ISO/IEC 30191:2013-07 (E)

Information technology - Digitally reco rded 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 Genarel 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 ni 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