

ISO/IEC 30191:2013-07 (E)

Information technology - Digitally recorded media for information interchange and storage - 120 mm Triple Layer (100,0 Gbytes per disk) and Quadruple Layer (128,0 Gbytes per disk) BD Recordable disk

Contents		Page
Foreword		xiii
Introduction		xiv
1	Scope	1
2	Conformance	2
2.1	Optical disk	2
2.2	Generating system	2
2.3	Receiving system	2
2.4	Compatibility statement	2
3	Normative references	2
4	Terms and definitions	3
5	Conventions and notations	7
5.1	Terminology	7
5.1.1	Meaning of words	7
5.1.2	Levels of grouping	7
5.2	Representation of numbers	7
5.3	Integer calculus	8
5.4	Names	8
6	List of acronyms	9
7	General description of disk	11
8	General requirements	13
8.1	Environments	13
8.1.1	Test environment	13
8.1.2	Operating environment	13
8.1.3	Storage environment	14
8.1.4	Transportation	15
8.2	Safety requirements	15
8.3	Flammability	15
9	Reference drive	16
9.1	General	16
9.2	Measurement conditions	16
9.3	Optical system	16
9.4	Optical beam	17
9.5	HF read channel	17
9.6	Radial PP read channel	18
9.7	Disk Clamping	18
9.8	Rotation of disk and Measurement Velocity	18
9.9	Normalized servo transfer function	19
9.10	Measurement Velocities and Reference servos for axial tracking	19
9.10.1	General	19

9.10.2	Reference servo for axial tracking at 1x Measurement Velocity	20
9.10.3	Reference servo for axial tracking at 2x Measurement Velocity	21
9.11	Measurement Velocities and Reference servos for radial tracking	22
9.11.1	General	22
9.11.2	Reference servo for radial tracking at 1x Measurement Velocity	22
9.11.3	Reference servo for radial tracking at 2x Measurement Velocity	23
10	Dimensional characteristics	24
10.1	General	24
10.2	Disk reference planes and reference axis	25
10.3	Overall dimensions	26
10.4	First transition Area	26
10.5	Protection ring	26
10.6	Clamping Zone	27
10.7	Second transition Area	27
10.8	Information Area	27
10.8.1	General	27
10.8.2	Subdivision of Information Zone on TL disk	28
10.8.3	Subdivision of Information Zone on QL disks	29
10.9	Rim Area	30
11	Mechanical characteristics	32
11.1	Mass	32
11.2	Moment of inertia	32
11.3	Dynamic imbalance	32
11.4	Axial runout	32
11.4.1	General	32
11.4.2	Residual axial tracking error for 1x Measurement Velocity	32
11.4.3	Residual axial tracking error for 2x Measurement Velocity	33
11.5	Radial runout	33
11.5.1	General	33
11.5.2	Residual radial tracking error on 1x Measurement Velocity	33
11.5.3	Residual radial tracking error on 2x Measurement Velocity	34
11.6	Durability of Cover Layer	34
11.6.1	Impact resistance of Cover Layer	34
11.6.2	Scratch resistance of Cover Layer	34
11.6.3	Repulsion of fingerprints by Cover Layer	34
12	Optical characteristics in Information Area	35
12.1	General	35
12.2	Refractive index of the Transmission Stacks (TS)	35
12.3	Thickness of Transmission Stacks (TS)	35
12.3.1	Thickness of Transmission Stack of TL disks	35
12.3.2	Example of target thickness of Spacer Layers for TL disks	36
12.3.3	Thickness of Transmission Stacks of QL disks	36
12.3.4	Example of target thickness of Spacer Layers for QL disks	37
12.4	Reflectivity of Recording Layers	40
12.5	Birefringence	40
12.6	Angular deviations	41
13	Data Format	42
13.1	General	42
13.2	Data Frame	44
13.3	Error-Detection Code (EDC)	44
13.4	Scrambled Data Frame	44
13.5	Data Block	45
13.6	LDC Block	46
13.7	LDC Code words	46
13.8	LDC Cluster	47
13.8.1	General	47
13.8.2	First interleaving step	47
13.8.3	Second interleaving step	48

13.9	Addressing and Control Data	50
13.9.1	General	50
13.9.2	Address Units	50
13.9.3	User Control Data	54
13.9.4	Byte/Bit assignments for User Control Data	54
13.10	Access Block	56
13.11	BIS Block	56
13.12	BIS Code words	57
13.13	BIS Cluster	58
13.14	ECC Cluster	62
13.15	Recording Frames	63
13.16	Physical Cluster	63
13.17	17PP Modulation for Recordable data	63
13.17.1	General	63
13.17.2	Bit conversion rules	64
13.17.3	dc-control procedure	64
13.17.4	Frame Sync	64
13.18	Modulation and NRZI conversion	66
14	Physical Data Allocation and Linking	67
14.1	General	67
14.2	Recording-Unit Block (RUB)	67
14.2.1	General	67
14.2.2	Data Run-in	67
14.2.3	Data Run-out	68
14.2.4	Guard_3 field	69
14.3	Locating data relative to wobble addresses	70
15	Track Format	71
15.1	General	71
15.2	Track shape	71
15.3	Track path	72
15.4	Track Pitch	73
15.4.1	Track Pitch in Zone reserved for BCA	73
15.4.2	Track Pitch in Embossed HFM Area	73
15.4.3	Track Pitch in Recordable Areas	73
15.4.4	Track Pitch between Embossed HFM Area and Recordable Area	73
15.5	Track layout of HFM Groove	73
15.5.1	General	73
15.5.2	Data Format	74
15.5.3	Addressing and Control Data	75
15.5.4	Recording Frames	79
15.6	Track layout of Wobbled Grooves	80
15.6.1	General	80
15.6.2	Modulation of wobbles	81
15.6.3	Wobble polarity	82
15.7	ADIP information	82
15.7.1	General	82
15.7.2	ADIP-Unit Types	83
15.7.3	ADIP word structure	83
15.7.4	ADIP data structure	84
15.7.5	ADIP error correction	88
15.8	Disk Information in ADIP Aux Frame	90
15.8.1	General	90
15.8.2	Error protection for Disk Information Aux Frames	90
15.8.3	Disk-Information Data structure	91
16	General description of Information Zone	137
16.1	General	137
16.2	Format of Information Zone on Triple-Layer disk	137
16.3	Format of Information Zone on Quadruple-Layer disk	137

17	Layout of Recordable Area of Information Zone	137
18	Inner Zone(s)	147
18.1	General	147
18.2	Permanent Information & Control Data (PIC) Zone	154
18.2.1	General	154
18.2.2	Content of PIC Zone	154
18.2.3	Emergency Brake	156
18.3	Recordable Area of Lead-in Zone of TL disk	158
18.3.1	Protection-Zone 2	158
18.3.2	Buffer	158
18.3.3	INFO 2 / Reserved 8	158
18.3.4	INFO 2 / Reserved 7	158
18.3.5	INFO 2 / Reserved 6	158
18.3.6	INFO 2 / Reserved 5	159
18.3.7	INFO2 / PAC 2	159
18.3.8	INFO2 / DMA 2	159
18.3.9	INFO2 / Control Data 2	159
18.3.10	INFO2 / Buffer 2	159
18.3.11	OPC 0 / Test Zone	159
18.3.12	Usage of OPC Areas	159
18.3.13	OPC 0 / OPC 0 Buffer	161
18.3.14	TDMA 0	161
18.3.15	INFO1 / Pre-write Area	161
18.3.16	INFO1 / Drive Area	161
18.3.17	INFO1 / DMA 1	162
18.3.18	INFO 1 / Control Data 1	163
18.3.19	INFO 1 / PAC 1	163
18.4	Recordable Area of Inner Zone 1 of TL disk	163
18.4.1	Buffer	163
18.4.2	OPC 1 / Test Zone	163
18.4.3	Reserved	163
18.4.4	INFO 2 / Reserved 8	163
18.4.5	INFO 2 / Reserved 7	163
18.4.6	INFO 2 / Reserved 6	163
18.4.7	INFO 2 / Reserved 5	163
18.4.8	INFO2 / PAC 2	163
18.4.9	INFO 2 / DMA 2	164
18.4.10	INFO 2 / Control Data 2	164
18.4.11	INFO 2 / Buffer 2	164
18.4.12	TDMA 1	164
18.4.13	Reserved	164
18.4.14	INFO1 / Pre-write Area	164
18.4.15	INFO1 / Drive Area	164
18.4.16	INFO1 / DMA 1	164
18.4.17	INFO 1 / Control Data 1	164
18.4.18	INFO 1 / PAC 1	164
18.5	Recordable Area of Inner Zone 2 of TL disk	165
18.5.1	Buffer	165
18.5.2	OPC 2 / Test Zone	165
18.5.3	OPC 2 / OPC 2 Buffer	165
18.5.4	Reserved	165
18.5.5	INFO 2 / Reserved 8	165
18.5.6	INFO 2 / Reserved 7	165
18.5.7	INFO 2 / Reserved 6	165
18.5.8	INFO 2 / Reserved 5	165
18.5.9	INFO 2 / Reserved	165
18.5.10	INFO2 / DMA 2	165
18.5.11	INFO2 / Control Data 2	166
18.5.12	INFO2 / Buffer 2	166
18.5.13	TDMA 2	166
18.5.14	Buffer	166

18.5.15	INFO1 / Pre-write Area	166
18.5.16	INFO1 / Drive Area	166
18.5.17	INFO1 / DMA 1	166
18.5.18	INFO 1 / Control Data 1	166
18.5.19	INFO 1 / Reserved	166
18.6	Recordable Area of Lead-in Zone of QL disk	166
18.6.1	Protection-Zone 2	166
18.6.2	Buffer	167
18.6.3	INFO 2 / Reserved 8	167
18.6.4	INFO 2 / Reserved 7	167
18.6.5	INFO 2 / Reserved 6	167
18.6.6	INFO 2 / Reserved 5	167
18.6.7	INFO2 / PAC 2	167
18.6.8	INFO2 / DMA 2	167
18.6.9	INFO2 / Control Data 2	167
18.6.10	INFO2 / Buffer 2	167
18.6.11	OPC 0 / Test Zone	167
18.6.12	Buffer	168
18.6.13	INFO1 / Pre-write Area	168
18.6.14	INFO1 / Drive Area	168
18.6.15	INFO1 / DMA 1	168
18.6.16	INFO 1 / Control Data 1	168
18.6.17	INFO 1 / PAC 1	168
18.7	Recordable Area of Inner Zone 1 of QL disk	168
18.7.1	Buffer	168
18.7.2	OPC 1 / Test Zone	168
18.7.3	INFO 2 / Reserved 8	168
18.7.4	INFO 2 / Reserved 7	169
18.7.5	INFO 2 / Reserved 6	169
18.7.6	INFO 2 / Reserved 5	169
18.7.7	INFO2 / PAC 2	169
18.7.8	INFO 2 / DMA 2	169
18.7.9	INFO 2 / Control Data 2	169
18.7.10	INFO 2 / Buffer 2	169
18.7.11	TDMA 0	169
18.7.12	Buffer	169
18.7.13	INFO1 / Pre-write Area	169
18.7.14	INFO1 / Drive Area	169
18.7.15	INFO1 / DMA 1	170
18.7.16	INFO 1 / Control Data 1	170
18.7.17	INFO 1 / PAC 1	170
18.8	Recordable Area of Inner Zone 2 of QL disk	170
18.8.1	Buffer	170
18.8.2	INFO 2 / Reserved 8	170
18.8.3	INFO 2 / Reserved 7	170
18.8.4	INFO 2 / Reserved 6	170
18.8.5	INFO 2 / Reserved 5	170
18.8.6	INFO 2 / Reserved	170
18.8.7	INFO2 / DMA 2	171
18.8.8	INFO2 / Control Data 2	171
18.8.9	INFO2 / Buffer 2	171
18.8.10	TDMA 1	171
18.8.11	Buffer	171
18.8.12	OPC 2 / Test Zone	171
18.8.13	OPC 2 / OPC 2 Buffer	171
18.8.14	TDMA 2	171
18.8.15	INFO1 / Pre-write Area	171
18.8.16	INFO1 / Drive Area	171
18.8.17	INFO1 / DMA 1	172
18.8.18	INFO 1 / Control Data 1	172
18.8.19	INFO 1 / Reserved	172
18.9	Recordable Area of Lead-out Zone of QL disk	172

18.9.1	OPC 3 / Test Zone	172
18.9.2	Buffer	172
18.9.3	INFO 2 / Reserved 8	172
18.9.4	INFO 2 / Reserved 7	172
18.9.5	INFO 2 / Reserved 6	172
18.9.6	INFO 2 / Reserved 5	172
18.9.7	INFO2 / Reserved	172
18.9.8	INFO 2 / DMA 2	173
18.9.9	INFO 2 / Control Data 2	173
18.9.10	INFO 2 / Buffer 2	173
18.9.11	TDMA 3	173
18.9.12	INFO1 / Pre-write Area	173
18.9.13	INFO1 / Drive Area	173
18.9.14	INFO1 / DMA 1	173
18.9.15	INFO 1 / Control Data 1	173
18.9.16	INFO 1 / Reserved	173
19	Data Zone	174
20	Outer Zones	174
20.1	General	174
20.2	Recordable Area of Outer Zones	175
20.2.1	INFO3 / Buffer 4	175
20.2.2	INFO3 / DMA 3	175
20.2.3	INFO3 / Control Data 3	175
20.2.4	Angular buffer	175
20.2.5	INFO4 / DMA 4	176
20.2.6	INFO4 / Control Data 4	176
20.2.7	INFO4 / Buffer 6	176
20.2.8	DCZ0 / Test Zone, DCZ1 / Test Zone, DCZ2 / Test Zone and DCZ3 / Test Zone	176
20.2.9	Usage of DCZ Area	176
20.2.10	Protection-Zone 3	177
21	Physical-Access Control Clusters	178
21.1	General	178
21.2	Layout of PAC Zones	178
21.3	General structure of PAC Clusters	179
21.4	IS1 and IS2 PAC Clusters	183
22	Disk Management	184
22.1	General	184
22.2	Recording Management	184
22.2.1	Sequential-Recording Mode (SRM)	184
22.2.2	Recording User Data in SRR	184
22.2.3	SRR status	185
22.2.4	Closing SRR	185
22.3	Temporary Disk-Management Areas (TDMA)	185
22.3.1	General	185
22.3.2	TDMA Access Indicators	185
22.4	Disk-Management Structure (DMS)	186
22.4.1	General	186
22.4.2	Temporary Disk-Management Structure (TDMS)	187
22.4.3	TDMS in Sequential-Recording Mode	187
22.4.4	Temporary Disk-Definition Structure (TDDS)	188
22.4.5	Temporary Defect List (TDFL)	194
22.4.6	Sequential-Recording Range Information (SRRi)	195
22.5	Unrecorded (blank) disk structure	197
22.5.1	General	197
22.5.2	Pre-recorded Areas on Unrecorded disk	197
22.5.3	Pre-recorded BCA	204
22.5.4	Pre-recorded INFO 2 / Reserved 5, Reserved 8 and Pre-recorded INFO1 / Pre-write Area	204
22.5.5	Pre-recorded INFO 1 / PAC 1 and Pre-recorded INFO2 / PAC 2	204

22.5.6	OPC 0 / Test Zone , OPC 1 / Test Zone, OPC 2 / Test Zone and OPC 3 / Test Zone	205
22.5.7	TDMA0	205
22.5.8	Initialization of disk	205
22.6	Recorded (Closed) disk structure	206
22.6.1	General	206
22.6.2	DMA Zones	206
22.6.3	Disk-Management Structure (DMS)	206
23	Assignment of Logical-Sector Numbers (LSNs)	210
24	Characteristics of Grooved Areas	211
25	Method of testing for Grooved Area	211
25.1	General	211
25.2	Environment	211
25.3	Reference drive	211
25.3.1	General	211
25.3.2	Read power	211
25.3.3	Read channels	211
25.3.4	Tracking requirements	212
25.3.5	Scanning velocities	212
25.4	Definition of signals	212
26	Signals from HFM Grooves	214
26.1	Push-Pull polarity	214
26.2	Push-Pull signal	214
26.3	Wobble signal	214
26.4	Jitter of HFM signal	214
27	Signals from Wobbled Grooves	215
27.1	Phase depth	215
27.2	Push-Pull signal	215
27.3	Wobble signal	215
27.3.1	General	215
27.3.2	Measurement of NWS	215
27.3.3	Measurement of wobble CNR	216
27.3.4	Measurement of harmonic distortion of wobble	216
28	Characteristics of Recording Layer	216
29	Method of testing for Recording Layer	217
29.1	General	217
29.2	Environment	217
29.3	Reference drive	217
29.3.1	General	217
29.3.2	Read power	217
29.3.3	Read channels	217
29.3.4	Tracking requirements	217
29.3.5	Scanning velocities	217
29.4	Write conditions	218
29.4.1	Write-pulse waveform	218
29.4.2	Write powers	218
29.4.3	Write conditions for i-MLSE measurement	219
29.5	Definition of signals	219
30	Signals from Recorded aAreas	220
30.1	HF signals	220
30.2	Modulated amplitude	220
30.3	Reflectivity-Modulation product	221
30.4	Asymmetry	221
30.5	i-MLSE	222
30.6	Read stability	222

31	Local defects	224
32	Characteristics of User Data	224
33	Method of testing for User Data	225
33.1	General	225
33.2	Environment	225
33.3	Reference drive	225
33.3.1	General	225
33.3.2	Read power	225
33.3.3	Read channels	225
33.3.4	Error correction	225
33.3.5	Tracking requirements	225
33.3.6	Scanning velocities	225
33.4	Definition of signals	226
34	Minimum quality of recorded information	227
34.1	Symbol Error Rate	227
34.2	Maximum burst errors	227
34.3	User-written Data	227
35	BCA	228
Annex A (normative) Thickness of Transmission Stacks in case of multiple layers		229
A.1	General	229
A.2	Refractive index n_i of all layers	229
A.3	Thickness variations of Transmission Stack for a TL disk	229
A.4	Thickness variations of Transmission Stack for a QL disk	229
A.5	Thickness variations of Spacer Layers for a TL disk	230
A.6	Thickness variations of Spacer Layers for a QL disk	230
A.7	Example of thickness calculation for a TL disk	231
Annex B (normative) Measurement of reflectivity		232
B.1	General	232
B.2	Calibration method	232
B.3	Measuring method	233
B.4	Procedure for compensating stray light effect from observed reflectivity	234
Annex C (normative) Measurement of scratch resistance of Cover Layer		236
C.1	General	236
C.2	Taber Abrasion test	236
Annex D (normative) Measurement of repulsion of grime by Cover Layer		238
D.1	General	238
D.2	Specifications of stamp	238
D.3	Preparation of ink	239
D.4	Preparation of ink pad	239
D.5	Using ink pad and stamp	240
Annex E (normative) Measurement of wobble amplitude		241
E.1	Measurement methods	241
E.2	Calibration of filters	245
Annex F (normative) Write-pulse waveform for testing		246
F.1	General write-pulse waveform	246

F.2	Extended N-1 write strategy	247
F.3	Extended Castle write strategy	250
F.4	Definition of pulse widths and rise and fall times	254
Annex G (normative) Optimum Power Control (OPC) procedure for media		255
G.1	General	255
G.2	Mathematical model for modulation versus power function	255
G.3	Procedure for determination of OPC parameters for media	257
G.4	Procedure to determine Beta value	257
Annex H (normative) HF signal Pre-processing for i-MLSE(Integrated-Maximum Likelihood Sequence Error Estimation) measurements		259
H.1	General	259
H.2	General implementation of i-MLSE measurement system	259
H.3	Specifications of Analogue filters (HPF, LPF)	259
H.4	Specifications of A/D converter	260
H.5	Specifications of Offset canceller	260
H.6	Specifications of Auto Gain Controller (AGC)	260
H.7	Specifications of Interpolator	261
H.8	Specifications of Phase Lock Loop	262
H.9	Specifications of Digital Equalizer	263
H.10	Specifications of Adaptive Equalizer	263
H.11	Specifications of Viterbi decoder	263
H.12	Description of i-MLSE (Integrated-Maximum Likelihood Sequence Error Estimation)	264
H.12.1	General	264
H.12.2	General implementation of i-MLSE detection units	264
H.12.3	Pattern detector	265
H.12.4	Metric Difference calculator	266
H.12.5	Error rate estimation	267
H.12.6	i-MLSE calculation	269
Annex I (normative) Measurement procedures		271
I.1	General	271
I.2	Initial adjustments of Reference drive	271
I.3	i-MLSE measurement	272
I.4	Modulated amplitude measurements	272
I.5	Measurement of Resolution I3pp / I8pp(informative)	272
I.6	Measurement of Modulation I8pp / I8H and I3pp / I8H	273
I.7	Asymmetry measurement	274
I.7.1	General	274
I.7.2	Sampling method	274
I.7.3	Level calculation block (Averaging method)	276
I.7.4	Asymmetry calculation	277
I.8	Measurement of light reflectivity	278
I.8.1	General	278
I.8.2	Measurement procedure of light reflectivity	278
I.9	Tracking-error signal measurements(PPnorm measurement procedure)	279
I.10	Residual error of axial tracking measurement procedure	281
I.11	Residual error of radial tracking measurement procedure	282
I.12	Random SER measurement	282
Annex J (informative) Measurement of birefringence		283
J.1	Principle of measurement	283
J.2	Measurements conditions	283
J.3	Example of measurement procedure	284
J.4	Interchangeability of measuring results	284
Annex K (informative) Measurement of thickness of Cover Layer and Spacer Layer		285

K.1	Focusing method	285
K.2	Interferometer method	285
Annex L (informative) Measurement of impact resistance of Cover Layer		288
L.1	General	288
L.2	Recommendation for drives	288
L.3	Measurements of impact resistance of Cover Layer	288
Annex M (informative) Groove deviation and the wobble amplitude		290
M.1	Relation between normalized wobble signal and wobble amplitude	290
M.2	Tolerances of normalized wobble signal	290
Annex N (informative) Guideline for write pulse adjustment using L-SEAT edge-shift		292
N.1	General	292
N.2	General implementation of edge-shift detection system	292
N.2.1	Edge-shift evaluation unit	292
N.2.2	Analogue filters (HPF, LPF)	292
N.2.3	AD Converter	292
N.2.4	Offset Canceller	293
N.2.5	Auto Gain Controller (AGC)	293
N.2.6	Interpolator	293
N.2.7	Phase Locked Loop	293
N.2.8	Digital Equalizer	293
N.2.9	Adaptive Equalizer	293
N.2.10	Viterbi decoder	293
N.2.11	L-SEAT evaluation block	294
N.3	HF signal processing for L-SEAT	294
N.3.1	General	294
N.3.2	Definition of L-SEAT	294
N.3.3	Edge detection bit patterns	295
N.4	General implementation of L-SEAT evaluation block	298
N.5	General write pulse adjustment procedure	299
Bibliography		301