

ISO/IEC 30191:2021 (E)

Information technology — Digitally recorded media for information interchange and storage — 120 mm Triple Layer (100,0 Gbytes single sided disk and 200,0 Gbytes double sided disk) and Quadruple Layer (128,0 Gbytes single sided disk) BD Recordable disk

Contents

	Foreword
	Introduction
1	Scope
2	Normative references
3	Terms and definitions
4	Symbol and abbreviated terms
5	Conformance
5.1	Optical disk
5.2	Generating system
5.3	Receiving system
5.4	Compatibility statement
6	Convention and notations
6.1	Levels of grouping
6.2	Representation of numbers
6.3	Integer calculus
7	General description of disk
8	General requirements
8.1	Environments
8.1.1	Test environment
8.1.1.1	General
8.1.1.2	Test conditions for sudden change in operating environment
8.1.2	Operating environment
8.1.3	Storage environment
8.1.3.1	General
8.1.3.2	Climatic storage tests
8.1.4	Transportation
8.1.4.1	General
8.1.4.2	Packaging
8.1.4.2.1	General
8.1.4.2.2	Temperature and humidity
8.1.4.2.3	Impact loads and vibrations
8.2	Safety requirements
8.3	Flammability
9	Reference drive
9.1	General
9.2	Measurement conditions
9.3	Optical system
9.4	Optical beam
9.5	HF read channel
9.6	Radial PP read channel

9.7	Disk clamping
9.8	Rotation of disk and measurement velocity
9.9	Normalized servo transfer function
9.10	Measurement velocities and reference servos for axial tracking
9.10.1	General
9.10.2	Reference servo for axial tracking at 1x measurement velocity
9.10.3	Reference servo for axial tracking at 2x measurement velocity
9.11	Measurement velocities and reference servos for radial tracking
9.11.1	General
9.11.2	Reference servo for radial tracking at 1x measurement velocity
9.11.3	Reference servo for radial tracking at 2x measurement velocity
10	Dimensional characteristics
10.1	General
10.2	Disk reference planes and reference axis
10.3	Overall dimensions
10.4	First transition area
10.5	Protection ring
10.6	Clamping zone
10.7	Second transition area
10.8	Information area
10.8.1	General
10.8.2	Subdivision of information zone on TL disk
10.8.3	Subdivision of information zone on QL disk
10.9	Rim area
11	Mechanical characteristics
11.1	Mass
11.2	Moment of inertia
11.3	Dynamic imbalance
11.4	Axial runout
11.4.1	General
11.4.2	Residual axial tracking error for 1x measurement velocity
11.4.3	Residual axial tracking error for 2x measurement velocity
11.5	Radial runout
11.5.1	General
11.5.2	Residual radial tracking error on 1x measurement velocity
11.5.3	Residual radial tracking error on 2x measurement velocity
11.6	Durability of cover layer
11.6.1	Impact resistance of cover layer
11.6.2	Scratch resistance of cover layer
11.6.3	Repulsion of fingerprints by cover layer
12	Optical characteristics in information area
12.1	General
12.2	Refractive index of the transmission stacks (TS)
12.3	Thickness of transmission stacks (TS)
12.3.1	Thickness of transmission stack of TL disks
12.3.2	Example of target thickness of spacer layers for TL disks
12.3.3	Thickness of transmission stacks of QL disks
12.3.4	Example of target thickness of spacer layers for QL disks
12.4	Reflectivity of recording layers
12.5	Birefringence
12.6	Angular deviations
13	Data format
13.1	General
13.2	Data frame
13.3	Error detection code (EDC)
13.4	Scrambled data frame
13.5	Data block
13.6	LDC block
13.7	LDC code words
13.8	LDC cluster

- 13.8.1 General
 - 13.8.2 First interleaving step
 - 13.8.3 Second interleaving step
 - 13.9 Addressing and control data
 - 13.9.1 General
 - 13.9.2 Address units
 - 13.9.2.1 General
 - 13.9.2.2 Byte assignments for address fields
 - 13.9.2.3 Address unit numbers
 - 13.9.2.4 Assignments for flag bits
 - 13.9.2.5 Usage of status bits Sai,j
 - 13.9.3 User control data
 - 13.9.4 Byte/bit assignments for user control data
 - 13.10 Access block
 - 13.11 BIS block
 - 13.12 BIS code words
 - 13.13 BIS cluster
 - 13.14 ECC cluster
 - 13.15 Recording frames
 - 13.16 Physical cluster
 - 13.17 17PP modulation for recordable data
 - 13.17.1 General
 - 13.17.2 Bit conversion rules
 - 13.17.3 dc-control procedure
 - 13.17.4 Frame sync
 - 13.18 Modulation and NRZI conversion
- 14 Physical data allocation and linking
- 14.1 General
 - 14.2 Recording unit block (RUB)
 - 14.2.1 General
 - 14.2.2 Data run-in
 - 14.2.2.1 General
 - 14.2.2.2 Content of Guard_1 fields
 - 14.2.2.3 Automatic power control (APC)
 - 14.2.2.4 Content of PrA fields
 - 14.2.3 Data run-out
 - 14.2.3.1 General
 - 14.2.3.2 Content of PoA fields
 - 14.2.3.3 Content of Guard_2 fields
 - 14.2.4 Guard_3 field
 - 14.2.4.1 General
 - 14.2.4.2 Automatic power control (APC)
 - 14.2.4.3 Linking requirements
 - 14.3 Locating data relative to wobble addresses
- 15 Track format
- 15.1 General
 - 15.2 Track shape
 - 15.3 Track path
 - 15.4 Track pitch
 - 15.4.1 Track pitch in zone reserved for BCA
 - 15.4.2 Track pitch in embossed HFM area
 - 15.4.3 Track pitch in recordable areas
 - 15.4.4 Track pitch between embossed HFM area and recordable area
 - 15.5 Track layout of HFM groove
 - 15.5.1 General
 - 15.5.2 Data format
 - 15.5.2.1 Data frame
 - 15.5.2.2 Scrambled data frame
 - 15.5.2.3 Data block
 - 15.5.2.4 LDC block
 - 15.5.2.5 Interleaving
 - 15.5.3 Addressing and control data

- 15.5.3.1 General
- 15.5.3.2 Address fields
- 15.5.3.3 User control data
- 15.5.3.4 BIS code words
- 15.5.3.5 BIS cluster
- 15.5.4 Recording frames
 - 15.5.4.1 General
 - 15.5.4.2 Modulation
 - 15.5.4.3 Frame sync
- 15.6 Track layout of wobbled grooves
 - 15.6.1 General
 - 15.6.2 Modulation of wobbles
 - 15.6.2.1 General
 - 15.6.2.2 MSK-cos modulation
 - 15.6.2.3 HMW modulation
 - 15.6.3 Wobble polarity
- 15.7 ADIP information
 - 15.7.1 General
 - 15.7.2 ADIP unit types
 - 15.7.3 ADIP word structure
 - 15.7.4 ADIP data structure
 - 15.7.4.1 General
 - 15.7.4.2 ADIP information bit assignments
 - 15.7.4.3 Relation between physical ADIP addresses on layers from layer L0 to layer L3
 - 15.7.5 ADIP error correction
- 15.8 Disk information in ADIP aux frame
 - 15.8.1 General
 - 15.8.2 Error protection for disk information aux frames
 - 15.8.3 Disk information data structure
 - 15.8.3.1 General
 - 15.8.3.2 General definitions for DI unit
 - 15.8.3.3 Definitions for DI format 4 (extended N-1 write strategy)
 - 15.8.3.4 Definitions for DI format 5 (extended castle write strategy)
 - 15.8.3.5 Write strategy requirements
 - 15.8.3.6 Usage of DI units for write strategies
- 16 General description of information zone
 - 16.1 General
 - 16.2 Format of information zone on triple-layer disk
 - 16.3 Format of information zone on quadruple-layer disk
- 17 Layout of recordable area of information zone
- 18 Inner zone(s)
 - 18.1 General
 - 18.2 Permanent information and control data (PIC) zone
 - 18.2.1 Genarel
 - 18.2.2 Content of PIC zone
 - 18.2.3 Emergency brake
 - 18.3 Recordable area of lead-in zone of TL disk
 - 18.3.1 Protection zone 2
 - 18.3.2 Buffer
 - 18.3.3 INFO 2/Reserved 8
 - 18.3.4 INFO 2/Reserved 7
 - 18.3.5 INFO 2/Reserved 6
 - 18.3.6 INFO 2/Reserved 5
 - 18.3.7 INFO 2/PAC 2
 - 18.3.8 INFO 2/DMA 2
 - 18.3.9 INFO 2/Control data 2
 - 18.3.10 INFO 2/Buffer 2
 - 18.3.11 OPC 0/Test zone
 - 18.3.12 Usage of OPC areas
 - 18.3.12.1 OPC procedure order
 - 18.3.12.2 OPC physical cluster usage

18.3.12.3 OPC update in the TDMA
 18.3.13 OPC 0/OPC 0 buffer
 18.3.14 TDMA 0
 18.3.15 INFO 1/Pre-write area
 18.3.16 INFO 1/Drive area
 18.3.16.1 General
 18.3.16.2 Format of drive-specific information
 18.3.17 INFO 1/DMA 1
 18.3.18 INFO 1/Control data 1
 18.3.19 INFO 1/PAC 1
 18.4 Recordable area of inner zone 1 of TL disk
 18.4.1 Buffer
 18.4.2 OPC 1/Test zone
 18.4.3 Reserved
 18.4.4 INFO 2/Reserved 8
 18.4.5 INFO 2/Reserved 7
 18.4.6 INFO 2/Reserved 6
 18.4.7 INFO 2/Reserved 5
 18.4.8 INFO 2/PAC 2
 18.4.9 INFO 2/DMA 2
 18.4.10 INFO 2/Control data 2
 18.4.11 INFO 2/Buffer 2
 18.4.12 TDMA 1
 18.4.13 Reserved
 18.4.14 INFO 1/Pre-write area
 18.4.15 INFO 1/Drive area
 18.4.16 INFO 1/DMA 1
 18.4.17 INFO 1/Control data 1
 18.4.18 INFO 1/PAC 1
 18.5 Recordable area of inner zone 2 of TL disk
 18.5.1 Buffer
 18.5.2 OPC 2/Test zone
 18.5.3 OPC 2/OPC 2 buffer
 18.5.4 Reserved
 18.5.5 INFO 2/Reserved 8
 18.5.6 INFO 2/Reserved 7
 18.5.7 INFO 2/Reserved 6
 18.5.8 INFO 2/Reserved 5
 18.5.9 INFO 2/Reserved
 18.5.10 INFO 2/DMA 2
 18.5.11 INFO 2/Control data 2
 18.5.12 INFO 2/Buffer 2
 18.5.13 TDMA 2
 18.5.14 Buffer
 18.5.15 INFO 1/Pre-write area
 18.5.16 INFO 1/Drive area
 18.5.17 INFO 1/DMA 1
 18.5.18 INFO 1/Control data 1
 18.5.19 INFO 1/Reserved
 18.6 Recordable area of lead-in zone of QL disk
 18.6.1 Protection zone 2
 18.6.2 Buffer
 18.6.3 INFO 2/Reserved 8
 18.6.4 INFO 2/Reserved 7
 18.6.5 INFO 2/Reserved 6
 18.6.6 INFO 2/Reserved 5
 18.6.7 INFO 2/PAC 2
 18.6.8 INFO 2/DMA 2
 18.6.9 INFO 2/Control data 2
 18.6.10 INFO 2/Buffer 2
 18.6.11 OPC 0/Test zone
 18.6.12 Buffer
 18.6.13 INFO 1/Pre-write area
 18.6.14 INFO 1/Drive area

- 18.6.15 INFO 1/DMA 1
- 18.6.16 INFO 1/Control data 1
- 18.6.17 INFO 1/PAC 1
- 18.7 Recordable area of inner zone 1 of QL disk
 - 18.7.1 Buffer
 - 18.7.2 OPC 1/Test zone
 - 18.7.3 INFO 2/Reserved 8
 - 18.7.4 INFO 2/Reserved 7
 - 18.7.5 INFO 2/Reserved 6
 - 18.7.6 INFO 2/Reserved 5
 - 18.7.7 INFO 2/PAC 2
 - 18.7.8 INFO 2/DMA 2
 - 18.7.9 INFO 2/Control data 2
 - 18.7.10 INFO 2/Buffer 2
 - 18.7.11 TDMA 0
 - 18.7.12 Buffer
 - 18.7.13 INFO 1/Pre-write area
 - 18.7.14 INFO 1/Drive area
 - 18.7.15 INFO 1/DMA 1
 - 18.7.16 INFO 1/Control data 1
 - 18.7.17 INFO 1/PAC 1
- 18.8 Recordable area of inner zone 2 of QL disk
 - 18.8.1 Buffer
 - 18.8.2 INFO 2/Reserved 8
 - 18.8.3 INFO 2/Reserved 7
 - 18.8.4 INFO 2/Reserved 6
 - 18.8.5 INFO 2/Reserved 5
 - 18.8.6 INFO 2/Reserved
 - 18.8.7 INFO 2/DMA 2
 - 18.8.8 INFO 2/Control data 2
 - 18.8.9 INFO 2/Buffer 2
 - 18.8.10 TDMA 1
 - 18.8.11 Buffer
 - 18.8.12 OPC 2/Test zone
 - 18.8.13 OPC 2/OPC 2 buffer
 - 18.8.14 TDMA 2
 - 18.8.15 INFO 1/Pre-write area
 - 18.8.16 INFO 1/Drive area
 - 18.8.17 INFO 1/DMA 1
 - 18.8.18 INFO 1/Control data 1
 - 18.8.19 INFO 1/Reserved
- 18.9 Recordable area of lead-out zone of QL disk
 - 18.9.1 OPC 3/Test zone
 - 18.9.2 Buffer
 - 18.9.3 INFO 2/Reserved 8
 - 18.9.4 INFO 2/Reserved 7
 - 18.9.5 INFO 2/Reserved 6
 - 18.9.6 INFO 2/Reserved 5
 - 18.9.7 INFO 2/Reserved
 - 18.9.8 INFO 2/DMA 2
 - 18.9.9 INFO 2/Control data 2
 - 18.9.10 INFO 2/Buffer 2
 - 18.9.11 TDMA 3
 - 18.9.12 INFO 1/Pre-write area
 - 18.9.13 INFO 1/Drive area
 - 18.9.14 INFO 1/DMA 1
 - 18.9.15 INFO 1/Control data 1
 - 18.9.16 INFO 1/Reserved
- 19 Data zone
- 20 Outer zones
 - 20.1 General
 - 20.2 Recordable area of outer zones

- 20.2.1 INFO 3/Buffer 4
- 20.2.2 INFO 3/DMA 3
- 20.2.3 INFO 3/Control data 3
- 20.2.4 Angular buffer
- 20.2.5 INFO 4/DMA 4
- 20.2.6 INFO 4/Control data 4
- 20.2.7 INFO 4/Buffer 6
- 20.2.8 DCZ 0/Test zone, DCZ 1/Test zone, DCZ 2/Test zone and DCZ 3/Test zone
- 20.2.9 Usage of DCZ area
- 20.2.9.1 DCZ procedure order
- 20.2.9.2 DCZ physical cluster usage
- 20.2.9.3 Update of TDMA
- 20.2.10 Protection zone 3
- 21 Physical access control clusters
 - 21.1 General
 - 21.2 Layout of PAC zones
 - 21.3 General structure of PAC clusters
 - 21.4 IS1 and IS2 PAC clusters
- 22 Disk management
 - 22.1 General
 - 22.2 Recording management
 - 22.2.1 General
 - 22.2.2 Sequential recording mode (SRM)
 - 22.2.3 Recording user data in SRR
 - 22.2.4 SRR status
 - 22.2.5 Closing SRR
 - 22.3 Temporary disk management areas (TDMA)
 - 22.3.1 General
 - 22.3.2 TDMA access indicators
 - 22.4 Disk management structure (DMS)
 - 22.4.1 General
 - 22.4.2 Temporary disk management structure (TDMS)
 - 22.4.3 TDMS in sequential recording mode
 - 22.4.4 Temporary disk definition structure (TDDS)
 - 22.4.5 Temporary defect list (TDFL)
 - 22.4.5.1 General
 - 22.4.5.2 TDFL data structure
 - 22.4.5.3 Defect list header
 - 22.4.5.4 Defect list terminator
 - 22.4.6 Sequential recording range information (SRRi)
 - 22.4.6.1 General
 - 22.4.6.2 SRRi data structure
 - 22.4.6.3 SRRi header
 - 22.4.6.4 SRR entry
 - 22.4.6.5 SRRi terminator
 - 22.5 Unrecorded (blank) disk structure
 - 22.5.1 General
 - 22.5.2 Pre-recorded areas on unrecorded disk
 - 22.5.3 Pre-recorded BCA
 - 22.5.4 Pre-recorded INFO 2/Reserved 5, Reserved 8 and Pre-recorded INFO 1/Pre-write area
 - 22.5.5 Pre-recorded INFO 1/PAC 1 and Pre-recorded INFO 2/PAC 2
 - 22.5.6 OPC 0/Test zone, OPC 1/Test zone, OPC 2/Test zone and OPC 3/Test zone
 - 22.5.7 TDMA 0
 - 22.5.8 Initialization of disk
 - 22.6 Recorded (closed) disk structure
 - 22.6.1 General
 - 22.6.2 DMA zones
 - 22.6.3 Disk management structure (DMS)
 - 22.6.3.1 General
 - 22.6.3.2 Disk management structure (DMS) on TL disk
 - 22.6.3.3 Disk management structure (DMS) on QL disk

- 23 **Assignment of logical sector numbers (LSNs)**
- 24 **Characteristics of grooved areas**
- 25 **Method of testing for grooved area**
 - 25.1 **General**
 - 25.2 **Environment**
 - 25.3 **Reference drive**
 - 25.3.1 **General**
 - 25.3.2 **Read power**
 - 25.3.3 **Read channels**
 - 25.3.4 **Tracking requirements**
 - 25.3.5 **Scanning velocities**
 - 25.4 **Definition of signals**
- 26 **Signals from HFM grooves**
 - 26.1 **Push-pull polarity**
 - 26.2 **Push-pull signal**
 - 26.3 **Wobble signal**
 - 26.4 **Jitter of HFM signal**
- 27 **Signals from wobbled grooves**
 - 27.1 **Phase depth**
 - 27.2 **Push-pull signal**
 - 27.3 **Wobble signal**
 - 27.3.1 **General**
 - 27.3.2 **Measurement of INWS**
 - 27.3.3 **Measurement of wobble CNR**
 - 27.3.4 **Measurement of harmonic distortion of wobble**
- 28 **Characteristics of recording layer**
- 29 **Method of testing for recording layer**
 - 29.1 **General**
 - 29.2 **Environment**
 - 29.3 **Reference drive**
 - 29.3.1 **General**
 - 29.3.2 **Read power**
 - 29.3.3 **Read channels**
 - 29.3.4 **Tracking requirements**
 - 29.3.5 **Scanning velocities**
 - 29.4 **Write conditions**
 - 29.4.1 **Write pulse waveform**
 - 29.4.2 **Write powers**
 - 29.4.3 **Average power**
 - 29.4.4 **Write conditions for i-MLSE measurement**
 - 29.5 **Definition of signals**
- 30 **Signals from recorded areas**
 - 30.1 **HF signals**
 - 30.2 **Modulated amplitude**
 - 30.3 **Reflectivity-modulation product**
 - 30.4 **Asymmetry**
 - 30.5 **i-MLSE**
 - 30.6 **Read stability**
- 31 **Local defects**
- 32 **Characteristics of user data**
- 33 **Method of testing for user data**
 - 33.1 **General**
 - 33.2 **Environment**

33.3	Reference drive
33.3.1	General
33.3.2	Read power
33.3.3	Read channels
33.3.4	Error correction
33.3.5	Tracking requirements
33.3.6	Scanning velocities
33.4	Error signals
34	Minimum quality of recorded information
34.1	Symbol error rate
34.2	Maximum burst errors
34.3	User-written data
35	BCA
Annex A	(normative) Thickness of transmission stacks in case of multiple layers
A.1	General
A.2	Refractive index n_i of all layers
A.3	Thickness variations of transmission stack for TL disk
A.4	Thickness variations of transmission stack for QL disk
A.5	Thickness variations of spacer layers for TL disk
A.6	Thickness variations of spacer layers for QL disk
A.7	Example of thickness calculation for TL disk
Annex B	(normative) Measurement of reflectivity
B.1	General
B.2	Calibration method
B.3	Measuring method
B.3.1	Reflectivity in unrecorded virgin recordable area
B.3.2	Reflectivity in recorded recordable areas
B.4	Procedure for compensating stray light effect from observed reflectivity
Annex C	(normative) Measurement of scratch resistance of cover layer
C.1	General
C.2	Taber abrasion test
Annex D	(normative) Measurement of repulsion of grime by cover layer
D.1	General
D.2	Specifications of stamp
D.3	Preparation of ink
D.4	Preparation of ink pad
D.5	Using ink pad and stamp
Annex E	(normative) Measurement of wobble amplitude
E.1	Measurement methods
E.2	Calibration of filters
Annex F	(normative) Write pulse waveform for testing
F.1	General write pulse waveform
F.2	Extended N-1 write strategy
F.3	Extended castle write strategy
F.4	Definition of pulse widths and rise and fall times
Annex G	(normative) Optimum power control (OPC) procedure for disk
G.1	General
G.2	Mathematical model for modulation versus power function
G.3	Procedure for determination of OPC parameters for disk
G.4	Procedure to determine beta value
Annex H	(normative) HF signal pre-processing for i-MLSE(integrated maximum likelihood sequence error estimation) measurements
H.1	General
H.2	General implementation of i-MLSE measurement system

- H.3 Specifications of analogue filters (HPF, LPF)
- H.4 Specifications of A/D converter
- H.5 Specifications of offset canceller
- H.6 Specifications of auto gain controller (AGC)
- H.7 Specifications of interpolator
- H.8 Specifications of phase lock loop
- H.9 Specifications of digital equalizer
- H.10 Specifications of adaptive equalizer
- H.11 Specifications of Viterbi decoder
- H.12 Description of i-MLSE (integrated maximum likelihood sequence error estimation)
 - H.12.1 General
 - H.12.2 General implementation of i-MLSE detection units
 - H.12.3 Pattern detector
 - H.12.4 Metric difference calculator
 - H.12.5 Error rate estimation
 - H.12.6 i-MLSE calculation

Annex I (normative) Measurement procedures

- I.1 General
- I.2 Initial adjustments of reference drive
- I.3 i-MLSE measurement
- I.4 Modulated amplitude measurements
- I.5 Measurement of resolution I3pp/I8pp
- I.6 Measurement of modulation I8pp/I8H and I3pp/I8H
- I.7 Asymmetry measurement
 - I.7.1 General
 - I.7.2 Sampling method
 - I.7.3 Level calculation block (averaging method)
 - I.7.4 Asymmetry calculation
- I.8 Measurement of light reflectivity
 - I.8.1 General
 - I.8.2 Measurement procedure of light reflectivity
- I.9 Tracking error signal measurements (VPPnorm measurement procedure)
- I.10 Residual error of axial tracking measurement procedure
- I.11 Residual error of radial tracking measurement procedure
- I.12 Random SER measurement

Annex J (informative) Measurement of birefringence

- J.1 Principle of measurement
- J.2 Measurements conditions
- J.3 Example of measurement procedure
- J.4 Interchangeability of measuring results

Annex K (informative) Measurement of thickness of cover layer and spacer layer

- K.1 Focusing method
- K.2 Interferometer method

Annex L (informative) Measurement of impact resistance of cover layer

- L.1 General
- L.2 Recommendation for drives
- L.3 Measurements of impact resistance of cover layer

Annex M (informative) Groove deviation and the wobble amplitude

- M.1 Relation between normalized wobble signal and wobble amplitude
- M.2 Tolerances of normalized wobble signal

Annex N (informative) Guideline for write pulse adjustment using L-SEAT edge shift

- N.1 General
- N.2 General implementation of edge shift detection system
 - N.2.1 Edge shift evaluation unit
 - N.2.2 Analogue filters (HPF, LPF)
 - N.2.3 AD converter
 - N.2.4 Offset canceller
 - N.2.5 Auto gain controller (AGC)

- N.2.6 Interpolator
- N.2.7 Phase-lock loop
- N.2.8 Digital equalizer
- N.2.9 Adaptive equalizer
- N.2.10 Viterbi decoder
- N.2.11 L-SEAT evaluation block
- N.3 HF signal processing for L-SEAT
 - N.3.1 General
 - N.3.2 Definition of L-SEAT
 - N.3.3 Edge detection bit patterns
- N.4 General implementation of L-SEAT evaluation block
- N.5 General write pulse adjustment procedure

Annex O (normative) Specific requirements for type TL/D disk

Annex P (informative) Bonding of type TL/D disk

- P.1 General
- P.2 Disk bonding at centre hole of disk
- P.3 Disk bonding at outer edge of disk

Page count: 298