserved

Documents
Document Sharing Hub

Full document details: BS ISO/IEC 30192:2021

Contents

Page

Foreword ... **ix**
Introduction ... **x**
1 Scope ... **1**
2 Normative references ... **1**
3 Terms and definitions ... **2**
4 Symbol and abbreviated terms ... **2**
5 Conformance ... **3**
5.1 Optical disk ... 3
5.2 Generating system ... 3
5.3 Receiving system ... 3
5.4 Compatibility statement ... 3
6 Conventions and notations ... **4**
6.1 Levels of grouping ... 4
6.2 Representation of numbers ... 4
6.3 Integer calculus ... 5
7 General descriptions of disk ... **5**
8 General requirements ... **7**
8.1 Environments ... 7
8.1.1 Test environment ... 7
8.1.2 Operating environment ... 8
8.1.3 Storage environment ... 9
8.1.4 Transportation ... 10
8.2 Safety requirements ... 10
8.3 Flammability ... 10
9 Reference drive ... **11**
9.1 General ... 11
9.2 Environmental conditions ... 11
9.3 Optical system ... 11
9.4 Optical beam ... 12
9.5 HF read channel ... 12
9.6 Radial PP read channel ... 13
9.7 Disk clamping ... 13
9.8 Rotation of the disk and measurement velocity ... 13
9.9 Normalized servo transfer function ... 14
9.10 Measurement velocity and reference servo for axial tracking ... 14
9.11 Measurement velocity and reference servo for radial tracking ... 16
10 Dimensional characteristics ... **17**
10.1 General ... 17
10.2 Disk reference planes and reference axis ... 17
10.3 Overall dimensions ... 18
10.4 First transition area ... 19
10.5 Protection ring ... 19
10.6 Clamping zone ... 19
10.7 Second transition area ... 19
10.8 Information area ... 20
10.8.1 General ... 20
10.8.2 Subdivisions of information zone on SL disk ... 20
10.8.3 Subdivisions of information zone on DL disks ... 21
10.9 Rim area ... 22
11 Mechanical characteristics ... **22**

© ISO/IEC 2021 – All rights reserved

AVA Documents
Document Sharing Hub
Full document details: BS ISO/IEC 30192:2021

11.1 Mass ... 22
11.2 Moment of inertia ... 22
11.3 Dynamic imbalance ... 22
11.4 Axial runout ... 23
11.4.1 General ... 23
11.4.2 Residual axial tracking error ... 23
11.5 Radial runout ... 23
11.5.1 General ... 23
11.5.2 Residual radial tracking error on SL disks ... 24
11.5.3 Residual radial tracking error on DL disks ... 24
11.6 Durability of cover layer ... 24
11.6.1 Impact resistance of cover layer ... 24
11.6.2 Scratch resistance of cover layer ... 24
11.6.3 Repulsion of fingerprints by cover layer ... 24

12 Optical characteristics in information area ... 25
12.1 General ... 25
12.2 Refractive index of transmission stacks (TS) ... 25
12.3 Thickness of transmission stack(s) ... 25
12.3.1 Thickness of transmission stack of SL disks ... 25
12.3.2 Thickness of transmission stack of DL disks ... 25
12.4 Reflectivity ... 26
12.4.1 Reflectivity of recording layer of SL disks ... 26
12.4.2 Reflectivity of recording layer of DL disks ... 27
12.5 Birefringence ... 27
12.6 Angular deviation ... 27

13 Data format ... 28
13.1 General ... 28
13.2 Data frames ... 31
13.3 Error detection code (EDC) ... 31
13.4 Scrambled data frame ... 31
13.5 Data block ... 32
13.6 LDC block ... 33
13.7 LDC code words ... 34
13.8 LDC cluster ... 35
13.8.1 General ... 35
13.8.2 First interleave step ... 35
13.8.3 Second interleaving step ... 35
13.9 Addressing and control data ... 37
13.9.1 General ... 37
13.9.2 Address units ... 37
13.9.3 User control data ... 40
13.9.4 Byte/bit assignments for user control data ... 41
13.10 Access block ... 41
13.11 BIS block ... 43
13.12 BIS code words ... 43
13.13 BIS cluster ... 44
13.14 ECC cluster ... 47
13.15 Recording frames ... 48
13.16 Physical cluster ... 49
13.17 17PP modulation for recordable data ... 49
13.17.1 General ... 49
13.17.2 Bit conversion rules ... 49
13.17.3 dc-control procedure ... 50
13.17.4 Frame sync ... 50
13.18 Modulation and NRZI conversion ... 52

14 Physical data allocation and linking ... 53
14.1 General ... 53

© ISO/IEC 2021 – All rights reserved
Documents
Document Sharing Hub
Full document details: BS ISO/IEC 30192:2021

14.2 Recording unit block (RUB) 53
14.2.1 General 53
14.2.2 Data run-in 53
14.2.3 Data run-out 55
14.2.4 Guard_3 field 56
14.3 Locating data relative to wobble addresses 56
14.3.1 General 56
14.3.2 Start position shift (SPS) 56

15 Track format 58
15.1 General 58
15.2 Track shape 58
15.3 Track path 60
15.4 Track pitch 60
15.4.1 Track pitch in BCA zone 60
15.4.2 Track pitch in embossed HFM areas 60
15.4.3 Track pitch in rewritable areas 61
15.4.4 Track pitch between embossed HFM area and rewritable area 61
15.5 Track layout of HFM groove 61
15.5.1 General 61
15.5.2 Data format 61
15.5.3 Addressing and control data 62
15.5.4 Recording frames 65
15.6 Track layout of wobbled groove(s) 67
15.6.1 General 67
15.6.2 Modulation of wobbles 68
15.7 ADIP information 69
15.7.1 General 69
15.7.2 ADIP unit types 70
15.7.3 ADIP Word structure 71
15.7.4 ADIP Data structure 72
15.7.5 ADIP error correction 74
15.8 Disk information in ADIP aux frame 76
15.8.1 General 76
15.8.2 Error protection for disk information aux frames 77
15.8.3 Disk information data structure 78

16 General description of information zone 109
16.1 General 109
16.2 Format of information zone on single-layer disk 109
16.3 Format of information zone on dual-layer disk 109

17 Layout of rewritable area of information zone 109

18 Inner zone 112
18.1 General 112
18.2 Permanent information and control data (PIC) zone 115
18.2.1 General 115
18.2.2 Content of PIC zone 115
18.2.3 Emergency brake 116
18.3 Rewritable area of inner zone(s) 118
18.3.1 Protection zone 2 118
18.3.2 INFO 2/Reserved 8 118
18.3.3 INFO 2/Reserved 7 118
18.3.4 INFO 2/Reserved 6 119
18.3.5 INFO 2/Reserved 5 119
18.3.6 INFO 2/PAC 2 119
18.3.7 INFO 2/DMA 2 119
18.3.8 INFO 2/Control data 2 119
18.3.9 INFO 2/Buffer 2 119

Documents
Document Sharing Hub

© ISO/IEC 2021 – All rights reserved

Full document details: BS ISO/IEC 30192:2021

18.3.10 OPC/Test zone 119
18.3.11 Reserved 119
18.3.12 INFO1/Buffer 1 120
18.3.13 INFO 1/Drive area (optional) 120
18.3.14 INFO 1/Reserved 3 121
18.3.15 INFO 1/Reserved 2 121
18.3.16 INFO 1/Reserved 1 121
18.3.17 INFO 1/DMA 1 121
18.3.18 INFO1/Controle data 1 121
18.3.19 INFO1/PAC 1 121

19 Data zone 121

20 Outer zone(s) 121
20.1 General 121
20.2 INFO 3/Buffer 4 122
20.3 INFO 3/DMA 3 122
20.4 INFO 3/Control data 4 122
20.5 Angular buffer 122
20.6 INFO 4/DMA 4 122
20.7 INFO 4/Control data 4 123
20.8 INFO 4 / Buffer 6 123
20.9 Protection zone 3 123

21 Physical access control clusters 123
21.1 General 123
21.2 Layout of PAC zones 123
21.3 General structure of PAC clusters 124
21.4 Primary PAC cluster (mandatory) 128
21.5 Disk write-protect PAC cluster (optional) 130
21.6 IS1 and IS2 PAC clusters 134

22 Disk management 135
22.1 General 135
22.2 Disk management structure (DMS) 136
22.2.1 General 136
22.2.2 Disk definition structure (DDS) 137
22.2.3 Defect list (DFL) 140
22.2.4 Defect list header (DLH) 141
22.2.5 List of defects 142
22.2.6 DFL entries 143

23 Assignment of logical sector numbers (LSNs) 145

24 Characteristics of grooved areas 145

25 Method of testing for grooved area 146
25.1 General 146
25.2 Environment 146
25.3 Reference drive 146
25.3.1 General 146
25.3.2 Read power 146
25.3.3 Read channels 146
25.3.4 Tracking requirements 146
25.3.5 Scanning velocity 146
25.4 Signals 146

26 Signals from HFM grooves 148
26.1 Push-pull signal 148
26.2 HFM wobble signal 148
26.3 Jitter of HFM signal 148

27 Signals from wobbled groove(s) 148

© ISO/IEC 2021 – All rights reserved
AVA Documents Document Sharing Hub
Full document details: BS ISO/IEC 30192:2021

27.1 Phase depth ... 148
27.2 Push-pull signal ... 148
27.3 Wobble signal ... 149
27.3.1 General ... 149
27.3.2 Measurement of I_{NWS} ... 149
27.3.3 Measurement of wobble CNR ... 150
27.3.4 Measurement of harmonic distortion requirements ... 150

28 Characteristics of recording layer ... 150

29 Method of testing for recording layer ... 150
29.1 General ... 150
29.2 Environment ... 151
29.3 Reference drive ... 151
29.3.1 General ... 151
29.3.2 Read power ... 151
29.3.3 Read channels ... 151
29.3.4 Tracking requirements ... 151
29.3.5 Scanning velocities ... 151
29.4 Write conditions ... 151
29.4.1 Write-pulse waveform ... 151
29.4.2 Write powers ... 152
29.4.3 Write conditions for jitter measurement ... 152
29.4.4 Write conditions for cross-erase measurement ... 152
29.4.5 Write conditions for inter-velocity overwrite measurements ... 152
29.5 Definition of signals ... 153

30 Signals from recorded areas ... 153
30.1 HF signals ... 153
30.2 Modulated amplitude ... 153
30.3 Reflectivity modulation product ... 154
30.4 Asymmetry ... 155
30.5 Jitter ... 155
30.6 Cross-erase ... 155
30.7 Inter-velocity overwrite ... 156
30.8 Read stability ... 156

31 Local defects ... 157

32 Characteristics of user data ... 158

33 Method of testing for user data ... 158
33.1 General ... 158
33.2 Environment ... 158
33.3 Reference drive ... 158
33.3.1 General ... 158
33.3.2 Read power ... 158
33.3.3 Read channels ... 158
33.3.4 Error correction ... 158
33.3.5 Tracking requirements ... 159
33.3.6 Scanning velocities ... 159
33.4 Error signals ... 159

34 Minimum quality of recorded information ... 160
34.1 Random symbol error rate ... 160
34.2 Maximum burst errors ... 160
34.3 User-written data ... 161

35 BCA ... 161

Annex A (normative) **Thickness of transmission stacks in case of multiple layers ... 163**

Annex B (normative) **Measurement of reflectivity ... 165**

AVA Documents
Document Sharing Hub

© ISO/IEC 2021 – All rights reserved

Full document details: BS ISO/IEC 30192:2021

Annex C (normative) **Measurement of scratch resistance of cover layer** **168**
Annex D (normative) **Measurement of repulsion of grime by cover layer** **170**
Annex E (normative) **Measurement of wobble amplitude** **173**
Annex F (normative) **Write-pulse waveform for testing** **178**
Annex G (normative) **Optimum power control (OPC) procedure for disk** **187**
Annex H (normative) **HF signal pre-processing for jitter measurements** **191**
Annex I (normative) **Measurement procedure** **198**
Annex J (informative) **Measurement of birefringence** **204**
Annex K (informative) **Measurement of thickness of cover layer and spacer layer** **207**
Annex L (informative) **Measurement of impact resistance of cover layer** **210**
Annex M (informative) **Groove deviation and wobble amplitude** **212**
Bibliography **214**

© ISO/IEC 2021 – All rights reserved
Documents
Document Sharing Hub
Full document details: BS ISO/IEC 30192:2021

Foreword

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

The procedures used to develop this document and those intended for its further maintenance are described in the ISO/IEC Directives, Part 1. In particular, the different approval criteria needed for the different types of document should be noted. This document was drafted in accordance with the editorial rules of the ISO/IEC Directives, Part 2 (see www.iso.org/directives).

Attention is drawn to the possibility that some of the elements of this document may be the subject of patent rights. ISO and IEC shall not be held responsible for identifying any or all such patent rights. Details of any patent rights identified during the development of the document will be in the Introduction and/or on the ISO list of patent declarations received (see www.iso.org/patents) or the IEC list of patent declarations received (see patents.iec.ch).

Any trade name used in this document is information given for the convenience of users and does not constitute an endorsement.

For an explanation of the voluntary nature of standards, the meaning of ISO specific terms and expressions related to conformity assessment, as well as information about ISO's adherence to the World Trade Organization (WTO) principles in the Technical Barriers to Trade (TBT), see www.iso.org/iso/foreword.html.

This document was prepared by Joint Technical Committee ISO/IEC JTC 1, *Information Technology*, Subcommittee SC 23, *Digitally recorded media for information interchange and storage*.

This third edition cancels and replaces the second edition (ISO/IEC 30192:2016), which has been technically revised. It also incorporates the Amendment ISO/IEC 30192:2016/Amd.1:2019.

The main changes compared to the previous edition is the addition of requirements for physical accesss control and reserved area of BD application.

Any feedback or questions on this document should be directed to the user's national standards body. A complete listing of these bodies can be found at www.iso.org/members.html.

© ISO/IEC 2021 – All rights reserved

Documents
Document Sharing Hub
Full document details: BS ISO/IEC 30192:2021

Introduction

In March 2002, the Blu-ray Disc Founders, or BDF, came together to create optical disk formats with the large capacity and high-speed transfer rates that would be needed for recording and reproducing of high-definition video content. The first edition of Blu-ray Disc™ Rewritable Format Part 1 Version 1.0 was issued in June 2002 (capacity 23 GB with catridge).

The BDA issued Version 2.1 of the Blu-ray Disc™ Rewritable Format Part1 in October 2005 and Version 3.0 in June of 2010 (capacity 25 GB and 50 GB without cartridge).

To keep the compatibility of the removable medium in the market, just to make a standard is not enough, and it is necessary to check that the disks and devices can satisfy the specifications. The BDA conducts verification activities for both disks and devices and has established more than 10 testing Centres in Asia, Europe and the USA.

Blu-ray™ disks, players, recorders and PC drives/software based on BDA standards became popular all over the world. The BDA gave consumer applications the highest priority in the first few years. But it was known, of course, that international standardization would be required before many government entities and their contractors would be allowed to use Blu-ray Disc™. In January and February 2011, the BDA was formally requested to consider international standardization. The reason for this was to enable the inclusion of writable BDs, along with DVDs and CDs, in an International Standard specifying test methods for the estimation of lifetime of optical storage media for long-term data storage. In October 2011, the BDA responded that it had decided to pursue international standardization of the basic physical formats for the Recordable and Rewritable Blu-ray Disc™.

In December 2011, the BDA sent project proposals for international standardization of four formats. They are 120 mm Single Layer (25,0 Gbytes per disk) and Dual Layer (50,0 Gbytes per disk) BD Recordablee disks, 120 mm Single Layer (25,0 Gbytes per disk) and Dual Layer (50,0 Gbytes per disk) BD Rewritable disks, 120 mm Triple Layer (100,0 Gbytes per disk) and Quadruple Layer (128,0 Gbytes per disk) BD Recordable disks and 120 mm Triple Layer (100,0 Gbytes per disk) BD Rewritable disk.

A few additional specifications are required in order to write and read video recording applications, such as the BDMV and BDAV formats, which have been specified by the BDA for use on BD recordable disks. These specifications, which are related to the BD application, the file system and the content-protection system, are required for the disk, the generating system and the receiving system[1)].

The International Organization for Standardization (ISO) and International Electrotechnical Commission (IEC) draw attention to the fact that it is claimed that compliance with this document may involve the use of a patent.

ISO and IEC take no position concerning the evidence, validity and scope of this patent right.

The holder of this patent right has assured ISO and IEC that he/she is willing to negotiate licences under reasonable and non-discriminatory terms and conditions with applicants throughout the world. In this respect, the statement of the holder of this patent right is registered with ISO and IEC. Information may be obtained from the patent database available at www.iso.org/patents.

Attention is drawn to the possibility that some of the elements of this document may be the subject of patent rights other than those in the patent database. ISO and IEC shall not be held responsible for identifying any or all such patent rights.

NOTE Blu-ray™, Blu-ray Disc™ and the logos are trademarks of the Blu-ray Disc Association.

1) For more information of the BD application, the content-protection system and the additional requirements for the Blu-ray™ Format specifications, see http://www.blu-raydisc.info.

© ISO/IEC 2021 – All rights reserved
Documents
Document Sharing Hub
Full document details: BS ISO/IEC 30192:2021

Information technology — Digitally recorded media for information interchange and storage — 120 mm Single Layer (25,0 Gbytes per disk) and Dual Layer (50,0 Gbytes per disk) BD Rewritable disk

1 Scope

This document specifies the mechanical, physical and optical characteristics of a 120 mm rewritable optical disk with a capacity of 25,0 Gbytes or 50,0 Gbytes. It specifies the quality of the recorded and unrecorded signals, the format of the data and the recording method, thereby allowing for information interchange by means of such disks. User data can be written, read and overwritten many times using a reversible method. This disk is identified as a BD rewritable disk.

This document specifies the following:

— two related but different types of this disk;

— conditions for conformance;

— environments in which the disk is to be operated and stored;

— mechanical and physical characteristics of the disk, which allow mechanical interchange between data processing systems;

— format of the information on the disk, including the physical disposition of the tracks and sectors;

— error-correcting codes and coding method used;

— characteristics of the signals recorded on the disk, which enable data processing systems to read data from the disk.

This document provides for interchange of disks between drives. Together with a standard for volume and file structure, it provides for full data interchange between data processing systems.

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 646, *Information technology — ISO 7-bit coded character set for information interchange*

ISO 9352, *Plastics — Determination of resistance to wear by abrasive wheels*

ISO 30193, *Information technology — Digitally recorded media for information interchange and storage — 120 mm Triple Layer (100,0 Gbytes per disk) BD Rewritable disk*

IEC 60068-2-2, *Environment testing — Part 2-2: Tests — Test B: Dry heat*

IEC 60068-2-30, *Environment testing — Part 2-30: Tests — Test Db: Damp heat, cyclic (12 h + 12 h cycle)*

IEC 60950-1, *Information technology equipment — Safety — Part 1: General requirements*

© ISO/IEC 2021 – All rights reserved

Documents
Document Sharing Hub
Full document details: BS ISO/IEC 30192:2021

3 Terms and definitions

For the purposes of this document, the terms and definitions given in ISO/IEC 30193 apply.

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

— ISO Online browsing platform: available at https://www.iso.org/obp

— IEC Electropedia: available at http://www.electropedia.org/

4 Symbol and abbreviated terms

ac	alternating current
ADIP	address in pre-groove
APC	automatic power control
AU	address unit
AUN	address unit number
BCA	burst-cutting area
BIS	burst-indicating subcode
BPF	band-pass filter
CAV	constant angular velocity
cbs	channel bits
CNR	carrier-to-noise ratio
dc	direct current
DDS	disk definition structure
DFL	defect list
DI	disk information
DL	dual layer
DMA	disk management area
DMS	disk management structure
DOW	direct overwrite
DOW(n)	the n-th overwrite
DOW(0)	the initial recording
DSV	digital-sum value
DWP	disk write protect
EB	emergency brake
ECC	error correction code
lsb	least significant bit
L_{SHD}	second harmonic distortion level
L_{SHL}	second harmonic level
LSN	logical sector number
MM	MSK mark
MSB	most significant byte
msb	most significant bit
MSK	minimum shift keying
MW	monotone wobble
NRD	non-re-allocatable defect
NRZ	non-return-to-zero
NRZI	non-return-to-zero inverting
NWL	nominal wobble length
OPU	optical pick-up unit
PAA	physical ADIP address
PAC	physical access control
PBA	possibly bad area
PIC	permanent information and control data
PLL	phase-lock loop
PoA	post-amble
PP	push-pull
pp	peak-to-peak
PrA	pre-amble
PSN	physical sector number
R_H	relative humidity

© ISO/IEC 2021 – All rights reserved
Documents
Document Sharing Hub
Full document details: BS ISO/IEC 30192:2021

EDC	error detection code	RMTR	repeated minimum transition run length
FAA	first ADIP address (of data zone)	R-M-W	read-modify-write
FS	frame sync	RS	Reed-Solomon (code)
FWHM	full width at half maximum	R_T	relative thickness
HF	high frequency	RUB	recording unit block
HFM	high frequency modulated	SER	symbol error rate
HMW	harmonic-modulated wave	SL	single layer
HPF	high-pass filter	S/N	signal-to-noise ratio
HTL	high-to-low	SPS	start position shift
I_{NHWS}	normalized HFM-wobble signal amplitude	STW	saw-tooth wobble
I_{NWS}	normalized wobble signal amplitude	Sync	synchronization
LAA	last ADIP address (of data zone)	TP	track pitch
LDC	long-distance code	TS	transmission stack
LPF	low-pass filter	wbs	wobbles
LSB	least significant byte	WP	write protect

5 Conformance

5.1 Optical disk

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

5.2 Generating system

A generating system shall be in conformance with this document if the optical disk it generates is in accordance with 5.1.

5.3 Receiving system

A receiving system shall be in conformance with this document if it is able to handle both Types of optical disks according to 5.1.

5.4 Compatibility statement

A claim of conformance by a generating or receiving system with this document shall include a statement listing any other standards supported. This statement shall specify the numbers of the standards, the optical disk types supported (where appropriate) and whether support includes reading only or both reading and writing.

© ISO/IEC 2021 – All rights reserved

Documents
Document Sharing Hub
Full document details: BS ISO/IEC 30192:2021

6 Conventions and notations

6.1 Levels of grouping

Many times, data is collected into that data can be collected into higher level groups. For the clarity of the grouping hierarchy, in this document, the following levels of hierarchy is used.

Frame: the lowest level of grouping. Generally, frames contain bytes of information.

Block: the second level of grouping. Generally, blocks consist of a number of frames.

Cluster: the highest level of grouping. Clusters consist of several blocks.

Fragment: a level of grouping that can be applied by the application. A certain amount of data is allocated to a (fixed) number of consecutive clusters.

6.2 Representation of numbers

A measured value $x_{measured}$ may be rounded off to the least significant digit of the corresponding specified value x before being compared with this specified value.

EXAMPLES:

- The specification is: $x = 1{,}26^{+0{,}01}_{-0{,}02}$:

  (nominal value = 1,26 with a positive tolerance of +0,01 and a negative tolerance of –0,02)

  - a measured value in the range $1{,}235 \leq x_{measured} < 1{,}275$ fulfills this specification.
- The specification is: $x \leq 0{,}3$:
  - a measured value $x_{measured} < 0{,}35$ fulfills this specification
    (rounding off is applied for $0{,}30 < x_{measured} < 0{,}35$: $x_{rounded} = 0{,}3$);
- The specification is: $x < 0{,}3$:
  - a measured value $x_{measured} = 0{,}299$ fulfills this specification
    (no rounding off needs to be applied);
  - a measured value $x_{measured} = 0{,}3$ exactly does not fulfil this specification.

In case the specified value is given as “maximum x units” or “minimum x units”, the measured value shall not be rounded off before comparing to the specified value. Parameters given in this way shall not violate the specified limits set by the exact value of x.

EXAMPLES:

- The specification is maximum 0,3 mm:
  - a measured value of 0,300 mm fulfills this specification;
  - a measured value of 0,301 mm does not fulfil this specification;
- The specification is minimum 3 dB:
  - a measured value of 3,00 dB fulfills this specification;
  - a measured value of 2,99 dB does not fulfil this specification.

© ISO/IEC 2021 – All rights reserved
Documents
Document Sharing Hub
Full document details: BS ISO/IEC 30192:2021

Numbers in decimal notation are represented by the digits 0 to 9. The decimal symbol is "," (comma). In large numbers, the " " (space) can be used as digit grouping symbol.

Numbers in hexadecimal notation are represented by the hexadecimal digits 0 to 9 and A to F in parentheses or followed by lowercase "h". The character x in hexadecimal numbers represents any digit 0 to 9 or A to F.

Numbers in binary notation and bit patterns are represented by strings of digits 0 and 1, with the most significant bit shown to the left. The character *x* in binary numbers represents a digit 0 or 1.

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

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

An uninterrupted sequence of *m* 0's in a bit pattern can be represented by $[0^m]$.

The setting of bits is denoted by ZERO and ONE.

In data fields composed of bytes, the data is recorded so that the most significant byte (MSB), identified as byte 0, shall be recorded first and the least significant byte (LSB) last.

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

In data fields composed of nibbles, the data is recorded so that the most-significant nibble, identified as nibble 0, shall be recorded first and the least-significant nibble last.

In a field of 4*n* bits, bit $b_{(4n-1)}$ shall be the most significant bit (msb) and bit b_0 the least significant bit (lsb). Bit $b_{(4n-1)}$ shall be recorded first.

A range of values is indicated as $x \sim y$, where the limits *x* and *y* are included in the range.

A list of integers is indicated as *i* .. *j*. The list contains all integers between *i* and *j* as well as *i* and *j* (e.g. $k = 0 .. 7$). If the step size is different from one, this is indicated as: *i*, (*i* + step) .. *j* (e.g. $k = 1, 4 .. 16$, where step = 3).

A group of parameters is indicated as param *m* .. *n* or $P_m .. P_n$. The group contains all parameters with an index between *m* and *n* as well as *m* and *n* (e.g. byte 16 .. 31, bit 7 .. 4, Add0 .. Add255).

If *x* is nearly equal to *y*, then it is expressed as $x \approx y$.

6.3 Integer calculus

div(*n*,*d*) represents the integer part of the division of *n* by *d*.

mod(*n*,*d*) represents the remainder of the division of *n* by *d*: $\mathrm{mod}(n,d) = n - d \times \mathrm{div}(n,d)$.

EXAMPLE

div(+11,+3) = +3	div(–11,+3) = –3	div(+11,–3) = –3	div(–11,–3) = +3
mod(+11,+3) = +2	mod(–11,+3) = –2	mod(+11,–3) = +2	mod(–11,–3) = –2

7 General descriptions of disk

The 120 mm optical disk that is the subject of this document consists of a substrate of about 1,1 mm nominal thickness. clamping is performed in the clamping zone.

The recording layer of the disk uses high-to-low (HTL) technology. Recorded HTL marks have lower reflection than the unrecorded layer(s).

© ISO/IEC 2021 – All rights reserved

Documents
Document Sharing Hub
Full document details: BS ISO/IEC 30192:2021

The recording layer of the disk may use phase-change recording technology. Recorded amorphous marks have lower reflection than the crystalline spaces of unrecorded layer(s).

This document provides for two types of disks

Type SL disk: the substrate is covered with a recording layer, consisting of several films. On top of this recording layer, a transparent cover layer of 0,1 mm is applied with precisely defined optical characteristics (see Figure 1). The capacity is 25,0 Gbytes.

Type DL disk: the substrate is covered with two recording layers, each consisting of several films. The two recording layers are separated by a transparent spacer layer of about 0,025 mm. The first recording layer seen from the read-out side of the disk shall be semi-transparent. On top of this recording layer, a transparent cover layer of about 0,075 mm is applied. Both the spacer layer and the cover layer shall have precisely defined optical characteristics (see Figure 2). The capacity is 50,0 Gbytes.

To improve scratch resistance of the disk, the cover layer optionally can be protected with an additional hard coating.

Data can be written and overwritten onto the disk with a high-power focused optical beam. The data can be read with a low-power focused optical beam, using the difference in the reflectivity of the amorphous marks and the crystalline spaces.

The recording layer(s) contain wobbled groove(s) with addresses that enable a speed control and navigation system for data to be read from or written to the recording layer concerned.

Recording and reading of the data is accomplished through the cover layer or through the total stack of cover layer, first recording layer and spacer layer, depending on which recording layer is involved.

For reference purposes, a layer that the light beam passes through when accessing a certain recording layer is called a transmission stack of that specific recording layer (see Figure 1 and Figure 2).

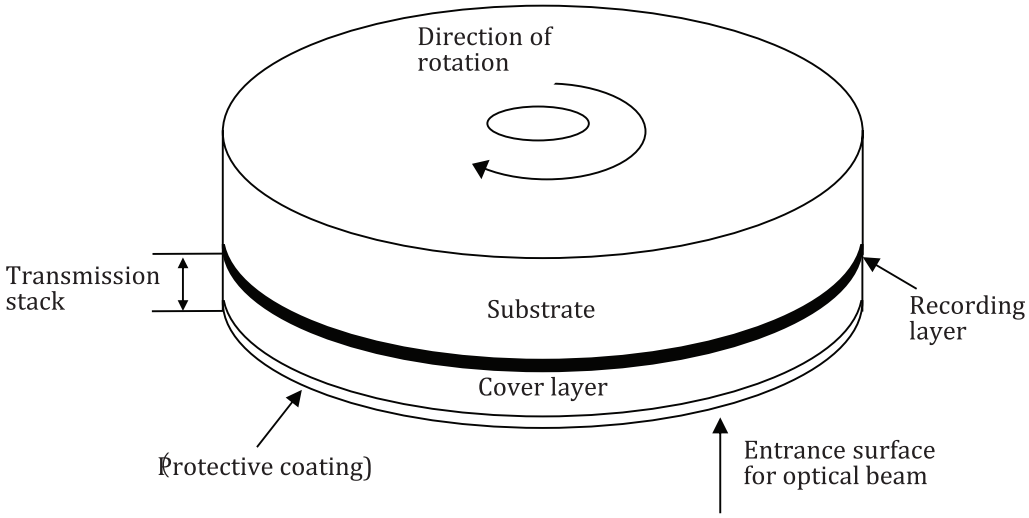

Figure 1 — Outline of type SL disk

© ISO/IEC 2021 – All rights reserved
Documents
Document Sharing Hub
Full document details: BS ISO/IEC 30192:2021

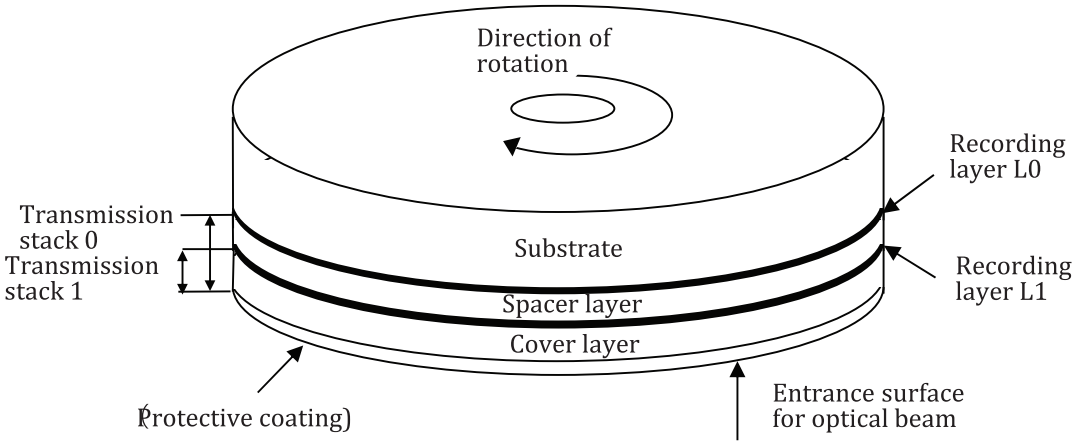

Figure 2 — Outline of type DL disk

This document specifies two kinds of recording velocity: 1x and 2x.

Figure 3 shows the recording velocity requirements for each disk type. At least one of the write strategies is reqired for each recording velocity.

Disk type	Disk type parameters		Recording velocity	
	Mark polarity	Layer type	1x	2x
Type SL	HTL	SL	M	M
Type DL	HTL	DL	M	M
M Mandatory				

Figure 3 — Recording velocity requirements for disk type

8 General requirements

8.1 Environments

8.1.1 Test environment

8.1.1.1 General

During measurements for testing conformance of a disk with this document, the disk shall be in the test environment. The test environment is the environment where the air immediately surrounding the disk shall have following properties:

— temperature, T: (23 ± 2) °C;

— relative humidity, R_H: 45 %to 55 %;

— atmospheric pressure: 86 kPa to 106 kPa.

No condensation on the disk shall occur. Before testing, the disk shall be conditioned in this environment for a sufficient time.

© ISO/IEC 2021 – All rights reserved

Documents
Document Sharing Hub
Full document details: BS ISO/IEC 30192:2021

8.1.1.2 Test conditions for sudden changes in operating environment

Some parameters can be rather sensitive to changes in the operating environment. Where specified, the following two tests shall be performed. In both cases, the required specifications shall be fulfilled during the time it takes for the disk to acclimatize to the new environment.

a) Apply a sudden change in relative humidity, while keeping the temperature at a constant level: R_H = 90 %, T = 25 °C → R_H = 45 %, T = 25 °C (see Figure 4).

b) Apply a sudden change in temperature, while keeping the absolute humidity at a constant level (≈10,4 g/m^3): T = 25 °C, R_H = 45 % → T = 55 °C, R_H = 10 % (see Figure 4).

8.1.2 Operating environment

A disk in conformance with this document shall provide data interchange over the specified ranges of environmental parameters in the operating environment. The operating environment is the environment where the air immediately surrounding the disk shall have the following properties:

— temperature, T: 5°C to 55 °C;

— relative humidity, R_H: 3 %to 90 %;

— absolute humidity: 0,5 g/m^3 to 30 g/m^3;

— atmospheric pressure: 60 kPa to 106 kPa.

There shall be no condensation of moisture on the disk. If a disk has been exposed to conditions outside those specified above, it shall be acclimatized in an operating environment for at least 2 h before use.

© ISO/IEC 2021 – All rights reserved
Documents
Document Sharing Hub
Full document details: BS ISO/IEC 30192:2021

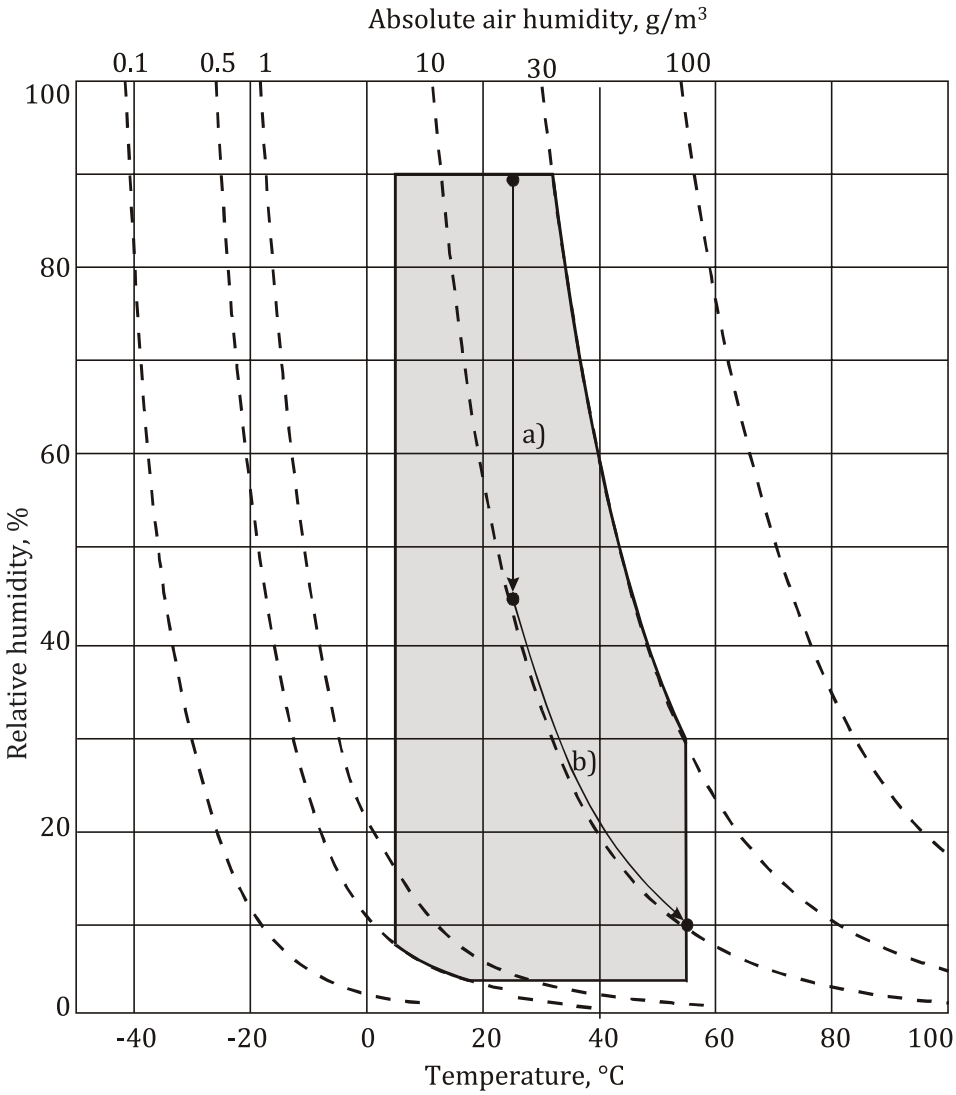

Figure 4 — Operating environment

8.1.3 Storage environment

8.1.3.1 General

The storage environment is an environment where the air immediately surrounding the optical disk shall have the following properties:

— temperature, T: –10 °C to 55 °C;

— relative humidity, R_H: 5 %to 90 %;

— absolute humidity: 1 g/m^3 to 30 g/m^3;

— atmospheric pressure: 60 kPa to 106 kPa;

— maximum temperature variation: 15 °C/h;

— maximum relative humidity variation: 10 %/h.

© ISO/IEC 2021 – All rights reserved

Documents
Document Sharing Hub
Full document details: BS ISO/IEC 30192:2021

8.1.3.2 Climatic storage tests

To check environmental stability of the disk, it shall be exposed to the following environments:

— dry heat test according to IEC 60068-2-2 Ba:

T = 55 °C, R_H = 50%, 96 h;

— damp heat cycle test according to IEC 60068-2-30 Db:

T_{high} = 40 °C, T_{low} = 25 °C, R_H = 95 %, cycle time = (12 + 12) h, 6 cycles.

After exposure to these environmental conditions, one should allow for some recovery time before measuring (24 h or 48 h).

8.1.4 Transportation

8.1.4.1 General

As transportation occurs under a wide range of temperature and humidity variations, for differing periods, by many methods of transport and in all parts of the world, it is not possible to specify mandatory conditions for transportation or for packaging.

8.1.4.2 Packaging

8.1.4.2.1 General

The form of packaging should be agreed between sender and recipient or, in absence of such an agreement, is the responsibility of the sender. It should take into account the following hazards.

8.1.4.2.2 Temperature and humidity

Insulation and wrapping should be designed to maintain the conditions for storage over the estimated period of transportation.

8.1.4.2.3 Impact loads and vibrations

a) Avoid mechanical loads that would distort the shape of the disk.

b) Avoid dropping the disk.

c) Disks should be packed in a rigid box containing adequate shock-absorbent material.

d) The final box should have a clean interior and a construction that provides sealing to prevent the ingress of dirt and moisture.

8.2 Safety requirements

The disk shall satisfy the requirements of IEC 60950-1, when used in the intended manner or in any foreseeable uses in an information system.

8.3 Flammability

The disk shall be made from materials that comply with the flammability class for HB materials, or better, as specified in IEC 60950-1.

© ISO/IEC 2021 – All rights reserved
Documents
Document Sharing Hub
Full document details: BS ISO/IEC 30192:2021

9 Reference drive

9.1 General

A reference drive shall be used for the measurement of optical and electrical signal parameters in order to confirm that a disk is in conformance with the requirements of this document. The characteristics of the critical components of this device are specified in Clause 9.

9.2 Environmental conditions

During tests, the disk shall be in a test environment as defined in 8.1.1, unless stated otherwise.

9.3 Optical system

The basic set-up of the optical system of the reference drive used for measuring specified (over)write and read parameters is shown in Figure 5. Different components and locations of components are permitted, provided that the performance remains the same as that of the set-up in Figure 5.

The optical system shall be aligned such that the focused optical beam is perpendicular to the recording layer on which the beam is focused at the radius where the measurement is to be performed.

The optical system shall be such that the detected light reflected from the entrance surface of the disk is minimized so as not to affect the accuracy of the measurements.

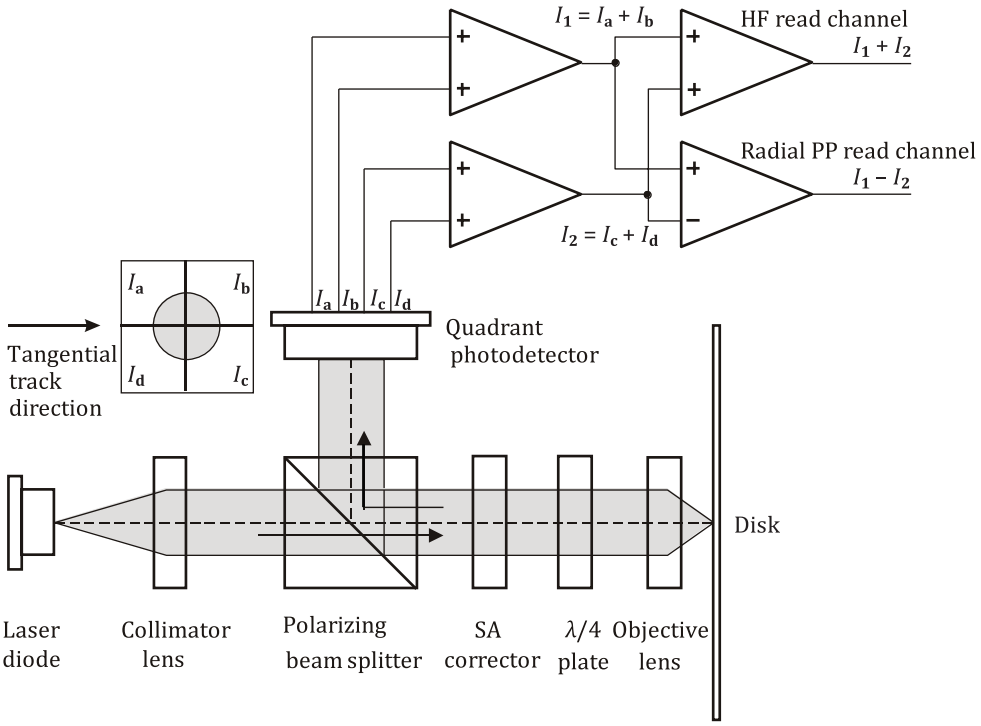

Figure 5 — Optical system of reference drive

A polarizing beam splitter and a quarter-wavelength plate shall be used to separate the entrance light beam, coming from the laser diode, and light beam reflected by the optical disk going towards the photodetector. The light beam transmitted through the splitter shall have a p:s intensity ratio of at least 100:1.

The optical beam shall be compensated for spherical aberrations (SA) such that these aberrations are minimized for the thickness of the transmission stack of the recording layer on which the beam is focused at the radius where the measurement is to be performed.

© ISO/IEC 2021 – All rights reserved

Documents
Document Sharing Hub
Full document details: BS ISO/IEC 30192:2021

During measurements on one layer of a dual-layer disk, light reflected from the other layer can influence the measurements on the layer under investigation. To cope with these effects, the photodetector shall have limited dimensions. Its length and width shall be smaller than $M \times 5$ µm, where M is the transversal optical magnification from the disk to its conjugate plane near the quadrant photodetector.

9.4 Optical beam

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

— wavelength (λ) of the laser beam:	(405 ± 5) nm;
— polarization:	circular;
— NA:	0,85 ± 0,01;
— light intensity at the rim of the pupil of the objective lens relative to the maximum intensity:	
— in the tangential direction:	(60 ± 5) %;
— in the radial direction:	(65 ± 5) %;
— maximum wave-front aberration at the recording layer(s): (after correction of tilt and spherical aberrations)	0,033 × λ rms;
— maximum relative-intensity noise of the laser diode: $\left[10\times\lg\left(\frac{P_m}{P_{dc}}\right)\right]$ where P_m is the ac light density, in Hz; P_{dc} is the dc light power.	–125 dB/Hz;
— normalized detector size:	$S/M^2 \leq 25$ µm^2 where S is the total surface of the quadrant photodetector;
— read power for disk testing (average):	
— SL disk:	(0,35 ± 0,1) mW;
— DL disk:	(0,70 ± 0,1) mW;
— write power and pulse shape:	For write power, see 29.4.2 for detailed specifications. The pulse shape shall follow Annex F.

9.5 HF read channel

The HF read channel is provided to supply a signal from which user data can be retrieved. This signal is generated by summing the currents from all four elements of the photodetector ($I_a + I_b + I_c + I_d$). These currents are modulated by the user-written information due to the difference in reflectivity of the marks and spaces caused by the phase-change effects.

© ISO/IEC 2021 – All rights reserved
Documents
Document Sharing Hub
Full document details: BS ISO/IEC 30192:2021

In the frequency range from dc to 22 MHz the HF read channel, including the photodetectors, shall have a flat amplitude response within ±1,0 dB relative to its dc gain.

The group delay variation shall be maximum 2 ns pp in the frequency range from 3 MHz to 22 MHz.

For measurement of jitter, the characteristics of the signal processing, the data slicer and the PLL, etc., are specified in Annex H.

9.6 Radial PP read channel

The radial PP read channel provides the tracking error signal to control the servo for radial tracking of the optical beam. It also provides a wobble signal from which the information modulated on the grooves can be retrieved.

The radial tracking error is generated as a signal $[(I_a + I_b) - (I_c + I_d)]$ related to the difference in the amount of light in the two halves of the exit pupil of the objective lens.

The read amplifiers including the photodetectors in the radial PP read channel shall have a flat amplitude response within ±1,0 dB relative to their dc gain from dc to 8 MHz.

9.7 Disk clamping

While its parameters are being measured, the disk shall be clamped between two concentric rings covering most of the clamping zone (see 10.6). The top clamping area shall have the same inner and outer diameters as the bottom clamping area (see Figure 6).

Clamping shall occur between d_{in} = (23,5 ± 0,5) mm and d_{out} = (32,5 ± 0,5) mm.

The total clamping force shall be F_1 = 2,0 N ± 0,5 N.

In order to prevent warping of the disk under the moment of force generated by the clamping force and the chucking force F_2, which is exerted by the tapered cone on the rim of the centre hole of the disk, F_2 shall not exceed 0,5 N (see Figure 6).

The top angle θ_a of the tapered cone for centring of the disk shall be 40,0° ± 0,5°.

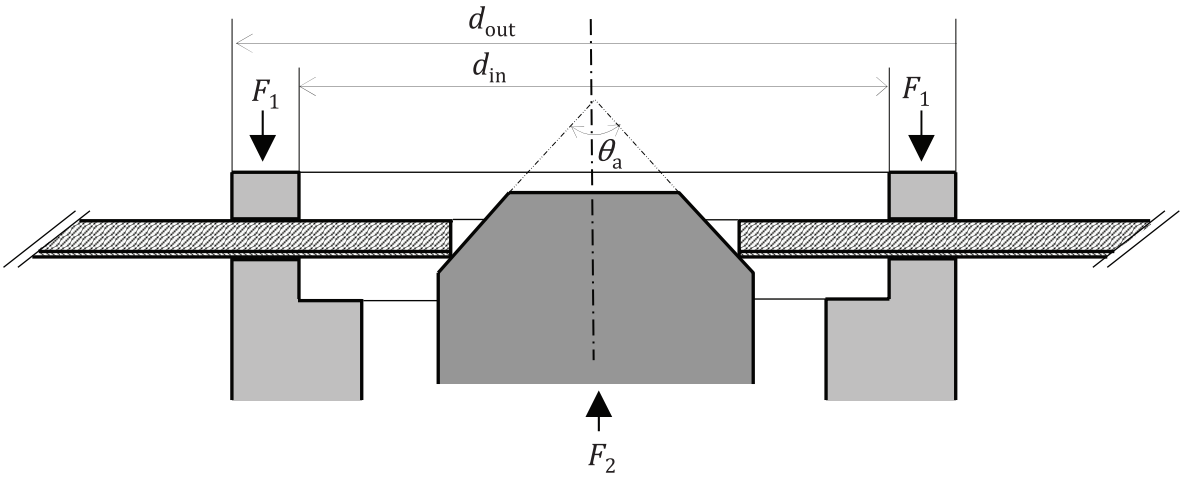

Figure 6 — Clamping conditions for measurement

9.8 Rotation of the disk and measurement velocity

The direction of rotation shall be counter-clockwise as viewed from the objective lens.

© ISO/IEC 2021 – All rights reserved

Documents
Document Sharing Hub
Full document details: BS ISO/IEC 30192:2021

All specifications are based on a tangential speed during reading that is equal to the reference velocity. This corresponds to a constant linear velocity of 4,917 m/s.

Tests for determining the recording characteristics of BD rewritable disks shall be carried out at all velocities defined in each of the DI units that are present on the disk (see 15.8.3).

9.9 Normalized servo transfer function

In order to specify the servo systems for axial and radial tracking, a function $H_N(\mathrm{i}\omega)$ is used. It specifies the nominal values of the open-loop transfer function H of the reference servo(s) as Formula (1):

$$H_N(\mathrm{i}\omega) = \frac{1}{3} \times \left(\frac{\omega_0}{\mathrm{i}\omega}\right)^2 \times \frac{1 + \frac{3 \times \mathrm{i}\omega}{\omega_0}}{1 + \frac{\mathrm{i}\omega}{3 \times \omega_0}} \times \left(1 + \frac{\omega_{\mathrm{int}}}{\mathrm{i}\omega}\right)^K \tag{1}$$

where

ω = $2\pi \times f$;

ω_0 = $2\pi \times f_0$;

ω_{int} = $2\pi \times f_{\mathrm{int}}$;

i^2 = –1;

K = order of integrator.

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

— lead break frequency: $f_1 = f_0 / 3$;

— lag break frequency: $f_2 = f_0 \times 3$.

The term $(1+\omega_{\mathrm{int}}/\mathrm{i}\omega)$ in the Formula (1) above represents an integrator function. Such an integrator or equivalent function is used to further reduce of low-frequency components, especially those due to deviations with frequencies equal to the rotational frequency of the disk or its harmonics.

Also, f_{int} is the 3 dB crossover frequency of the integrator function.

Another frequency of importance is the frequency f_X at which a sinusoidal displacement with an amplitude equal to the maximum allowed residual tracking error $e_{\max}$, corresponds to the maximum expected acceleration $\alpha_{\max}$. This frequency can be calculated with Formula (2):

$$f_x = \frac{1}{2\pi}\sqrt{\frac{\alpha_{\max}}{e_{\max}}} \tag{2}$$

Because the tracking error signals from the disk can have rather large variations, the tracking error signal fed into each reference servo loop shall be adjusted to a fixed level (effectively calibrating the total loop gain), which guarantees the specified bandwidth.

9.10 Measurement velocity and reference servo for axial tracking

Regarding the open-loop transfer function $H(f)$ of the reference servo for axial tracking, $|1 + H(f)|$ is shown schematically by the shaded area in Figure 7.

© ISO/IEC 2021 – All rights reserved
Documents
Document Sharing Hub
Full document details: BS ISO/IEC 30192:2021

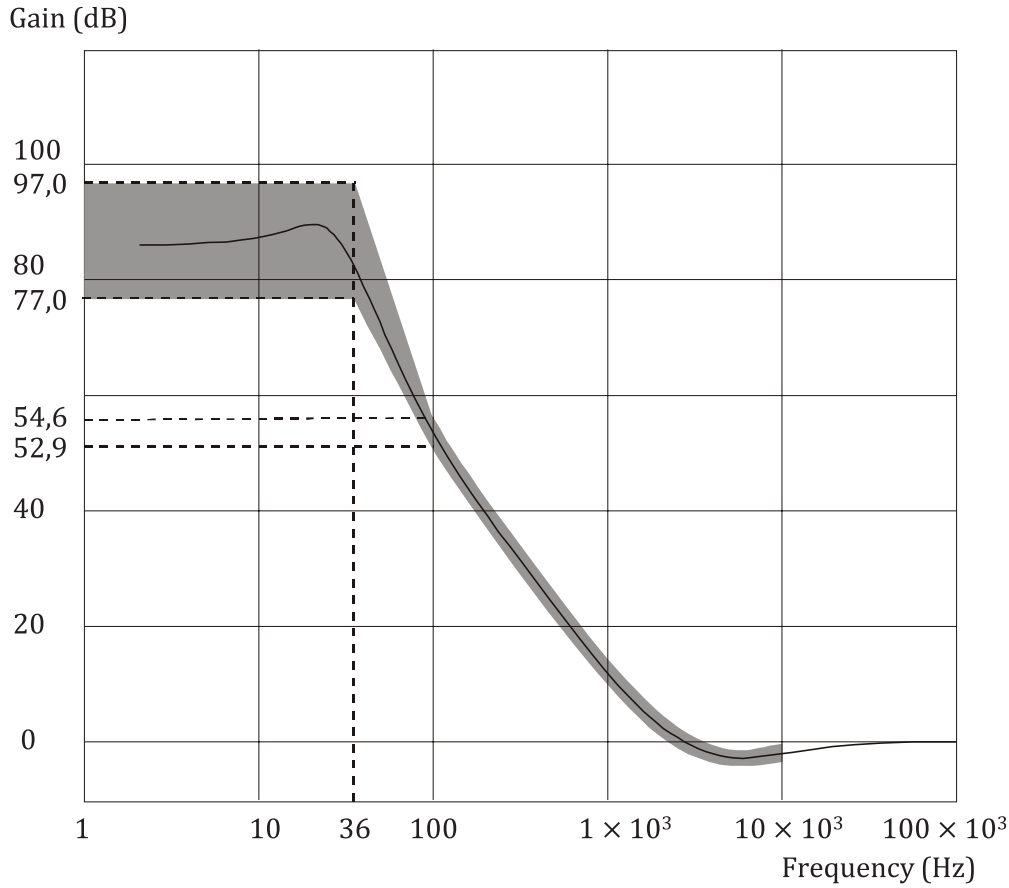

Figure 7 — Servo characteristic for axial tracking

The crossover frequency, f_0 of $H_N(f)$ (see 9.9), in kHz, used to define the limits of $|1 + H(f)|$, is specified by the Formula (3), where α_{max} = 6,0 m/s^2 is the maximum expected axial acceleration due to local disturbances, and α_{max} is multiplied by a factor m = 1,25 for servo margin. The tracking error e_{max}, caused by this $m \times \alpha_{max}$, shall be 55 nm. Thus, the 0 dB crossover frequency shall be as follows:

$$f_0 = \frac{1}{2\pi}\sqrt{\frac{3 \times m \times \alpha_{max}}{e_{max}}} = \frac{1}{2\pi}\sqrt{\frac{3 \times 1{,}25 \times 6{,}0}{55 \times 10^{-9}}} = 3{,}2 \qquad (3)$$

The integrator 3 dB crossover frequency shall be: f_{int} = 100 Hz.

In the frequency range 100 Hz to 10 kHz, $|1 + H(f)|$ shall be within –10 % to +10 % of $|1 + H_N(f)|$.

In the frequency range 36 Hz to 100 Hz, $|1 + H(f)|$ shall be within the limits defined by the following four points:

— 52,9 dB at 100 Hz ($|1 + H_N(f)|$ at 100 Hz – 10 %);

— 54,6 dB at 100 Hz ($|1 + H_N(f)|$ at 100 Hz + 10 %);

— 77,0 dB at 36 Hz ($|1 + H_N(f)|$ at 36 Hz – 10 %);

— 97,0 dB at 36 Hz ($|1 + H_N(f)|$ at 36 Hz – 10 % + 20 dB).

In the frequency range up to 36 Hz, $|1 + H(f)|$ shall be between 77,0 dB and 97,0 dB.

© ISO/IEC 2021 – All rights reserved

Documents
Document Sharing Hub
Full document details: BS ISO/IEC 30192:2021

The frequency f_X, in kHz, has the value as per Formula (4):

$$f_x = \frac{1}{2\pi}\sqrt{\frac{\alpha_{max}}{e_{max}}} = \frac{1}{2\pi}\sqrt{\frac{6{,}0}{55\times10^{-9}}} \approx 1{,}6 \quad (4)$$

9.11 Measurement velocity and reference servo for radial tracking

Regarding the open-loop transfer function $H(f)$ of the reference servo for radial tracking, $|1 + H(f)|$ is shown schematically by the shaded area in Figure 8.

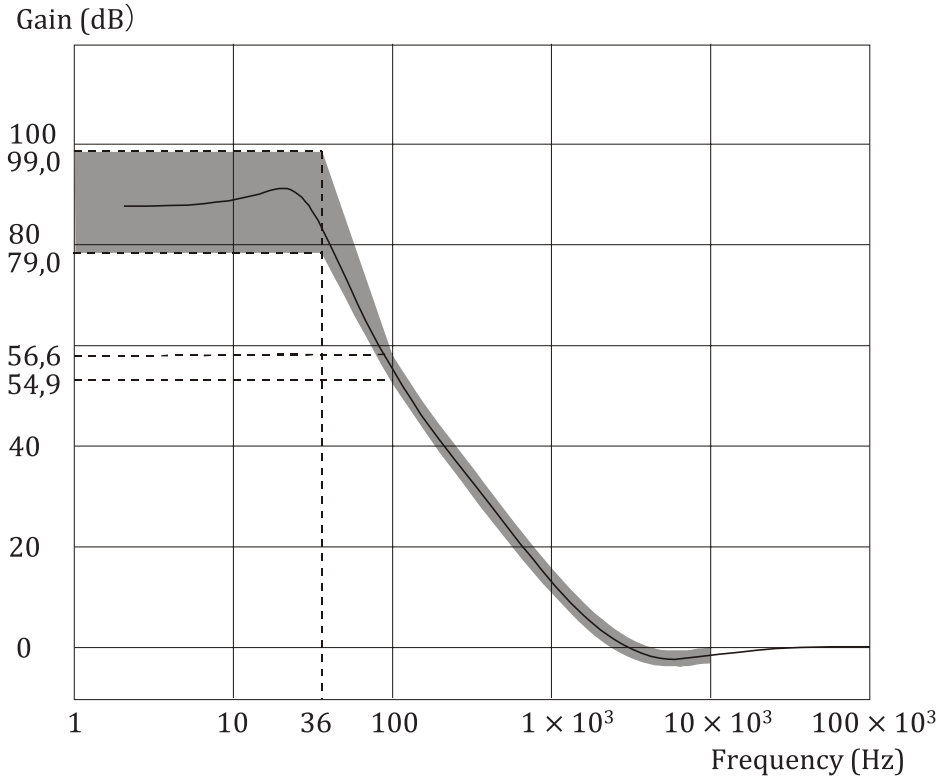

Figure 8 — Servo characteristic for radial tracking

The crossover frequency, f_0 of $H_N(f)$ (see 9.9), in kHz, which is used to define the limits of $|1 + H(f)|$, is specified by the Formula (5), where α_{max} = 2,2 m/s^2 is the worst-case maximum expected radial acceleration due to local disturbances, and α_{max} is multiplied by a factor m = 1,25 for servo margin. The tracking error e_{max}, caused by this $m \times \alpha_{max}$, shall be 16 nm. Thus, the 0-dB crossover frequency shall be as per Formula (5):

$$f_0 = \frac{1}{2\pi}\sqrt{\frac{3\times m\times\alpha_{max}}{e_{max}}} = \frac{1}{2\pi}\sqrt{\frac{3\times1{,}25\times2{,}2}{16\times10^{-9}}} = 3{,}6 \quad (5)$$

The integrator 3 dB crossover frequency shall be f_{int} = 100 Hz.

In the frequency range 100 Hz to 10 kHz, $|1 + H(f)|$ shall be within –10 % to +10 % of $|1 + H_N(f)|$.

In the frequency range 36 Hz to 100 Hz, $|1 + H|$ shall be within the limits defined by the following four points:

— 54,9 dB at 100 Hz ($|1 + H_N(f)|$ at 100 Hz – 10 %);

— 56,6 dB at 100 Hz ($|1 + H_N(f)|$ at 100 Hz + 10 %);

— 79,0 dB at 36 Hz ($|1 + H_N(f)|$ at 36 Hz – 10 %);

© ISO/IEC 2021 – All rights reserved
Documents
Document Sharing Hub
Full document details: BS ISO/IEC 30192:2021

— 99,0 dB at 36 Hz (|1 + $H_N(f)$| at 36 Hz – 10 % + 20 dB).

In the frequency range up to 36 Hz, |1 + $H(f)$| shall be between 79,0 dB and 99,0 dB.

The frequency f_X, in kHz, has the value as per Formula (6):

$$f_x = \frac{1}{2\pi}\sqrt{\frac{\alpha_{max}}{e_{max}}} = \frac{1}{2\pi}\sqrt{\frac{2{,}2}{16\times10^{-9}}} \approx 1{,}8 \qquad (6)$$

10 Dimensional characteristics

10.1 General

Dimensional characteristics are specified for those parameters deemed mandatory for interchange and compatible use of the disk. Where there is freedom of design, only the functional characteristics of the elements described are indicated. Figure 9 shows the dimensional requirements in summarized form. The different parts of the disk are described from the centre hole to the outside rim.

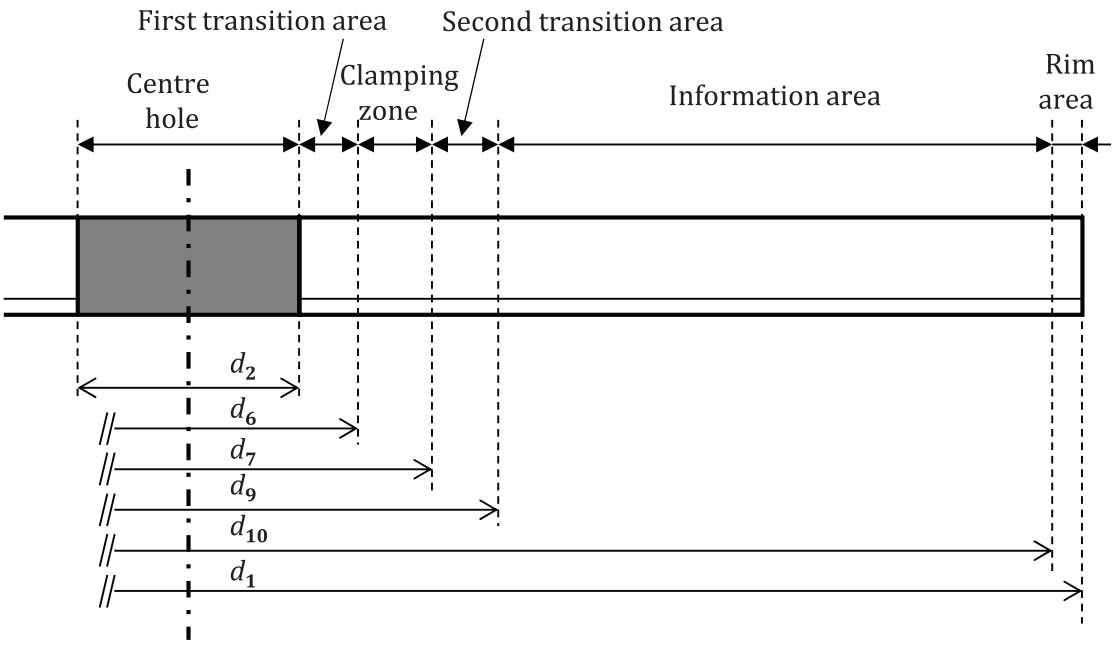

Figure 9 — Overview of disk dimensions

10.2 Disk reference planes and reference axis

For disk reference planes, see also Figure 10 and Figure 11.

The disk reference plane P is the plane determined by the surface of the clamping zone (see 10.6) at the read-out side of the disk.

The disk reference plane Q is the plane determined by the surface of the clamping zone at the substrate side of the disk.

The reference axis A is the axis through the middle of the centre hole, perpendicular to the disk reference plane P.

The disk reference plane R is a plane parallel to the disk reference plane P. The distance between disk reference plane R and disk reference plane P shall be e_4 = (100 ± 25) µm towards the inside of the disk (see Figure 10 and Figure 11).

© ISO/IEC 2021 – All rights reserved

Documents
Document Sharing Hub
Full document details: BS ISO/IEC 30192:2021

The disk reference plane R shall intersect with recording layer L0 at layer L0's average position between radius r_a = 23 mm and r_b = 24 mm (layer L0 is the only recording layer on an SL disk or the deepest recording layer on a DL disk).

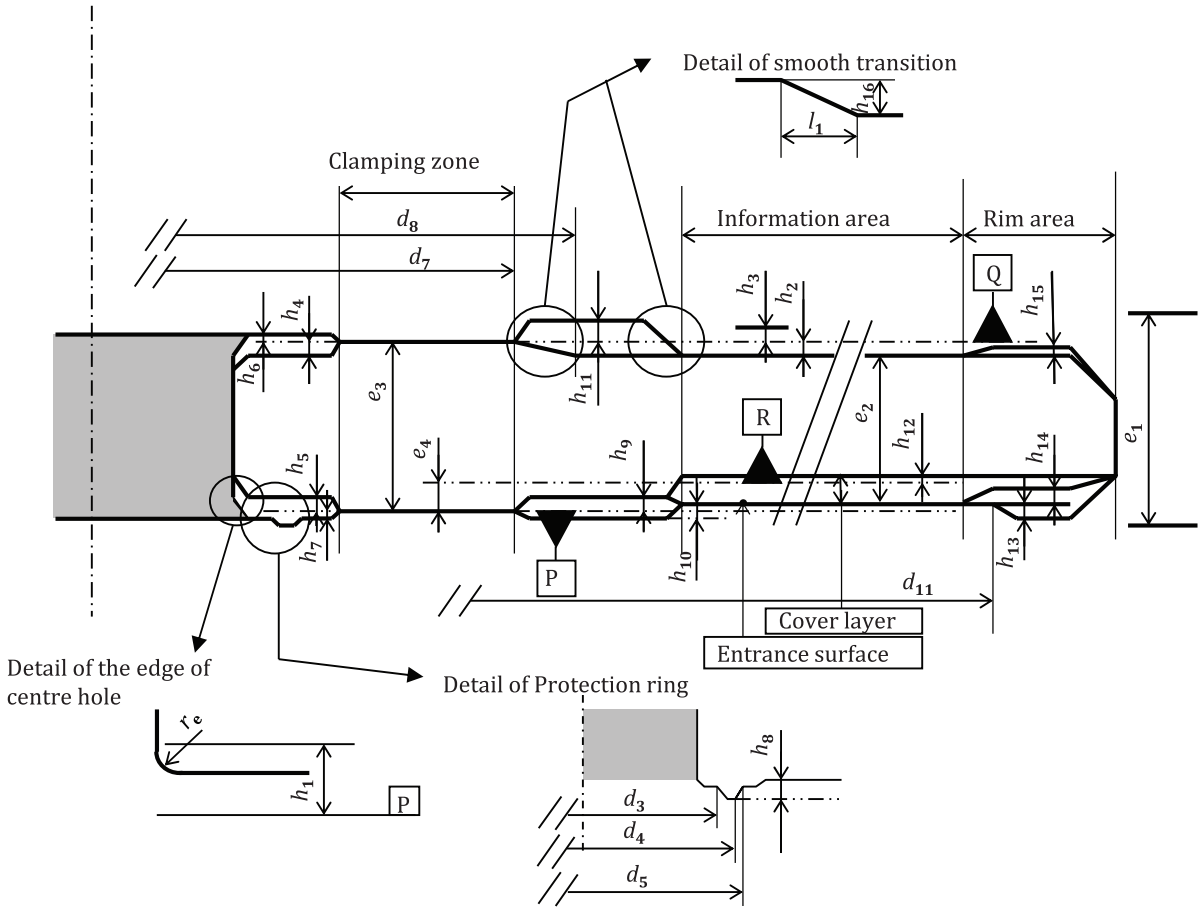

Figure 10 — Details of disk dimensions

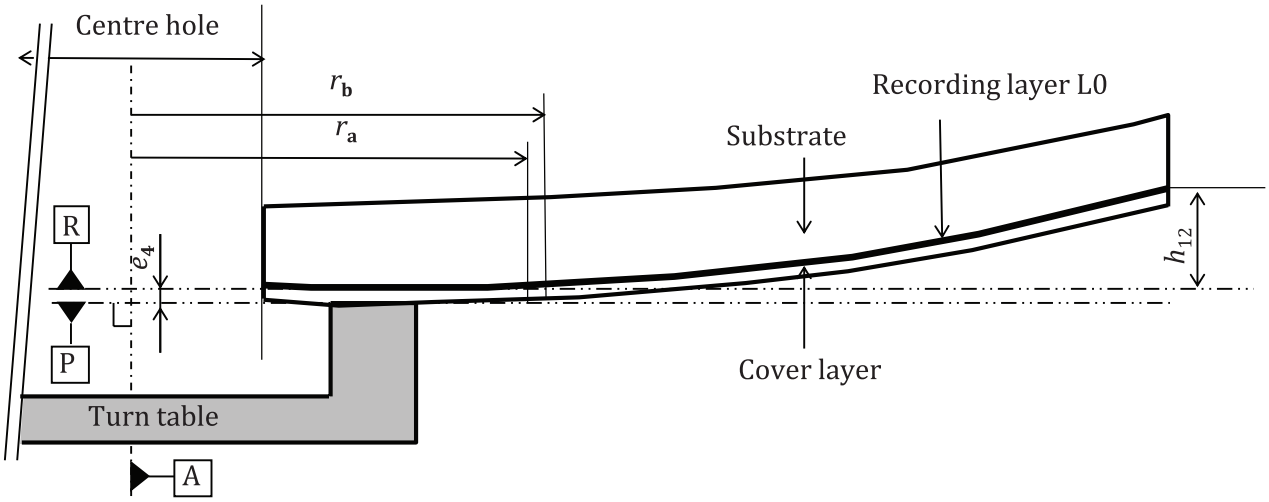

Figure 11 — Details of disk reference planes P and R and recording layer L0

10.3 Overall dimensions

The overall outer diameter of the disk shall be d_1 = (120,0 ± 0,3) mm (see Figure 9).

© ISO/IEC 2021 – All rights reserved
Documents
Document Sharing Hub
Full document details: BS ISO/IEC 30192:2021

The diameter of the centre hole shall be $d_2 = 15{,}00^{+0{,}10}_{0{,}00}$ mm (see Figure 9).

There shall be no burr on the edge of the centre hole at the read-out side.

The edge of the centre hole at the read-out side is the reference for centring the disk and shall be rounded off or chamfered. The rounding radius shall be maximum r_e = 0,1 mm. The height of chamfer shall be maximum 0,1 mm above the bottom surface of the first transition area. The rounding or chamfer shall be maximum h_1 = 0,25 mm from disk reference plane P (see detail in Figure 10).

The maximum thickness of the disk is defined as the distance in the direction of the reference axis A between the highest structure protruding from the entrance surface of the disk and the highest structure protruding from the top surface of the disk.

Maximum thickness of the disk, including cover layer, protective coating and label printing, at any radius shall be e_1 = 1,40 mm (see Figure 10).

Minimum thickness of the disk in the information area shall be e_2 = 0,90 mm.

Outside the clamping zone, the top surface may be inside the disk reference plane Q by maximum h_2 = 0,4 mm.

Outside the clamping zone, the top surface may be outside the disk reference plane Q by maximum h_3 = 0,1 mm (see Figure 10).

10.4 First transition area

In the inner area inside the clamping zone ($d < d_6$), the surfaces may be inside the disk reference planes P and Q by maximum h_5 = 0,20 mm and maximum h_4 = 0,12 mm, respectively. These surfaces may be uneven or may have burrs up to maximum h_7 = 0,05 mm and h_6 = 0,05 mm outside the disk reference planes P and Q, respectively (see Figure 9 and Figure 10).

10.5 Protection ring

An optional ring-shaped protrusion in the inner area of the disk that can prevent full contact between the surface of the disk and a surface on which such a disk is laid down. By applying such a ring, the chance for damage to the read-out side of the disk can be minimized.

When applied, the protection ring shall be located between diameter d_3 = 17,5 mm and diameter d_5 = 21,0 mm. Between d_3 and diameter d_4 = 20,5 mm, the height of the protection ring shall be maximum 0,12 mm above the clamping surface.

Between d_4 and d_5, the height of the protection ring shall sink gradually to the surrounding surface (see Figure 10).

10.6 Clamping zone

The inner diameter of the disk clamping zone shall be $d_6 \leq 23{,}0$ mm.

The outer diameter of the disk clamping zone shall be $d_7 \geq 33{,}0$ mm (see Figure 9).

The thickness of the disk within the clamping zone shall be $e_3 = 1{,}20^{+0{,}10}_{-0{,}05}$ mm (see Figure 10).

Within the clamping zone, ($d_6 < d < d_7$), both sides of the disk shall be flat within maximum 0,1 mm.

Within the clamping zone, ($d_6 < d < d_7$), both sides of the disk shall be parallel within maximum 0,1 mm.

10.7 Second transition area

The second transition area is an area between the clamping zone and the information area: $d_7 < d < d_9$ (see Figure 9).

© ISO/IEC 2021 – All rights reserved

Documents
Document Sharing Hub
Full document details: BS ISO/IEC 30192:2021

In the second transition area, the surface at the read-out side of the disk may be inside the reference plane P by maximum h_9 = 0,12 mm. This surface may be outside the entrance surface in the information area by maximum h_{10} = 0,01 mm (see Figure 10).

In the second transition area, the top surface of the disk may be outside the disk reference plane Q by maximum h_{11} = 0,2 mm.

The step from the top surface in the area to the top surface in the information area is h_{16}. The distance between the start and the end diameters of the step is l_1. If h_{16} > 0,2 mm, then the slope down to the top surface of the information area shall be smooth and l_1 > 1,8 mm, as indicated in Figure 10. If the top surface in the information area is stepped down from the top surface in the second transition area, then the step shall end within diameter d_8 = 40,0 mm.

10.8 Information area

10.8.1 General

The information area shall extend from diameter d_9 = 42 mm to diameter d_{10} = 117 mm (see Figure 9 and Figure 12).

On each recording layer, the data zone shall be located between inner diameter d_{DZI} and outer diameter d_{DZO}. The data zones on all recording layers shall have the same storage capacity.

The inner diameter d_{DZI} on recording layer L*n* shall be $d_{DZIn} = 48{,}0^{0{,}0}_{-0{,}2}$ mm while and the outer diameter d_{DZO} on recording layer L*n* shall be $d_{DZOn} \leq 116{,}2$ mm.

The area between d_9 and d_{DZI} is called the inner zone and the area between d_{DZO} and d_{10} is called the outer zone (see Figure 12).

The total thickness of the disk in the information area is as specified in 10.3.

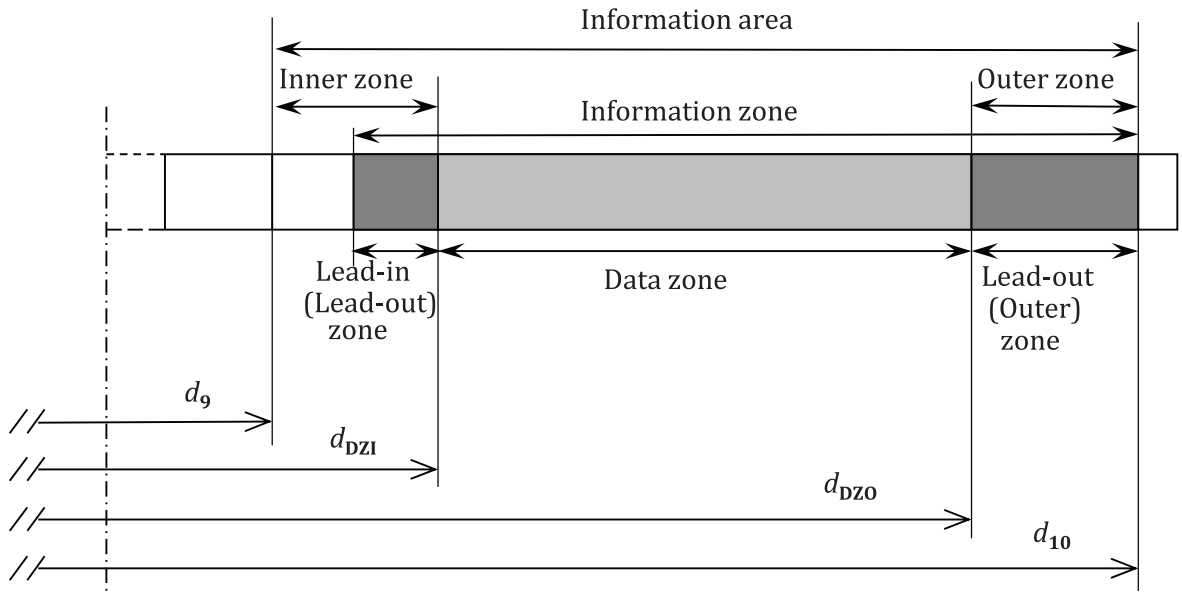

Figure 12 — Division of information area

10.8.2 Subdivisions of information zone on SL disk

The information area is used to record the information zone.

© ISO/IEC 2021 – All rights reserved
Documents
Document Sharing Hub
Full document details: BS ISO/IEC 30192:2021

The information zone is subdivided into the following main parts (see Figure 13):

— lead-in zone (part of the inner zone);

— data zone;

— lead-out zone (outer zone).

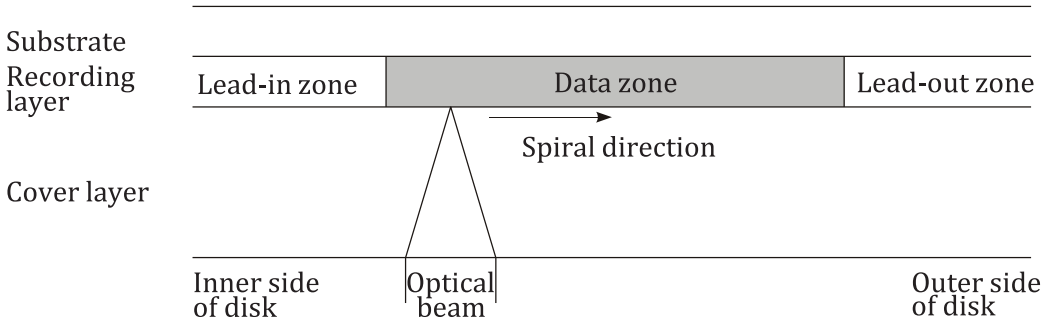

Figure 13 — Subdivision of information zone on SL disk

The lead-in zone starts in the area extending from 44,0 mm to 44,4 mm in diameter and shall end at the beginning of the data zone at diameter d_{DZI}.

The lead-out zone shall start at the end of the data zone at diameter d_{DZO} and shall end at minimum 117 mm in diameter.

10.8.3 Subdivisions of information zone on DL disks

The information area is used to record the information zone, divided over the two recording layers.

The information zone is subdivided into the following main parts (see Figure 14):

On recording layer L0:

— lead-in zone (part of the inner zone 0),

— data zone 0, and

— outer zone 0.

On recording layer L1:

— outer zone 1,

— data zone 1, and

— lead-out zone (part of the inner zone 1).

On layer L0, the spiral groove shall run from the inner side of the disk towards the outer side of the disk.

On layer L1, the spiral groove shall run from the outer side of the disk towards the inner side of the disk.

© ISO/IEC 2021 – All rights reserved

Documents
Document Sharing Hub
Full document details: BS ISO/IEC 30192:2021

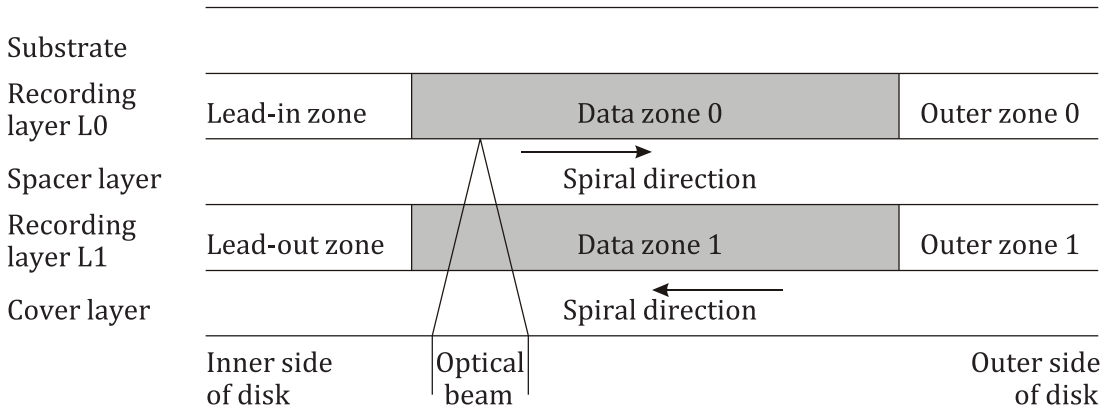

Figure 14 — Subdivision of information zone on DL disk

The lead-in zone starts in the area extending from 44,0 mm to 44,4 mm in diameter and shall end at the beginning of the data zone 0 at diameter d_{DZI0}.

The outer zone 0 shall start at the end of the data zone 0 at diameter d_{DZO0} and shall end at minimum 117 mm in diameter.

The outer zone 1 shall start at minimum 117 mm in diameter and shall end at the beginning of data zone 1 at diameter d_{DZO1}.

The lead-out zone shall start at the end of the data zone 1 at diameter d_{DZI1} and shall end in the area extending from diameter 44,0 mm to diameter 44,4 mm.

10.9 Rim area

The rim area is the area outside the information area, starting at d_{10} and extending to the outer diameter of the disk (see Figure 9).

In the first 0,5 mm of the rim area, the surface at the read-out side of the disk shall not be outside the entrance surface in the information area.

In the remainder of the rim area, the surface at the read-out side of the disk shall not be outside the entrance surface in the information area by maximum h_{13} = 0,05 mm (see Figure 10).

In the rim area, the surface at the read-out side of the disk may be inside the entrance surface in the information area by maximum h_{14} = 0,12 mm (see Figure 10).

In the rim area, the top surface of the disk shall not be outside the top surface in the information area by maximum h_{15} = 0,05 mm (see Figure 10).

11 Mechanical characteristics

11.1 Mass

The mass, m, of the disk shall be 12 g ≤ m ≤ 17 g.

11.2 Moment of inertia

The moment of inertia of the disk shall be ≤0,032 g.m^2.

11.3 Dynamic imbalance

The dynamic imbalance of the disk shall be ≤2,5 g.mm.

© ISO/IEC 2021 – All rights reserved
Documents
Document Sharing Hub
Full document details: BS ISO/IEC 30192:2021

11.4 Axial runout

11.4.1 General

When measured by an optical system using the reference servo for axial tracking and with the disk rotating at a scanning velocity of 4,917 m/s (for all capacities), the distance between each recording layer and the disk reference plane R (see Figure 10 and Figure 11) in the direction of the reference axis A shall be maximum h_{12} = 0,3 mm over the entire disk.

Within one track (one revolution), the deviation of each recording layer from its average position in the direction of the reference axis A shall be maximum 0,1 mm.

At the inner side of the disk, rotating at a velocity of 4,917 m/s, this corresponds to a maximum acceleration of about 4,6 m/s^2, based on a sinusoidal deviation at the rotational frequency of the disk.

Due to the integrator function in the reference servo (see 9.10), this component is suppressed sufficiently such that the residual tracking errors as defined in 11.4.2 are mainly due to local disturbances.

11.4.2 Residual axial tracking error

The residual axial tracking error of each recording layer for frequencies below 1,6 kHz (equals f_X, see 9.10), measured using the reference servo for axial tracking as specified in 9.10, shall be maximum 45 nm (displacement of the objective lens needed to move the focal point of the optical beam onto the recording layer).

Spikes in the residual axial tracking error signal due to local defects, such as dust and scratches, shall be excluded.

The measuring filter shall be a Butterworth LPF, with f_{-3dB} = 1,6 kHz and slope = –60 dB/decade.

This means that, for frequencies <1,6 kHz, the maximum local acceleration of the recording layer in the direction of the reference axis A does not exceed 6,0 m/s^2.

The rms noise value of the residual error signal in the frequency band from 1,6 kHz to 10 kHz, measured with an integration time of 20 ms and using the reference servo for axial tracking, shall be at maximum 32 nm. The measuring filter shall be a Butterworth BPF, from f_{-3dB} = 1,6 kHz with slope = +60 dB/decade, to f_{-3dB} = 10 kHz with slope = –60 dB/decade.

11.5 Radial runout

11.5.1 General

The runout of the outer edge of the disk shall be maximum of 0,3 mm pp.

The radial runout of the tracks in each recording layer (including eccentricity and unroundness) shall be measured by an optical system using the reference servo for radial tracking, while the disk is rotating at a scanning velocity of 4,917 m/s (for all capacities).

The radial runout shall be maximum 75 µm pp (SL and DL disks).

At the inner side of the disk, rotating at a velocity of 4,917 m/s, this corresponds to a maximum acceleration of about 1,7 m/s^2, based on a sinusoidal deviation at the rotational frequency of the disk.

Due to the integrator function in the reference servo (see 9.11), this component is suppressed sufficiently such that the residual tracking errors as defined in 11.5.2 and 11.5.3 are mainly due to local disturbances.

The residual tracking error shall be determined by applying the radial PP read channel ($I_1 - I_2$) signal for both measurement and radial servo control purposes as indicated in Figure 5.

© ISO/IEC 2021 – All rights reserved

Documents
Document Sharing Hub
Full document details: BS ISO/IEC 30192:2021

11.5.2 Residual radial tracking error on SL disks

The residual radial tracking error for frequencies below 1,8 kHz (equals f_X, see 9.11), measured using the reference servo for radial tracking as specified in 9.11, shall be a maximum of 9 nm.

Spikes in the residual radial tracking error signal due to local defects, such as dust and scratches, shall be excluded.

The measuring filter shall be a Butterworth LPF, with f_{-3dB} = 1,8 kHz and slope = 60 dB/decade.

This means that, for frequencies <1,8 kHz, the maximum local acceleration of the tracks in the radial direction does not exceed 1,5 m/s^2.

The rms noise value of the residual error signal in the frequency band from 1,8 kHz to 10 kHz, measured with an integration time of 20 ms and using the reference servo for radial tracking, shall be maximum 6,4 nm. The measuring filter shall be a Butterworth BPF, from f_{-3dB} = 1,8 kHz with slope = +60 dB/decade, to f_{-3dB} = 10 kHz with slope = –60 dB/decade.

11.5.3 Residual radial tracking error on DL disks

The residual radial tracking error in each recording layer at frequencies below 1,8 kHz (equals f_X, see 9.11), measured using the reference servo for radial tracking as specified in 9.11, shall be a maximum of 13 nm.

Spikes in the residual radial tracking error signal due to local defects, such as dust and scratches, shall be excluded.

The measuring filter shall be a Butterworth LPF, with f_{-3dB} = 1,8 kHz and slope = –60 dB/decade.

This means that for frequencies <1,8 kHz, the maximum acceleration of the tracks in the radial direction does not exceed 2,2 m/s^2.

The rms noise value of the residual error signal in the frequency band from 1,8 kHz to 10 kHz, measured with an integration time of 20 ms and using the reference servo for radial tracking, shall be a maximum of 9,2 nm. The measuring filter shall be a Butterworth BPF, from f_{-3dB} = 1,8 kHz with slope = +60 dB/decade, to f_{-3dB} = 10 kHz with slope = –60 dB/decade.

11.6 Durability of cover layer

11.6.1 Impact resistance of cover layer

To prevent excessive damage by accidential impact, the entrance surface of the disk should have a certain minimum impact resistance.

The minimum impact resistance can be tested by procedures described in Annex L.

11.6.2 Scratch resistance of cover layer

To prevent excessive scratching, the surface of the disk shall have at least a certain minimum hardness.

The scratch resistance shall be tested by a procedure described in Annex C.

11.6.3 Repulsion of fingerprints by cover layer

To prevent excessive contamination, the surface of the disk shall repel grime as much as possible.

The repulsion of grime shall be tested by a procedure described in Annex D.

© ISO/IEC 2021 – All rights reserved
Documents
Document Sharing Hub
Full document details: BS ISO/IEC 30192:2021

12 Optical characteristics in information area

12.1 General

The following requirements shall be fulfilled within the information area of the disk.

These specifications of the transmission stacks (TS) include all possible layers on top of the recording layer concerned (such as gluing layers in case of foils, the spacer layer and the semi-transparent recording layer of layer L1 in case of TS0, the cover layer and possibly a protective coating).

12.2 Refractive index of transmission stacks (TS)

If the layers making up the total TS have different refractive indexes, then the procedure described in Annex A shall be followed.

The refractive index n of the cover layer and spacer layer of the disk shall be as per Formula (7):

$$1{,}45 \leq n \leq 1{,}70 \tag{7}$$

12.3 Thickness of transmission stack(s)

12.3.1 Thickness of transmission stack of SL disks

The average thickness between radius r_a and radius r_b is called the reference thickness of the transmission stack (TS) on the disk (see 10.2 and Figure 11).

The thickness of the TS, measured over the whole disk, shall fulfil the following two requirements.

a) The thickness of the TS, as determined by its refractive index, shall be within the upper shaded area in Figure 15 (in case of a refractive index of 1,6 the thickness shall be between 95 µm and 105 µm and the dashed line indicates the nominal thickness as a function of the refractive index).

b) The maximum deviation ΔD of the thickness of the TS from the reference thickness shall meet the requirement $|\Delta D| \leq 2{,}0$ µm.

12.3.2 Thickness of transmission stack of DL disks

The average thickness between radius r_a and radius r_b is called the reference thickness of the related transmission stack (TS0 or TS1) on the disk.

The thickness of TS0 and TS1, measured over the whole disk, shall fulfil the following four requirements.

a) The thickness of TS0 (all layers on top of layer L0), as determined by its refractive index, shall be within the upper shaded area in Figure 15 (in case of a refractive index of 1,6, the thickness shall be between 95 µm and 105 µm and the dashed line indicates the nominal thickness as a function of the refractive index).

b) The thickness of TS1 (all layers on top of layer L1), as determined by its refractive index, shall be within the lower shaded area in Figure 15 (in case of a refractive index of 1,6, the thickness shall be between 70 µm and 80 µm and the dashed line indicates the nominal thickness as a function of the refractive index).

c) The thickness of the spacer layer shall be between 20 µm and 30 µm.

d) The maximum deviation ΔD of the thicknesses of TS0 and TS1 from their respective reference thicknesses shall meet the requirement $|\Delta D| \leq 2{,}0$ µm.

© ISO/IEC 2021 – All rights reserved

Documents
Document Sharing Hub
Full document details: BS ISO/IEC 30192:2021

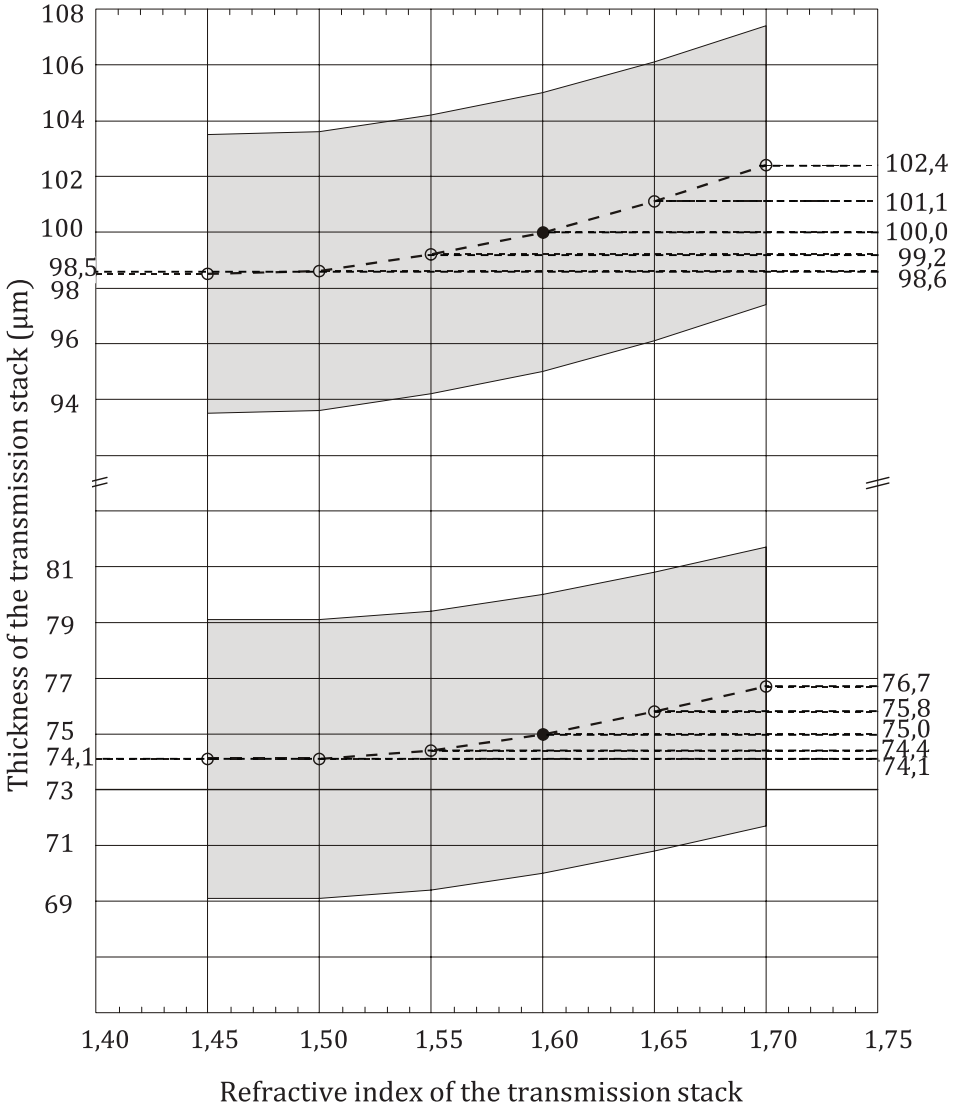

Figure 15 — Thickness of transmission stacks as function of refractive index

12.4 Reflectivity

12.4.1 Reflectivity of recording layer of SL disks

The reflectivity of the recording layer in the information zone, including transmission through the cover layer, shall fulfil the requirements of Formulae (8) to (12) under the measurement conditions of Annex B:

— in unrecorded virgin groove:

$$R_{g-v} = 12\ \%\ \text{to}\ 24\ \% \tag{8}$$

— in unrecorded erased groove:

$$R_{g-e} = 11\ \%\ \text{to}\ 24\ \% \tag{9}$$

— at each location on the disk;

$$0{,}75 \times R_{g-v} < R_{g-e} < 1{,}25 \times R_{g-v} \tag{10}$$

© ISO/IEC 2021 – All rights reserved
Documents
Document Sharing Hub
Full document details: BS ISO/IEC 30192:2021

— in recorded grooves for the first ten DOW cycles:

$$R_{8H} = 11 \text{ to } 24\ \% \tag{11}$$

— at each location on the disk;

$$0{,}75 \times R_{g-v} < R_{8H} < 1{,}25 \times R_{g-v} \tag{12}$$

Written marks shall have a lower reflectivity than the unrecorded layer.

12.4.2 Reflectivity of recording layer of DL disks

The reflectivity of each recording layer in the information zone, including transmission through the transmission stack concerned, shall fulfil requirements of Formulae (13) to (17), independent of the recording status of the other recording layer (whether unrecorded, recorded or partially recorded), under the measurement conditions of Annex B:

— in unrecorded virgin grooves:

$$R_{g-v} = 4\ \% \text{ to } 8\ \% \tag{13}$$

— in unrecorded erased grooves:

$$R_{g-e} = 3{,}5\ \% \text{ to } 8\ \% \tag{14}$$

— at each location on the disk;

$$0{,}75 \times R_{g-v} < R_{g-e} < 1{,}25 \times R_{g-v} \tag{15}$$

— in recorded grooves for the first ten DOW cycles:

$$R_{8H} = 3{,}5\ \% \text{ to } 8\ \% \tag{16}$$

— at each location on the disk;

$$0{,}75 \times R_{g-v} < R_{8H} < 1{,}25 \times R_{g-v} \tag{17}$$

Written marks shall have a lower reflectivity than the unrecorded layer.

12.5 Birefringence

The in-plane birefringence of the transmission stacks shall be as per Formula (18) (see Annex J for detailed information):

$$\Delta n_{//} \leq 1{,}5 \times 10^{-4} \tag{18}$$

The perpendicular birefringence of the transmission stacks shall be as per Formula (19) (see Annex J for detailed information):

$$\Delta n_{\perp} \leq 1{,}2 \times 10^{-3} \tag{19}$$

12.6 Angular deviation

The angular deviation is the angle θ_a between a parallel incident beam perpendicular to the disk reference plane P and the reflected beam. The incident beam shall have a diameter in the range 0,3 mm

© ISO/IEC 2021 – All rights reserved

AVA Documents Document Sharing Hub
Full document details: BS ISO/IEC 30192:2021

to 1,0 mm. The angle θ_a includes deflections of the entrance surface and to lack of parallelism of the cover layer and/or spacer layer (see Figure 16).

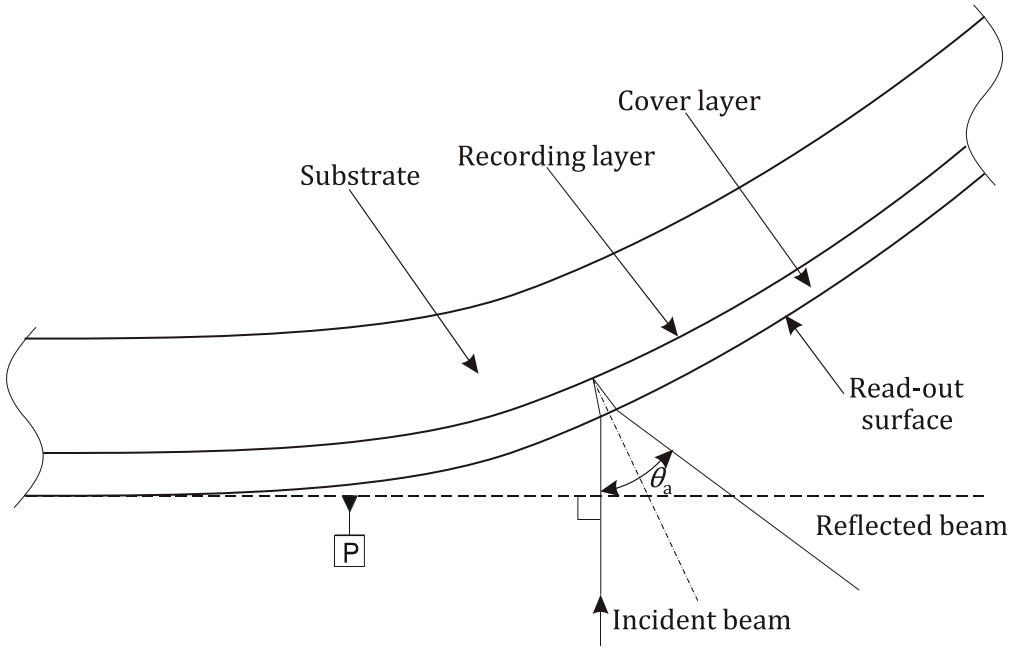

Figure 16 — Definition of angular deviation

The requirements for the angle θ_a shall be as follows:

— in the radial direction:

  — under the normal test conditions specified in 8.1.1: $|\theta_a|_{max.} = 0{,}60°$;

  — under the "sudden change" test conditions specified in 8.1.1: $|\theta_a|_{max.} = 0{,}70°$;

— in the tangential direction:

  — under the normal test conditions specified in 8.1.1: $|\theta_a|_{max.} = 0{,}30°$.

13 Data format

13.1 General

The data received from the source (application or host), called user data frames, are formatted in a number of steps before being recorded on the disk (see Figure 17).

© ISO/IEC 2021 – All rights reserved
Documents
Document Sharing Hub
Full document details: BS ISO/IEC 30192:2021

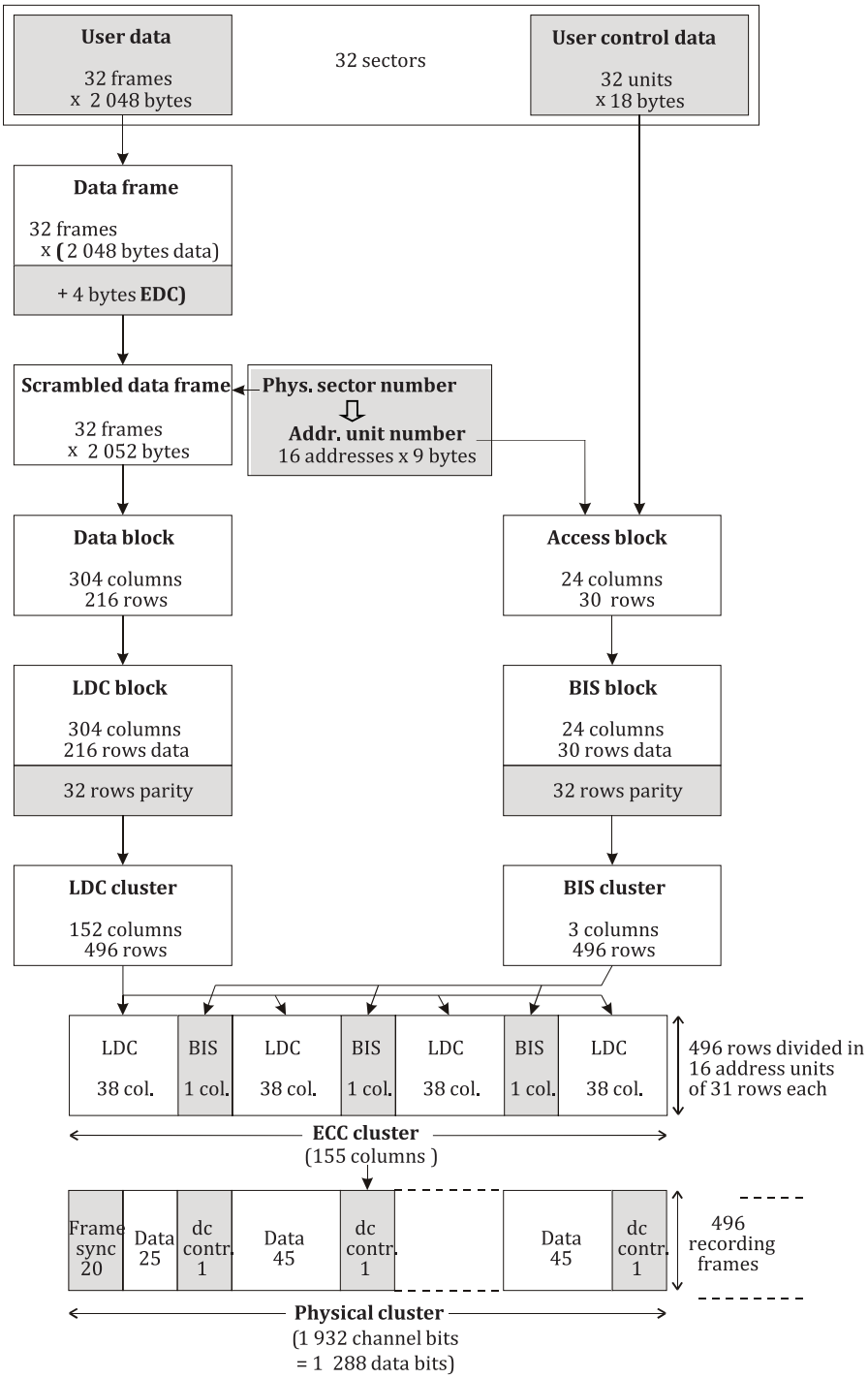

Figure 17 — Schematic representation of encoding process

They are transferred successively into data frames, scrambled data frames, a data block, an LDC block, and an LDC cluster.

The address and control data added by the BD rewritable system are transferred successively into an access block, a BIS block and a BIS cluster.

The LDC cluster and the BIS cluster are multiplexed and modulated into the following:

— an ECC cluster, subdivided into 16 address units;

— a physical cluster, consisting of 496 recording frames.

© ISO/IEC 2021 – All rights reserved

Documents
Document Sharing Hub
Full document details: BS ISO/IEC 30192:2021

The data on BD rewritable disks is recorded in 64K partitions, called clusters, containing 32 data frames with 2 048 bytes of user data. These clusters are protected by the following two error correction mechanisms as follows.

— First, the data is protected by a long distance (LDC) error correction code, consisting of (248,216,33) Reed-Solomon (RS) code words. This code has ample parities and interleaving length with a good overall efficiency and can correct both random errors and burst errors;

— Then, the data is multiplexed with a powerful burst-indicating subcode (BIS), which consists of (62,30,33) Reed-Solomon (RS) code words. These BIS code words carry addresses for allocation purposes and control information belonging to the user data. They can also be used to indicate long burst errors, by means of which the LDC can efficiently perform erasure corrections.

The combination of these two codes is called an "LDC+BIS code" (see Figure 18).

All the data is arranged in an array as indicated in Figure 18. This array is read in the horizontal direction, row after row, and recorded on the disk after insertion of additional dc-control bits, modulation, and insertion of synchronization patterns.

The error correction codes are applied in the vertical direction, which gives a good basic break-up of burst errors on the disk. Additionally, the LDC code words have been interleaved in a diagonal direction.

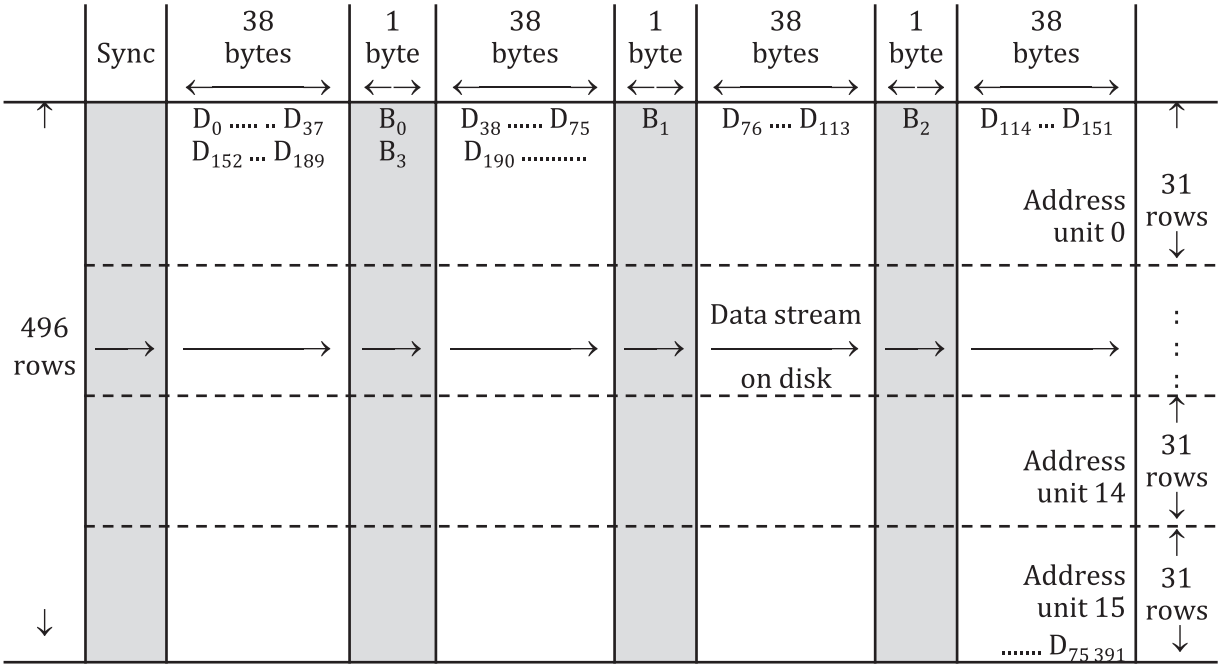

Figure 18 — Schematic representation of physical cluster on disk

Address units, physical sectors and logical sectors are defined as follows.

Address units:

For the purpose of allocating the optical pick-up to a certain position on the disk, the physical cluster is subdivided into 16 address units, each consisting of 31 consecutive rows. The address unit numbers (AUN) provide a fast addressing mechanism embedded in the written data.

Physical sectors:

A data frame accompanied by its control data is called a sector. All sectors in all physical clusters all over the disk (including the inner and outer zones) are called physical sectors. All physical sectors have a virtual number assigned, called the physical sector number (PSN). These PSNs are not recorded onto the disk; however, they are synchronized with the AUNs.

© ISO/IEC 2021 – All rights reserved
Documents
Document Sharing Hub
Full document details: BS ISO/IEC 30192:2021

Logical sectors:

Not all physical sectors are available for storage of user data delivered by the application or host. The inner and outer zones are excluded. The remaining sectors are available for storing user data and are called logical sectors.

13.2 Data frames

A data frame consists of 2 052 bytes: 2 048 bytes of user data and 4 bytes of error detection code (EDC). The 2 048 user data bytes are identified as ud_0 to $ud_{2\,047}$ and the 4 EDC bytes as $ed_{2\,048}$ to $ed_{2\,051}$ (see Figure 19).

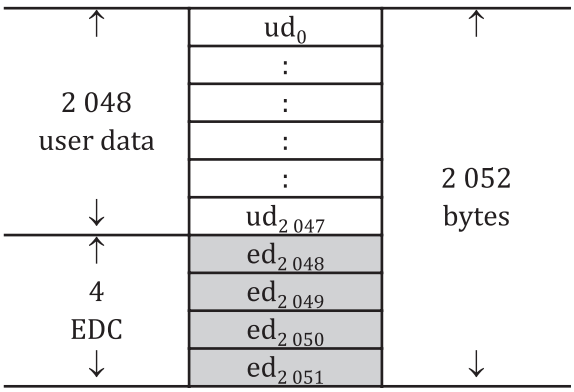

Figure 19 — Data frame

13.3 Error detection code (EDC)

The 4-byte field $ed_{2\,048}$ to $ed_{2\,051}$ shall contain an error detection code computed over the 2 048 bytes of user data.

Considering the data frame as a single-bit field, starting with the most significant bit of the first user data byte (ud_0) and ending with the least significant bit of the last EDC byte ($ed_{2\,051}$), then the msb is $b_{16\,415}$ and the lsb is b_0.

Each bit b_i of the EDC is shown as Formula (20) for i = 0 to 31:

$$EDC(x) = \sum_{i=31}^{0} b_i x^i = I(x) \bmod G(x) \tag{20}$$

where

$$I(x) = \sum_{i=16\,415}^{32} b_i x^i \text{; and}$$

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

13.4 Scrambled data frame

Each data frame consisting of 2 052 bytes of user data + EDC shall be scrambled with the output of the circuit defined in Figure 20, in which bits s_7 (msb) to s_0 (lsb) represent a scrambling byte at each 8-bit shift.

© ISO/IEC 2021 – All rights reserved

Documents
Document Sharing Hub
Full document details: BS ISO/IEC 30192:2021

The heart of the circuit is a linear-feedback shift register (LFSR) based on the polynomial as per Formula (21):

$$\Phi(x) = x^{16} + x^{15} + x^{13} + x^{4} + 1 \tag{21}$$

Here, s_0 to s_{15} form a 16-bit shift register. At each shift clock the content of s_n shifts to s_{n+1} (n = 0 .. 14), while s_0 is set to $s_{15} \oplus s_{14} \oplus s_{12} \oplus s_3$ ($\oplus$ stands for exclusive-or).

At the beginning of the scrambling procedure of each data frame, the shift register s_0 to s_{15} shall be preset with a value derived from the (virtual) PSN associated with the data frame (see Clause 17). The 16-bit preset value shall be composed in the following way:

— s_{15} shall be set to ONE;

— s_{14} .. s_0 shall be set to PS_{19} .. PS_5 of the PSN (see Figure 20).

The same preset value shall be used for all 32 data frames within the same cluster.

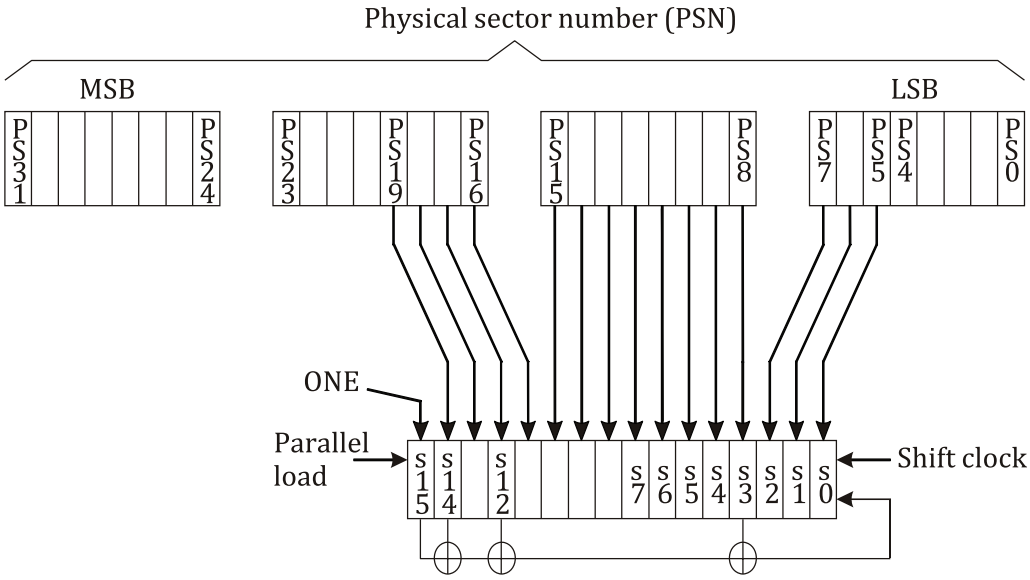

Figure 20 — Scrambler circuit

After loading the preset value, s_7 .. s_0 are taken out as scrambling byte S_0. Then, an 8-bit shift is repeated 2 051 times and the following 2 051 bytes are taken from s_7 .. s_0 as the scrambling bytes S_1 to $S_{2\,051}$.

The 2 052 bytes ud/ed_k of the data frame become scrambled bytes d_k where $d_k = ud/ed_k \oplus S_k$ for k = 0 to 2 051; ($\oplus$ stands for exclusive-or).

13.5 Data block

In the next step, 32 scrambled data frames (F = 0 .. 31) are combined into one block of data as shown in Figure 21.

© ISO/IEC 2021 – All rights reserved
Documents
Document Sharing Hub
Full document details: BS ISO/IEC 30192:2021

	← 32 frames →					
	0	1	:	F	:	31
↑	$d_{0,0}$	$d_{0,1}$	:	$d_{0,F}$	:	$d_{0,31}$
	$d_{1,0}$	$d_{1,1}$	:	$d_{1,F}$	:	$d_{1,31}$
2 052	:		:	:	:	:
bytes	:		:	:	:	:
	$d_{2\,050,0}$	$d_{2\,050,1}$	:	$d_{2\,050,F}$	:	$d_{2\,050,31}$
↓	$d_{2\,051,0}$	$d_{2\,051,1}$	:	$d_{2\,051,F}$	:	$d_{2\,051,31}$

Figure 21 — 32 scrambled data frames

These data are rearranged into an array of 216 rows × 304 columns by dividing each scrambled data frame into 9,5 columns as shown in. Figure 22. This new array is called a data block. It should be noted that every even scrambled data frame ends halfway down a column and every odd scrambled data frame starts halfway down a column.

	← 304 columns →									
	0	1	:	9	10	:	18	19		303
↑	$d_{0,0}$	$d_{216,0}$	:	$d_{1\,944,0}$	$d_{108,1}$	:	$d_{1\,836,1}$	$d_{0,2}$	:	$d_{1\,836,31}$
	$d_{1,0}$	$d_{217,0}$	:	$d_{1\,945,0}$	$d_{109,1}$	:	$d_{1\,837,1}$	$d_{1,2}$	:	$d_{1\,837,31}$
	:	:	:	:	:	:	:	:	:	:
	:	:	:	$d_{2\,050,0}$	:	:	:	:	:	:
216	:	:	:	$d_{2\,051,0}$	:	:	:	:	:	:
rows	:	:	:	$d_{0,1}$	:	:	:	:	:	:
	:	:	:	$d_{1,1}$	:	:	:	:	:	:
	:	:	:	:	:	:	:	:	:	:
	:	:	:	$d_{106,1}$	:	:	:	:	:	:
↓	$d_{215,0}$	$d_{431,0}$	:	$d_{107,1}$	$d_{323,1}$	:	$d_{2\,051,1}$	$d_{215,2}$	:	$d_{2\,051,31}$

Figure 22 — Composition of data block from 32 scrambled data frames

13.6 LDC block

The bytes in each column of the data block are renumbered as shown in Figure 23 starting from the top of each column as follows: $e_{0,L}$ $e_{1,L}$ .. $e_{i,L}$ .. to $e_{215,L}$, in which L represents the code-word number (= the column number: 0 to 303).

The LDC block is completed by extending each of the columns with 32 parity bytes according to a (248,216,33) long-distance RS code. The parity bytes are numbered: $p_{216,L}$ $p_{217,L}$ .. $p_{j,L}$ .. to $p_{247,L}$.

© ISO/IEC 2021 – All rights reserved

Documents
Document Sharing Hub
Full document details: BS ISO/IEC 30192:2021

		← 304 columns →						
		Code word 0	Code word 1	:	Code word L	:	Code word 302	Code word 303
↑	↑	$e_{0,0}$	$e_{0,1}$	:	$e_{0,L}$	:	$e_{0,302}$	$e_{0,303}$
	216	$e_{1,0}$	$e_{1,1}$	:	$e_{1,L}$	:	$e_{1,302}$	$e_{1,303}$
	rows	$e_{2,0}$	:	:	:	:	:	:
	with	:	:	:	:	:	:	:
1 LDC	data	:	:	:	:	:	:	:
code word	↓	$e_{215,0}$	$e_{215,1}$	:	$e_{215,L}$	:	$e_{215,302}$	$e_{215,303}$
= 248	↑	$p_{216,0}$	$p_{216,1}$	:	$p_{216,L}$	:	$p_{216,302}$	$p_{216,303}$
bytes	32	:	:	:	:	:	:	:
	rows	:	:	:	:	:	:	:
	with	:	:	:	:	:	:	:
	parity	:	:	:	:	:	:	:
↓	↓	$p_{247,0}$	$p_{247,1}$	:	$p_{247,L}$	:	$p_{247,302}$	$p_{247,303}$

Figure 23 — Renumbering data bytes and forming LDC block by adding parities

13.7 LDC code words

The long-distance RS code is defined over the finite field GF(2^8). The non-zero elements of the finite field GF(2^8) are generated by a primitive element α, where α is a root of the primitive polynomial $p(x)$ as per Formula (22):

$$p(x) = x^8 + x^4 + x^3 + x^2 + 1 \tag{22}$$

The symbols of GF(2^8) are represented by bytes (groups of 8 bits), using the polynomial-base representation, with (α^7, α^6, α^5, .., α^2, α, 1) as a basis. The root α is thus represented as α = 00000010.

Each LDC code word, represented by the vector l_{dc} = ($e_{0,L}$ .. $e_{i,L}$ .. $e_{215,L}$ $p_{216,L}$ .. $p_{j,L}$ .. $p_{247,L}$), is a Reed-Solomon code over GF(2^8) having 32 parity bytes and 216 information bytes. Such a code word can be represented by a polynomial $l_{dc}(x)$ of degree 247 (possibly having some coefficients equal to zero), where the highest degrees correspond to the information part of the vector ($e_{0,L}$ .., etc.) and the lowest degrees correspond to the parity part of the vector ($p_{216,L}$ .., etc.).

$l_{dc}(x)$ is a multiple of the generator polynomial $g(x)$ of the LDC code word. The generator polynomial is as per Formula (23):

$$g(x) = \prod_{i=0}^{31} \left(x - \alpha^i\right) \tag{23}$$

The LDC is systematic: the 216 information bytes appear unaltered in the highest-degree positions of each code word. For all LDC code words l_{dc} , the parity-check matrix H_{LDC} of code l_{dc} is as per Formula (24):

$$H_{LDC} \times l_{dc}^{T} = 0 \tag{24}$$

The second row h_{LDC2} of the parity-check matrix H_{LDC} corresponding to the zero α of the generator polynomial $g(x)$, defines the code-word positions to be used for error locations. This second row h_{LDC2} of the parity-check matrix H_{LDC} is given by Formula (25):

$$h_{LDC2} = (\alpha^{247}, \alpha^{246} .. \alpha^2, \alpha, 1) \tag{25}$$

© ISO/IEC 2021 – All rights reserved
Documents
Document Sharing Hub
Full document details: BS ISO/IEC 30192:2021

13.8 LDC cluster

13.8.1 General

After generating the LDC code words, the LDC block is interleaved in a two-step process resulting in the LDC cluster.

13.8.2 First interleave step

In the first interleaving step, the 304 columns of height 248 are rearranged into a new array with 152 columns and 496 rows.

Each new column is formed by multiplexing each even column from the LDC block with the next odd column. The new column is filled by taking the first byte from the even LDC block column, then the first byte from the odd LDC block column, next the second byte from the even LDC block column, followed by the second byte from the odd LDC block column, etc. as shown in Figure 24.

	← 152 columns →					
	0	1			151	
↑	$e_{0,0}$	$e_{0,2}$	:	:	$e_{0,302}$	↑
	$e_{0,1}$	$e_{0,3}$	:	:	$e_{0,303}$	
432	$e_{1,0}$	$e_{1,2}$	:	:	$e_{1,302}$	
rows	$e_{1,1}$	$e_{1,3}$	:	:	$e_{1,303}$	
with	:	:	:	:	:	
data	:	:	:	:	:	
	$e_{215,0}$	$e_{215,2}$	:	:	$e_{215,302}$	
↓	$e_{215,1}$	$e_{215,3}$	:	:	$e_{215,303}$	496
↑	$p_{216,0}$	$p_{216,2}$	:	:	$p_{216,302}$	rows
	$p_{216,1}$	$p_{216,3}$	:	:	$p_{216,303}$	
64	$p_{217,0}$	$p_{217,2}$	:	:	$p_{217,302}$	
rows	$p_{217,1}$	$p_{217,3}$	:	:	$p_{217,303}$	
with	:	:	:	:	:	
parity	:	:	:	:	:	
	$p_{247,0}$	$p_{247,2}$	:	:	$p_{247,302}$	
↓	$p_{247,1}$	$p_{247,3}$	:	:	$p_{247,303}$	↓

Figure 24 — First step of interleaving

13.8.3 Second interleaving step

To reduce the influence of error propagation and further improve the burst-error correcting capabilities, an additional interleaving is introduced.

All rows of an LDC block resulting from the first interleaving step, shall be shifted over mod(k × 3, 152) bytes to the left where k = div(row_number, 2), 0 ≤ row_number ≤ 495. The bytes that shift out at the left side are re-entered in the array from the right side (see Figure 25).

After this process, the bytes are renumbered in the horizontal direction through all the rows resulting in the numbering D_0 to $D_{75\,391}$ as indicated in Figure 18.

© ISO/IEC 2021 – All rights reserved

Documents
Document Sharing Hub
Full document details: BS ISO/IEC 30192:2021

	← 152 bytes →																
← shift 0	$e_{0,0}$	$e_{0,2}$		...						...						$e_{0,300}$	$e_{0,302}$
	$e_{0,1}$	$e_{0,3}$		...						...						$e_{0,301}$	$e_{0,303}$
← shift 3	$e_{1,6}$	$e_{1,8}$		...						...			$e_{1,300}$	$e_{1,302}$	$e_{1,0}$	$e_{1,2}$	$e_{1,4}$
	$e_{1,7}$	$e_{1,9}$		...						...			$e_{1,301}$	$e_{1,303}$	$e_{1,1}$	$e_{1,3}$	$e_{1,5}$
← shift 6	$e_{2,12}$	$e_{2,14}$		...						...	$e_{2,302}$	$e_{2,0}$	$e_{2,2}$	$e_{2,4}$	$e_{2,6}$	$e_{2,8}$	$e_{2,10}$
	$e_{2,13}$	$e_{2,15}$		...						...	$e_{2,303}$	$e_{2,1}$	$e_{2,3}$	$e_{2,5}$	$e_{2,7}$	$e_{2,9}$	$e_{2,11}$
	...	...		...						...							
	...	...		...						...							
← shift 150	$e_{50,300}$	$e_{50,302}$	$e_{50,0}$	...						...							$e_{50,298}$
	$e_{50,301}$	$e_{50,303}$	$e_{50,1}$	...						...							$e_{50,299}$
← shift 1	$e_{51,2}$	$e_{51,4}$		...						...					$e_{51,300}$	$e_{51,302}$	$e_{51,0}$
	$e_{51,3}$	$e_{51,5}$		...						...					$e_{51,301}$	$e_{51,303}$	$e_{51,1}$
	...	...		...						...							
	...	...		...						...							
← shift mod(k×3, 152)	...	...		...						...							
	...	...		...						...							
	...	...		...						...							
	...	...		...						...							
← shift 130	$p_{246,260}$	$p_{246,262}$		...				$p_{246,302}$	$p_{246,0}$	...							$p_{246,258}$
	$p_{246,261}$	$p_{246,263}$		...				$p_{246,303}$	$p_{246,1}$	...							$p_{246,259}$
← shift 133	$p_{247,266}$	$p_{247,268}$		...	$p_{247,302}$	$p_{247,0}$	$p_{247,2}$	$p_{247,4}$	$p_{247,6}$	...							$p_{247,264}$
	$p_{247,267}$	$p_{247,269}$		...	$p_{247,303}$	$p_{247,1}$	$p_{247,3}$	$p_{247,5}$	$p_{247,7}$	...							$p_{247,265}$

Figure 25 — LDC cluster

© ISO/IEC 2021 – All rights reserved

Full document details: BS ISO/IEC 30192:2021

13.9 Addressing and control data

13.9.1 General

For the purpose of accessing the data on the disk, addressing and control data is included.

13.9.2 Address units

13.9.2.1 General

For positioning the optical head onto the desired track, a fast addressing mechanism is implemented by subdividing the 64K physical clusters into 16 address units. Each address unit contains an address, which is placed in such a way into the BIS code words (see 13.11) that it can be accessed quickly (see Figure 26).

Each address field consists of nine bytes as follows:

— 4 bytes for the address unit number (see Clause 17);

— 1 byte for flag bits;

— 4 bytes for error correction.

		←		16 addresses			→
		0	1	:	S	:	15
↑	Address-unit numbers	$AF_{0,0}$	$AF_{0,1}$	:	$AF_{0,S}$	:	$AF_{0,15}$
		$AF_{1,0}$	$AF_{1,1}$	:	:	:	$AF_{1,15}$
		:	:	:	:	:	:
9 bytes		$AF_{3,0}$	$AF_{3,1}$	:	$AF_{3,S}$	:	$AF_{3,15}$
	Flag bits	$AF_{4,0}$	$AF_{4,1}$	:	$AF_{4,S}$	:	$AF_{4,15}$
	Parities	$AF_{5,0}$	$AF_{5,1}$	:	$AF_{5,S}$	:	$AF_{5,15}$
		:	:	:	:	:	:
↓		$AF_{8,0}$	$AF_{8,1}$	:	$AF_{8,S}$	:	$AF_{8,15}$

Figure 26 — 16 address fields

13.9.2.2 Bytes assignments for address fields

$AF_{0,S}$: MSB of the address unit number;

$AF_{1,S}$: 2nd SB of the address unit number;

$AF_{2,S}$: 3rd SB of the address unit number;

$AF_{3,S}$: LSB of the address unit number;

$AF_{4,S}$: flag bits: These bits can be used to indicate a status of individual data frames in a cluster or can be used to hold other information, such as an address. The basic format for assigning some of these flag bits is specified in 13.9.2.4. Flag bits not used shall be set to ZERO.

$AF_{5,S}$ .. $AF_{8,S}$: parity bytes for forming an (9,5,5) RS code over the primary address field.

© ISO/IEC 2021 – All rights reserved

Documents
Document Sharing Hub
Full document details: BS ISO/IEC 30192:2021

This RS code is defined over the finite field GF(2^8). The non-zero elements of the finite field GF(2^8) are generated by a primitive element α, where α is a root of the primitive polynomial $p(x)$ as per Formula (26):

$$p(x) = x^8 + x^4 + x^3 + x^2 + 1 \tag{26}$$

The symbols of GF(2^8) are represented by bytes (groups of 8 bits), using the polynomial-base representation, with (α^7, α^6, α^5, .., α^2, α, 1) as a basis. The root α is thus represented as α = 00000010.

Each address-field code word, represented by the vector afc = ($AF_{0,S}$ .. $AF_{i,S}$ .. $AF_{8,S}$), is a Reed-Solomon code over GF(2^8), having four parity bytes and five information bytes. Such a code word can be represented by a polynomial $afc(x)$ of degree 8 (possibly having some coefficients equal to zero), where the highest degrees correspond to the information part of the vector ($AF_{0,S}$ .., etc.) and the lowest degrees correspond to the parity part of the vector ($AF_{5,S}$ .., etc.).

$afc(x)$ is a multiple of the generator polynomial $g(x)$ of the address-field code word. The generator polynomial is as per Formula (27):

$$g(x) = \prod_{i=0}^{3} \left(x - \alpha^i\right) \tag{27}$$

The address-field code is systematic: the five information bytes appear unaltered in the highest-degree positions of each code word. For all address-field code words afc, the parity-check matrix H_{AFC} of code afc is as per Formula (28):

$$H_{AFC} \times afc^T = 0 \tag{28}$$

The second row h_{AFC2} of the parity-check matrix $H_{AFC,}$ corresponding to the zero α of the generator polynomial $g(x)$, defines the code word positions to be used for error locations. This second row h_{AFC2} of the parity-check matrix H_{AFC} is given by Formula (29):

$$h_{AFC2} = (\alpha^8, \alpha^7 .. \alpha^2, \alpha, 1) \tag{29}$$

13.9.2.3 Address unit numbers

The 16 address fields, to be recorded in the BIS columns of the physical cluster each contain a 4-bytes address unit number (AUN).

The address unit numbers shall be derived from the physical sector numbers (PSN) as defined in Figure 27. The address unit numbers increase by two for each successive address unit, for reasons of synchronization with the PSNs (see Clause 17).

The address unit number of the first address unit of each physical cluster is a multiple of 32.

The first address unit number in data zone 0 is 00 10 00 00h (1 048 576 decimal).

The last address unit number in data zone 1 is 01 EF FF FEh (32 505 854 decimal).

The bits of the address unit numbers shall be set as follows:

— AU_{31} .. AU_5 shall be a copy of PS_{31} .. PS_5 from the PSNs;

— AU_4 .. AU_1 shall count from 0 to 15 inside the physical cluster;

— AU_0 shall be reserved.

© ISO/IEC 2021 – All rights reserved
Documents
Document Sharing Hub
Full document details: BS ISO/IEC 30192:2021