INTERNATIONAL STANDARD

ISO/IEC 15898

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1998-07-15

Information technology — Data interchange on 356 mm optical disk cartridges — WORM, using phase change technology — Capacity: 14,8 Gbytes and 25 Gbytes per cartridge

Technologies de l'information — Échange de données sur cartouches de disques optiques 356 mm *[WORM], utilisant la technologie de changement de phase — Capacité:* 14,8 Gbytes *et* 25 Gbytes *par cartouche*

Reference number
ISO/IEC 15898:1998(E)

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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.

In the field of information technology, ISO and IEC have established a joint technical committee, ISO/IEC JTC 1. Draft International Standards adopted by the joint technical committee are circulated to national bodies for voting. Publication as an International Standard requires approval by at least 75 % of the national bodies casting a vote.

International Standard ISO/IEC 15898 was prepared by ECMA (as ECMA-260) and was adopted, under a special “fast-track procedure”, by Joint Technical Committee ISO/IEC JTC 1, *Information technology*, in parallel with its approval of national bodies of ISO and IEC.

Annexes A to Q form an integral part of this International Standard. Annex R is for information only.

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Information technology — Data interchange on 356 mm optical disk cartridges — WORM, using phase change technology — Capacity: 14,8 Gbytes and 25 Gbytes per cartridge

Section 1 - General

1 Scope

This International Standard specifies the characteristics of 356 mm Optical Disk Cartridges (ODCs) of the type providing for information to be written once and read many times.

This International Standard specifies:

- definitions of essential concepts,
- the environment in which the characteristics shall be tested,
- the environments in which the cartridge shall be operated and stored,
- the mechanical, physical and dimensional characteristics of the case and of the optical disk,
- the optical characteristics and the recording characteristics for recording the information once and for reading it many times, so as to provide physical interchangeability between data processing systems.
- the format for the physical disposition of the tracks and sectors, the error correction codes, the modulation methods used for recording and the quality of the recorded signals.

Together with a standard for volume and file structure, this International Standard provides for full data interchange between data processing systems.

2 Conformance

2.1 Optical disk cartridge

An optical disk cartridge shall be in conformance with this International Standard if it meets all the mandatory requirements herein.

2.2 Generating system

A manufacturer of a system generating an ODC for interchange shall be in conformance with this International Standard if the ODC it generates is in accordance with 2.1.

2.3 Receiving system

A manufacturer of a system receiving an ODC for interchange shall be entitled to claim conformance with this International Standard if it is able to handle an ODC according to 2.1.

2.4 Compatibility statement

A claim of conformance by a generating or receiving system with this International Standard shall include a statement listing any other ECMA or International Optical Disk Cartridge Standard(s) supported. This statement shall specify the number of the standard(s) and whether support includes reading or both reading and writing.

3 Normative references

The following standards contain provisions which, through reference in this text, constitute provisions of this International Standard. At the time of publication, the editions indicated were valid. All standards are subject to revision, and parties to agreements based on this International Standard are encouraged to investigate the possibility of applying the most recent editions of the standards indicated below. Members of IEC and ISO maintain registers of currently valid International Standards.

ISO/IEC 646:1991, *Information technology — ISO 7-bit coded character set for information interchange.*

IEC 950:1991, *Safety of information technology equipment.*

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4 Definitions

For the purposes of this International Standard, the following definitions apply.

4.1 actual write power: The actual write power is two times the recording beam power exiting the objective lens for a time averaged measurement of 50 % duty cycle optical pulses where the pulse length is measured at one half the peak power.

4.2 air sandwich disk: A disk which consists at least of a substrate with a recording layer and a cover separated by two annular spaces providing an enclosed air gap for the recording layer.

4.3 band: An annular area of the optical disk recording zone.

4.4 baseline reflectance: The reflectance of an unwritten, non-grooved area of a disk through the protective layer.

4.5 birefringence: The property of a material which causes incident light waves of different polarizations to be refracted differently by the material.

4.6 case: An enclosure which protects the optical disk and carrier from contamination and damage due to physical handling. The case may include space for physical labelling, write-inhibit features and provisions for automatic handling to facilitate disk interchange.

4.7 clamping zone: The annular part of the disk within which the clamping force is applied by the clamping device.

4.8 cover sheet: A transparent covering placed at a pre-determined distance from the recording surface to protect the optical disk from surface contamination and to cause surface contaminants to be out of focus.

4.9 cross-talk level: The ratio of the level of a spurious signal generated by an adjacent track to the level of the signal of that track.

4.10 cyclic redundancy check (CRC): A method to detect errors in data.

4.11 defect management: In real time, refers to automated programs for altering read or write power, focus or tracking when difficulties are detected, and for the decision to abandon sectors of high error content. In batch mode, refers to guidelines for disk rewrite or retirement.

Note - Disk retirement is retention of a disk which can be read but not written.

4.12 disk reference plane: A plane defined by the perfectly flat annular surface of an ideal spindle which contacts the clamping zone of the disk and which is normal to the axis of rotation.

4.13 entrance surface: The disk surface onto which the optical beam first impinges.

4.14 error correction code (ECC): An error-detecting code designed to correct certain kinds of errors in data.

4.15 error detection and correction (EDAC): A family of methods in which redundancy is added to data in known fashion and is written with the data. Upon readback, a decoder removes the redundancy and uses the redundant information to detect and correct erroneous channel symbols.

4.16 format: The arrangement or layout of the data on a data medium.

4.17 hub: The central feature on the disk which interacts with the spindle of the disk drive to provide radial centring and clamping force and, in some cases, axial location.

4.18 interleaving: The process of allocating the physical sequence of units of data to render the data more immune to burst errors.

4.19 mark: A feature of the recording layer that may take the form of an amorphous spot, crystalline spot, a pit, or other form that can be sensed by the optical system. The pattern of marks represents the data on the disk.

4.20 mark edge: The transition between a region with a mark and one without a mark or vice versa, along a track.

4.21 mark edge recording: A recording method which uses a mark edge to represent a channel bit.

4.22 narrow band signal-to-noise ratio: The ratio of the root mean square (RMS) voltage of a signal at a specified frequency to the RMS voltage of the noise in a specified bandwidth, expressed in decibels.

4.23 noise floor: The noise spectrum in a specified bandwidth.

4.24 optical disk: A disk containing information in the form of marks in a recording layer that can be read with an optical beam.

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4.25 optical disk carrier: A framework which captures and holds an optical disk except when the optical disk is mounted on the disk drive spindle. The carrier provides the interface with the equipment for handling of an optical disk. The carrier and the optical disk are permanently mated and as a sub-assembly interchangeable with any case, disk drive or library equipment.

4.26 optical disk cartridge (ODC): A device consisting of a case containing an optical disk and carrier.

4.27 optical retardation: The change, after passage through a birefringent material, of the phase between two orthogonally, linearly polarized plane waves associated with a given propagation direction.

4.28 perimeter ring: An outside diameter feature of the optical disk to provide an interface to the carrier and to handling devices of an optical disk drive.

4.29 pre-formatted mark: A mark written by the manufacturer for use by the optical disk drive.

4.30 protective layer: A transparent layer on the disk provided for mechanical protection of the recording layer, through which the optical beam accesses the recording layer.

4.31 read power: The incident power specified at the entrance surface that can be used to read the data on the disk without damaging the recording layer.

4.32 recording layer: A layer of the disk on or in which data is written during manufacture and/or use.

4.33 Reed-Solomon code: An error detection and/or correction code which is particularly suited to the correction of errors which occur in bursts or are strongly correlated.

4.34 spindle: The part of the disk drive which contacts the disk and/or the hub.

4.35 tilt: The angle which the normal to the entrance surface makes with the normal to the disk reference plane.

4.36 track: A 360 ° segment of the path which is to be followed by the read beam during reading or the write beam during writing.

4.37 track pitch: The distance between adjacent track centrelines measured in a radial direction.

4.38 write power: The incident power specified at the entrance surface used to produce marks.

4.39 zone: An annular area of the disk.

5 Conventions and notations

Bits and bytes mean data bits and bytes unless otherwise specified.

5.1 Representation of numbers

The following conventions apply to numbers:

- A measured value is rounded off to the least significant digit of the corresponding value. It implies that a specified value of 1,26 with a positive tolerance of + 0,01, and a negative tolerance of -0,02 allows a range of measured values from 1,235 to 1,275. A value ≥ 0,015 is rounded up to 0,02 and a value < 0,015 is rounded down to 0,01.
- Letters and digits in parentheses represent numbers in hexadecimal notation.
- The setting of a bit is denoted by ZERO or ONE.
- Numbers in binary notation and bit combinations are represented by strings of digits 0 and 1.
- Numbers in binary notation and bit combinations are shown with the most significant bit to the left.
- Negative values of numbers in binary notation are given in TWO's complement.
- In the sector headers, character data are recorded according to the IRV of ISO/IEC 646.
- All other data are stored as binary integers.
- Multiple-byte binary data are stored least significant byte first.

5.2 Names

The names of entities, for example, specific tracks, fields, etc., are given with a capital initial.

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6 List of acronyms

AM	Address mark
CRC	Cyclic Redundancy Code
DCF	Data Control Field
DMA	Defect Management Area
DM-M	Delay Modulation Mark
EDAC	Error Detection and Correction
ECC	Error Correction Code
GDL	Grown Defect List
ID	Inside diameter
IDENT	Identification
LSB	Least Significant Byte
MSB	Most Significant Byte
NRZ	Non Return to Zero
OD	Outside diameter
ODC	Optical Disk Cartridge
PAD	Tracking pad
PDL	Primary Defect List
RA	Reallocation Area
RLL	Run length limited (code)
RPM	Revolutions per minute
R-S/LDC	Reed-Solomon long distance code
SDL	Secondary Defect List
VFO	Variable frequency oscillator

7 General description of the optical disk cartridge

The optical disk cartridge which is the subject of this International Standard consists of a case containing an optical disk and carrier sub-assembly.

The case provides protection from contaminants and during human handling. The case has an access door for automatic unload and load of the carrier and the disk.

The carrier supports and retains the disk during loading into the drive or unloading from it, and while being moved by an automated library storage device.

The optical disk is recordable on both sides. Data is written onto the disk as marks in the form of crystalline spots in the amorphous recording layer with a focused optical beam, using the phase-change effect between crystalline and amorphous states. The composition of the recording layer is such that the marks cannot be erased or transformed back into an unrecorded state. The data can be read with a focused optical beam, using the phase-change effect as the reflective difference between amorphous and crystalline states. The beam accesses the recording layer through a thin transparent protective layer (cover sheet) on the disk surface.

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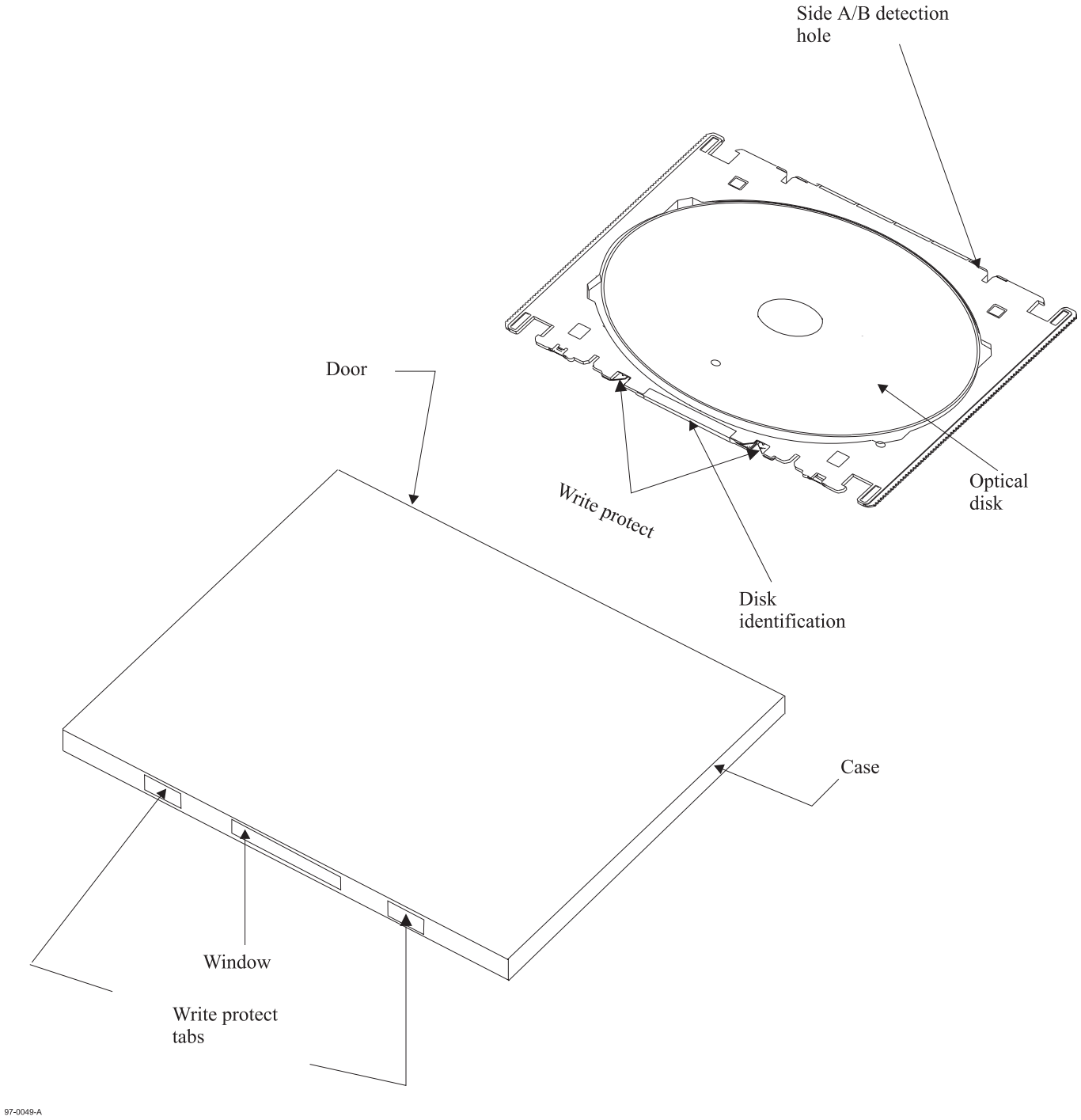


Figure 1 - Optical disk cartridge

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8 General requirements

8.1 Environments

8.1.1 Test environment

Unless otherwise specified, tests and measurements made on the ODC to check the requirements of this International Standard shall be carried out in an environment where the air immediately surrounding the ODC is within the following conditions.

temperature	: 23 °C ± 2 °C
relative humidity	: 45 % to 55 %
atmospheric pressure	: 75 kPa to 110 kPa
air cleanliness	: Class 100 000 (see annex A)
conditioning before testing	: 48 h min.

Before testing, the ODC shall be conditioned in this environment for 48 h minimum. No condensation on or in the ODC shall occur.

8.1.2 Operating environment

Optical disk cartridges used for data interchange shall be operated in an environment where the air immediately surrounding the optical disk and carrier is within the following conditions when the drive has reached its stable operating conditions.

temperature	: 10 °C to 50 °C
relative humidity	: 10 % to 80 %
wet bulb temperature	: 29 °C max.
atmospheric pressure	: 75 kPa to 110 kPa
temperature gradient	: 10 °C / h max.
relative humidity gradient	: 10 % / h max.
air cleanliness	: Class 100 000 (see annex A)

No condensation on or in the ODC shall be allowed to occur.

If an ODC has been exposed during storage and/or transportation to conditions outside those specified above, it shall be acclimatized in the operating environment for at least 2 h before use.

8.1.3 Storage environment

Storage environment is the ambient condition to which the ODC, without any additional protective enclosure, is exposed when stored.

8.1.3.1 Short-term storage

For a time of six consecutive weeks the optical disk cartridge within its specified shipping package shall not be exposed to the environmental conditions outside those given below.

temperature	: -20 °C to +55 °C
relative humidity	: 5 % to 90 %
wet bulb temperature	: 29 °C max.
atmospheric pressure	: 75 kPa to 110 kPa
temperature gradient	: 20 °C / h max.
relative humidity gradient	: 20 % / h max.

No condensation on or in the optical disk assembly shall be allowed to occur.

8.1.3.2 Long-term storage

For a storage period longer than six consecutive weeks the optical disk cartridge shall not be exposed to environmental conditions outside those given below.

temperature	: -10 °C to 50 °C
relative humidity	: 10 % to 90 %
wet bulb temperature	: 29 °C max.
atmospheric pressure	: 75 kPa to 110 kPa
temperature gradient	: 15 °C / h max.

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relative humidity gradient : 10 % / h max.
air cleanliness : Class 100 000 (see annex A)

No condensation on or in the optical disk cartridge shall be allowed to occur.

8.1.4 Transportation

This International Standard does not specify requirements for transportation but guidance is given in annex R.

8.2 Temperature shock

In the operating environment an ODC shall be capable of withstanding a thermal shock of up to 20 °C when inserted into, or removed from, the drive.

8.3 Safety requirements

The cartridge shall satisfy the safety requirements of Standard IEC 950 and its components shall not constitute any safety or health hazard when used in its intended manner or in any foreseeable use in an information processing system.

8.4 Flammability

The cartridge and its components shall be made from materials that comply with the flammability class for HB materials, or better, as specified in Standard IEC 950.

9 Reference Drive

The Reference Drive is a drive for which several critical components have well defined properties and which is used to test write and read parameters of the disk for conformance to this International Standard.

9.1 Optical system

The basic set-up of the optical system of the Reference Drive used for measuring the write and read parameters is shown in figure 2. Different components and locations of components are permitted, provided that the performance remains the same as that of the setup in figure 2. The optical system shall be such that the detected light reflected from the entrance surface of the disk is minimized so as not to influence the accuracy of the measurements.

a) Write and read wavelength : 680 nm ± 10 nm

b) Numerical aperture (NA) : 0,50 ± 0,01

c) Focused spot size in each dimension : 0,75 μm ± 0,04 μm

d) Wave front at recording layer : ≤ 0,045 rms

(through 90 μm thick coversheet)
and coma3 : ≤ | 0,10 | rms
and astig3 : ≤ | 0,13 | rms
and spher3 : ≤ | 0,10 | rms

where:

coma3 = third order coma aberration
astig3 = third order astigmatism aberration
spher3 = third order spherical aberration

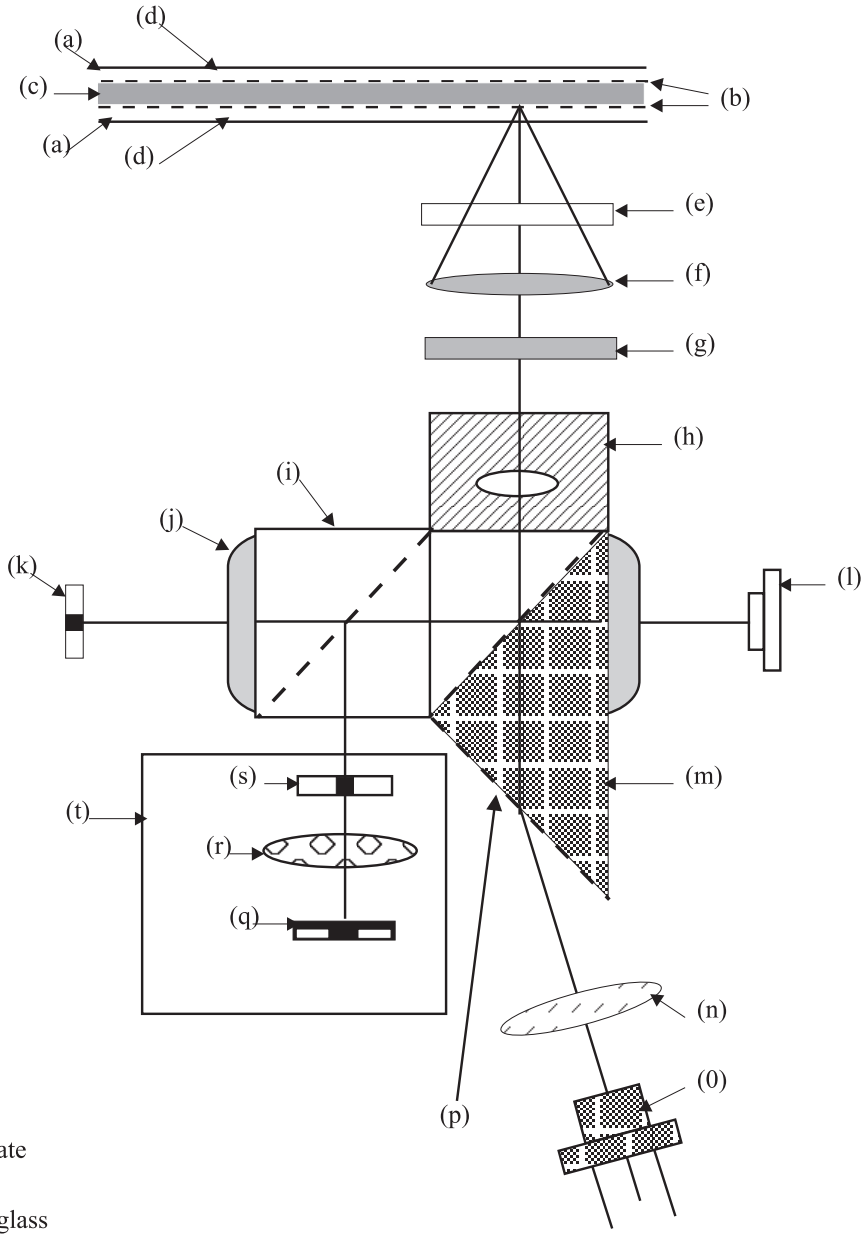
e) Polarization of the light: circular

f) Detection method:

- Reflected light collected by central aperture method
- Transitions detected by gated second derivative method

g) The data rate for testing shall be 30 Mega channel bits per second.

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(a) Cover sheet
(b) Recording layers
(c) Aluminum substrate
(d) air
(e) AR coated cover glass
(f) 0,50 NA objective lens in actuator
(g) 680 nm QWP
(h) Turning prism
(i) BS cube, RS = 0,25
(j) Cylinder lens
(k) RF / split cell phase tracking detector
(l) Front facet detector
(m) Achromatic beam expander / "leaky" polarization beamsplitter Rs = 1,0 Rp = 0,05
(n) Collimating lens
(o) SDL 680 nm 30 mW laser diode
(p) AR coating for p, all other surfaces coated for 670 to 700 nm
(q) Focus detector
(r) Assembly lens
(s) Dual prism
(t) Dual half-aperture focus detector

97-0050-A

Figure 2 - Optical system of the Reference Drive

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9.2 Read conditions

Marks on the disk shall be read from the disk with a constant optical power. The read power shall be = 1,0 mW.

9.3 Write conditions

Marks are written on the disk by pulses of optical power superimposed upon the read power. The pulse shape shall be as specified in annex L.

The write power is the optical power incident at the entrance surface when writing in the user area.

The write power shall be determined according to annex L.

The test patterns to be written shall be as specified in annex L.

9.4 Tracking

The tracking channel of the drive provides the tracking error signals to control the servos for the radial tracking of the optical beam.

9.5 Rotation of the disk

The direction of rotation shall be counterclockwise for side A and clockwise for side B as seen from the optical head of the disk drive.

Section 2 - Mechanical and physical characteristics

10 Dimensional and mechanical characteristics of the case

10.1 General (figures 1, 3, 4, and 9)

The case contains the 356 mm optical disk which is captured within the carrier. The case provides the optical disk and carrier sub-assembly protection from contaminants and during human handling. (see figure 1)

The case shall enclose the carrier and optical disk at all times when they are external to a disk drive or automated library storage equipment.

Any case shall be interchangeable with any carrier.

The case shall be a rigid, protective enclosure of rectangular shape and include a means for positioning and retaining the carrier and optical disk.

The case shall have write protect tabs that interface with the carrier and the tabs shall also be accessible for manual enable or inhibit (see figure 3).

The case shall have an access door for automated unload and load of the carrier and optical disk (see figure 4).

The case shall have a window for viewing the label on the end of the carrier and the case shall have areas provided for manufacturer labels (see figure 3).

The case shall provide drive/backup roller surfaces for disk drive cartridge load and unload operations (see figure 9).

10.2 Case drawings

The case is represented schematically in the following drawings.

Figure 1	shows a typical optical disk cartridge,
Figure 3	shows the case bottom surface,
Figure 4	shows the case top surface,
Figure 5	shows the case write protect tabs,
Figure 6	shows the case overall dimensions,
Figure 7	shows the case door opener force location,
Figure 8	shows the case window location,
Figure 9	shows the case autoload drive surfaces.

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10.3 Relationship of sides and interface with carrier

10.3.1 Relationship of sides

The case shall be interchangeable with any carrier and shall accept a carrier with either Side A up or Side B up.

10.3.2 Interface with carrier

The case shall mechanically retain the carrier and optical disk sub-assembly. The case shall allow the carrier and optical disk sub-assembly to be loaded and unloaded through the case door.

10.3.3 Write protect features (figure 5)

The case shall have write-protect features to interface with the carrier. Side A of the optical disk shall be down and write-protected under the following conditions:

a) The letter "A" is correctly seen on the carrier label when viewed through the case window.

b) The left-hand write protect tab is positioned so that the arrow on the tab is in alignment with the arrow on the case.

c) The carrier write protect feature blocks the write protect holes in the carrier (see 11.11).

d) The write protect mode selected shall remain with the carrier when loaded into a disk drive and the case is removed from the disk drive.

e) The case write protect tabs shall be automatically moved into the position that is consistent with the carrier write protect mode when the carrier and optical disk sub-assembly is reloaded into a case.

10.4 Materials

The case shall be constructed from any suitable materials such that it meets the requirements of this International Standard.

10.5 Mass

The total mass of the empty case shall be less than 1,5 kg.

10.6 Case dimensions

10.6.1 Overall dimensions of the case (figure 6)

The length, width, and height of the case shall be:

L_1 = 443,76 mm ± 1,50 mm

L_2 = 421,84 mm ± 0,64 mm

L_3 = 25,40 mm ± 0,51 mm

10.6.2 Opening force of the case door (figure 7)

The case door shall be opened by a force applied at the following locations:

L_4 = 35,81 mm ± 3,2 mm

L_5 = 12,70 mm ± 1,5 mm

The opening force shall be:

F_1 = 7,50 N min.

10.6.3 Location of the case window (figure 8)

The location of the case window from case side shall be:

L_6 = 151,0 mm ± 0,64 mm

The width of the window shall be:

L_7 = 101,0 mm min.

The location of the window from the case top or bottom surface shall be:

L_8 = 6,35 mm ± 0,25 mm

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The height of the window shall be:

L_9 = 12,50 mm min.

10.6.4 Case write protect tabs (figure 5)

A case write protect tab shall be enabled when an arrow on the tab is in alignment with an arrow on the case. The write protect conventions are specified in 10.3.3.

10.6.5 Case autoload drive surfaces (figure 9)

The drive roller surface location on the top and bottom case surfaces from the case side shall be:

L_{10} = 9,65 mm ± 0,51 mm

The width of the roller surface of the drive shall be:

L_{11} = 38,10 mm max.

The force exerted on drive roller surface by the drive roller shall be:

F_2 = 62,30 N max.

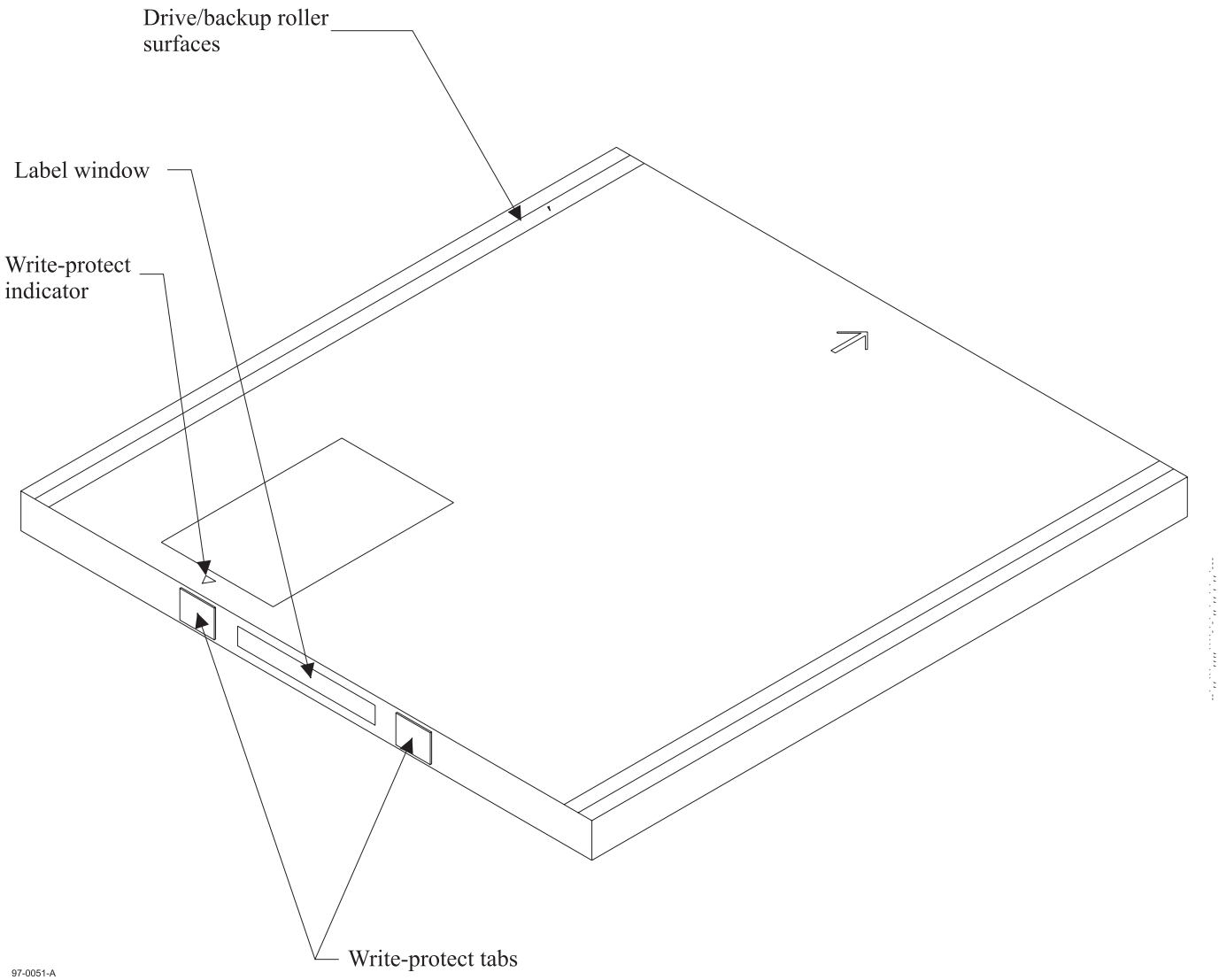


Figure 3 - Bottom surface of the case

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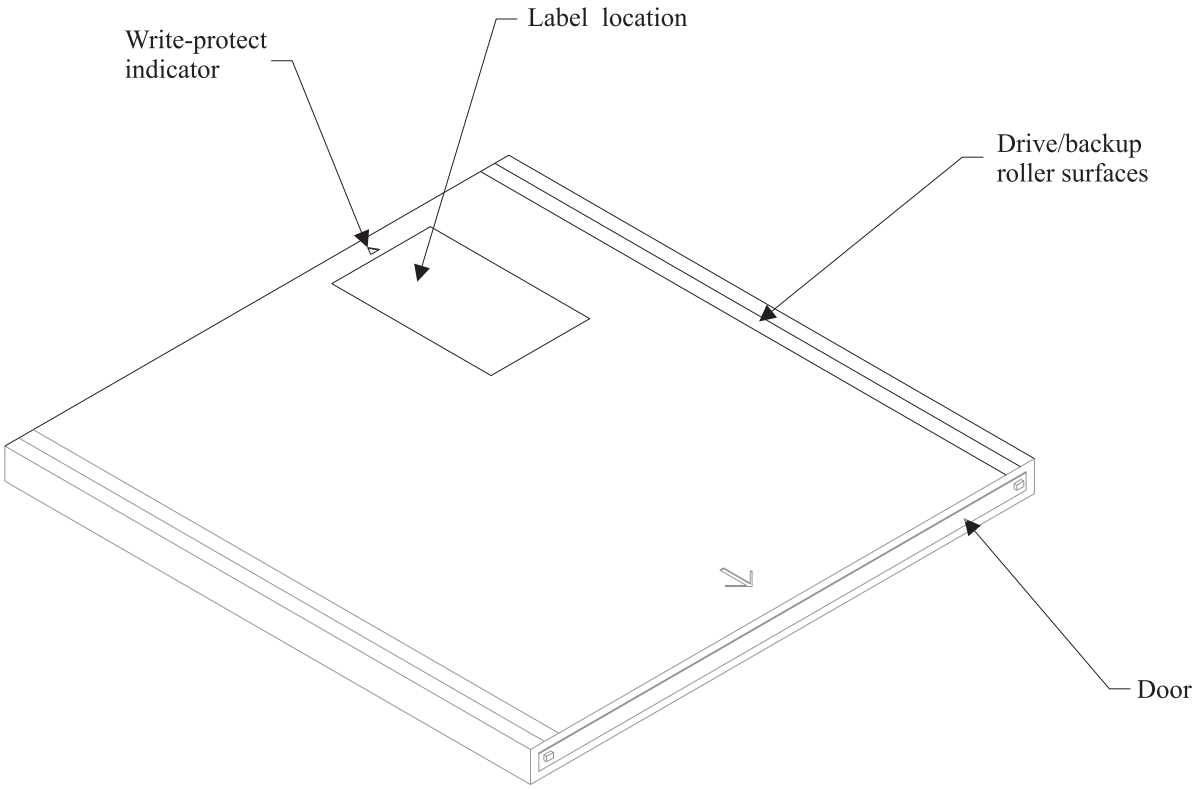


Figure 4 - Top surface of the case

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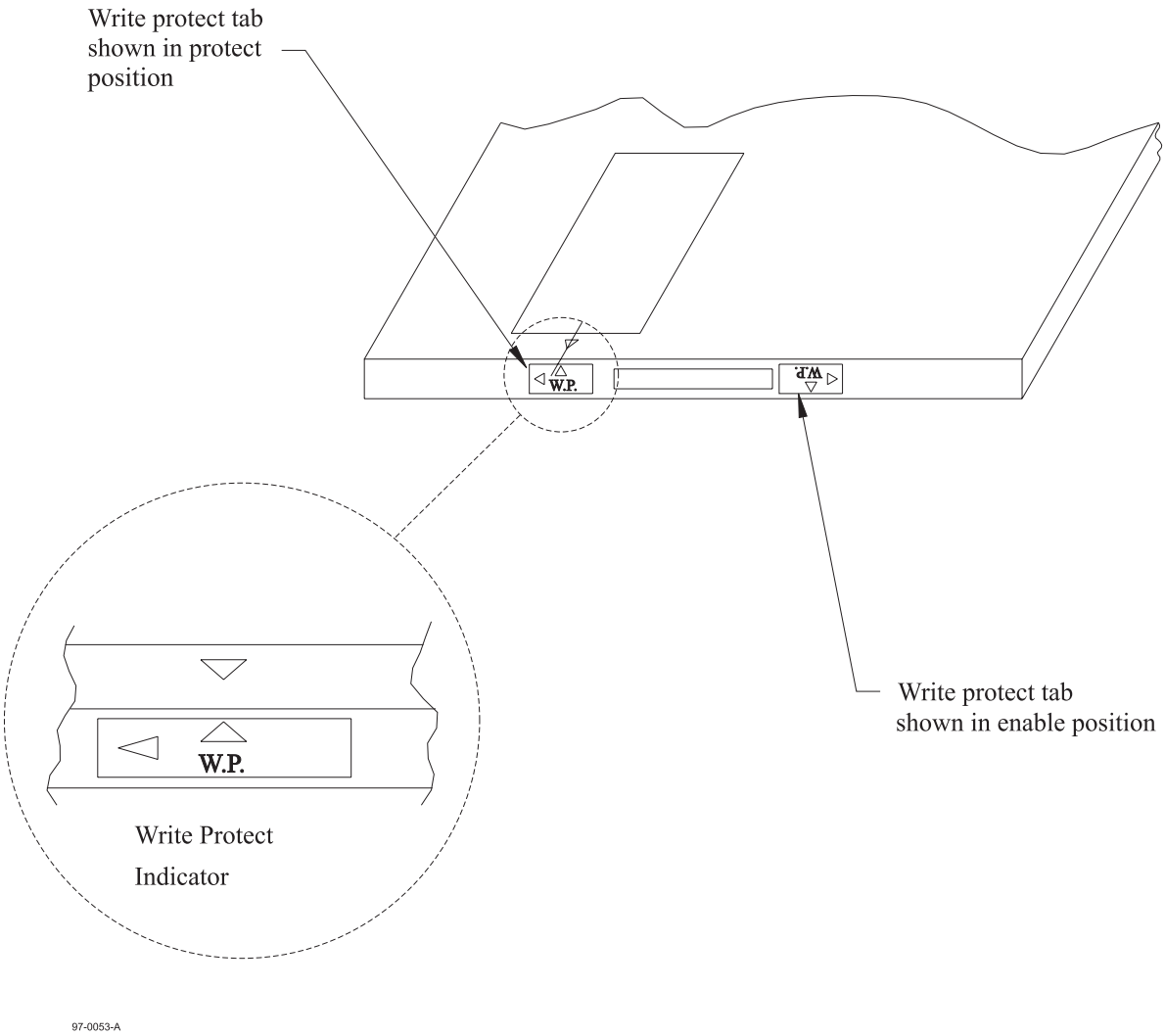


Figure 5 - Write-protect tabs

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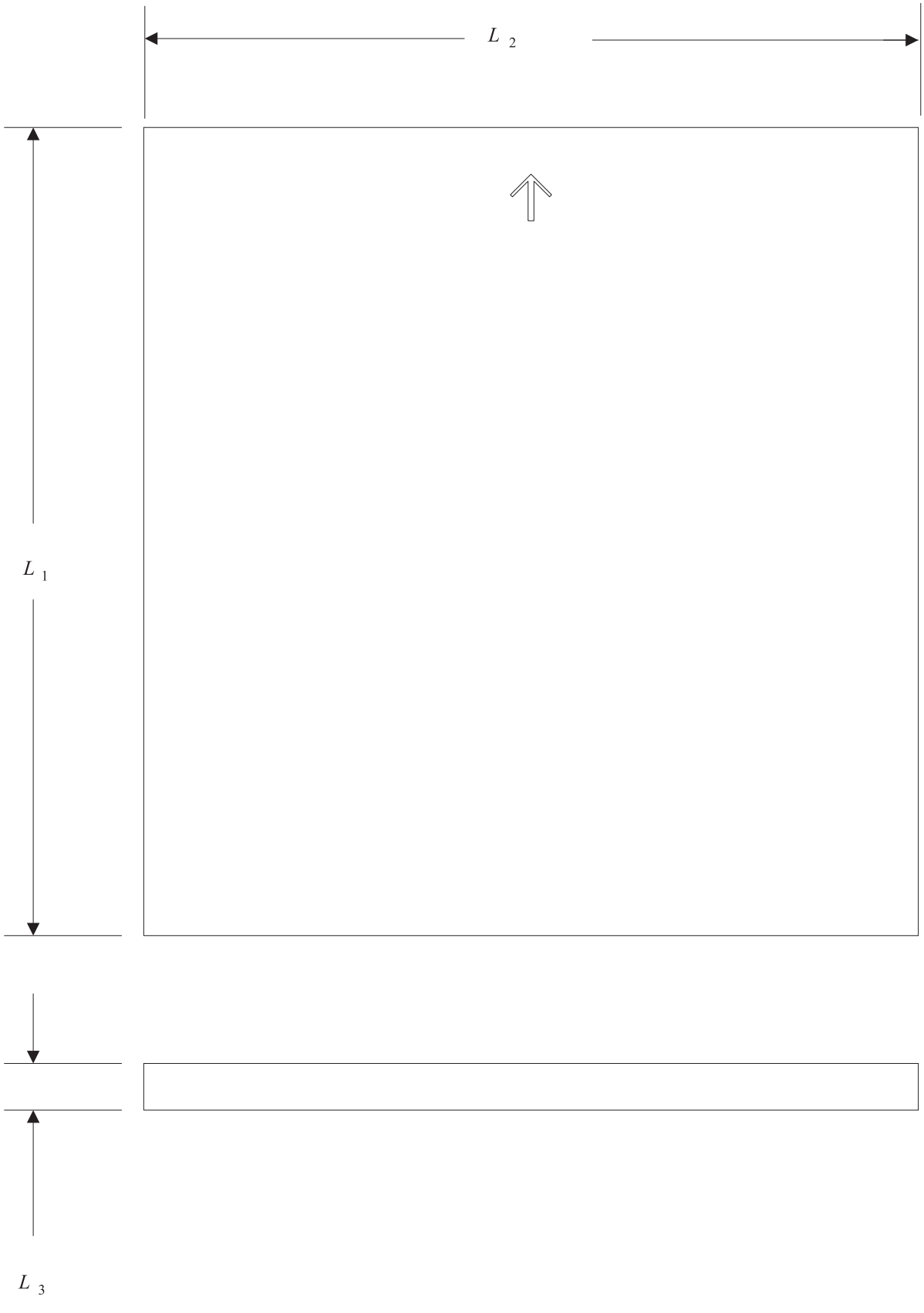


Figure 6 - Overall dimensions of the case

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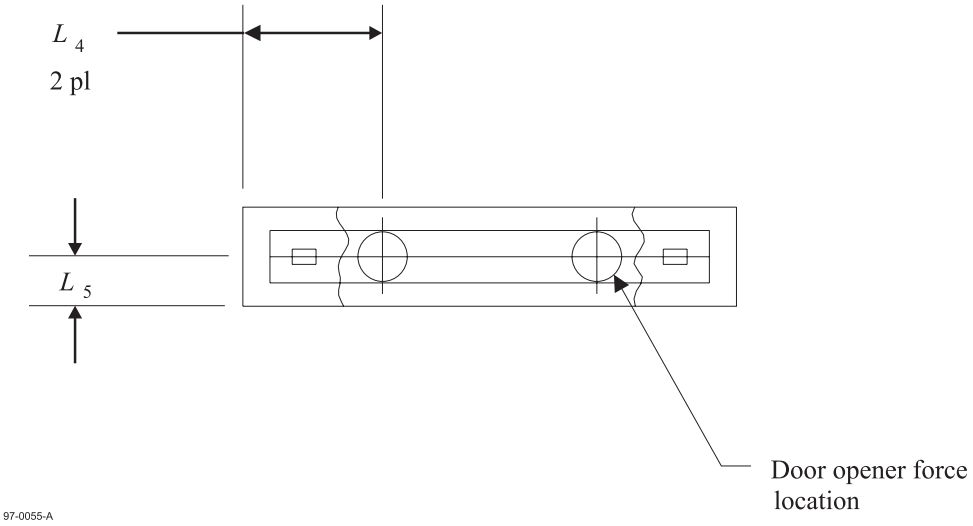


Figure 7 - Door opener force location

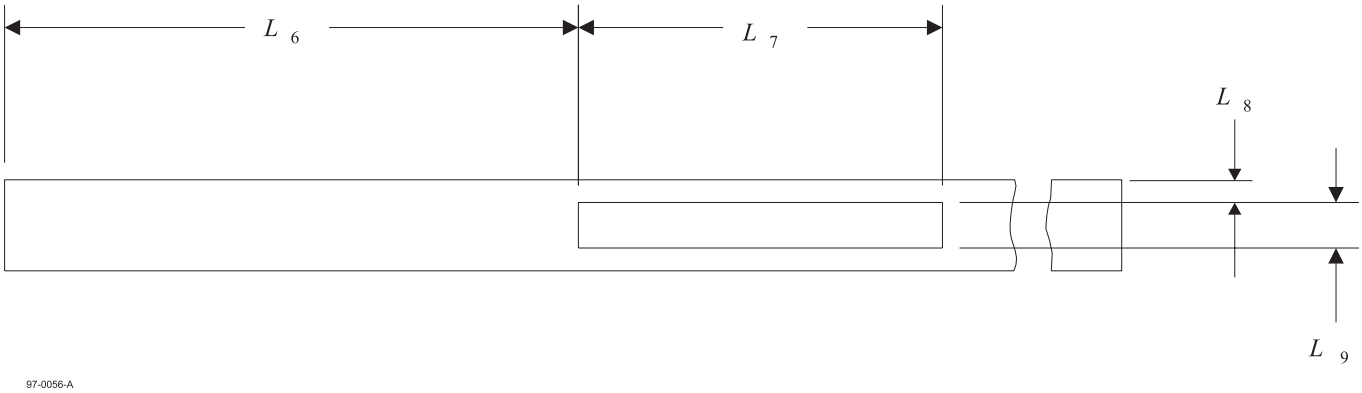


Figure 8 - Window location

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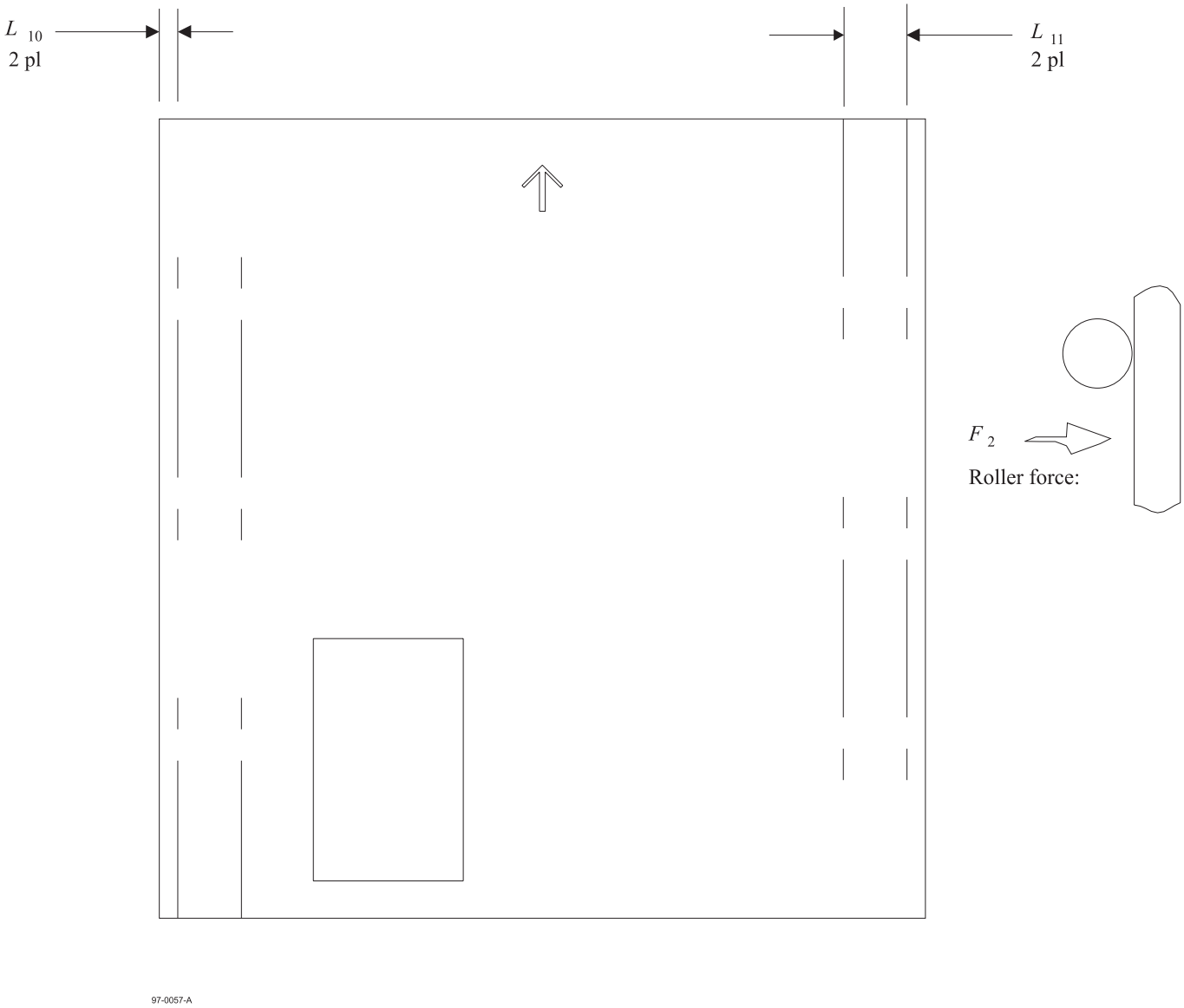


Figure 9 - Autoload drive surfaces of the case

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11 Dimensional and mechanical characteristics of the carrier

11.1 General (figure 10)

The function of the carrier is to capture and retain the optical disk and to provide the interface with optical disk drives and automated library storage equipment.

The carrier shall be capable of supporting and retaining an optical disk while being manipulated or moved to any position during transportation or storage in a case, during load into and unload from a disk drive and while being moved by automated library storage devices.

The carrier and optical disk shall be permanently mated and are interchangeable as a sub-assembly. The optical disk is separated from the carrier only when the disk is mounted on the disk drive spindle.

The carrier shall provide symmetry for optical disk centreline location regardless of the orientation of the optical disk and carrier sub-assembly in the disk drive.

Both the carrier label end and the opposite end shall be able to be inserted into the storage cells of automated library storage equipment with Side A either up or down.

Both the carrier label end and the opposite end shall be able to be inserted into a disk drive incorporated within automated library storage equipment with Side A either up or down.

The carrier shall enable release of the optical disk by the disk drive during loading of the optical disk on to the disk drive spindle. The four carrier latch release holes provide the interface to the disk drive for applying a force F_3 to unlatch the carrier and to release the disk.

The carrier latch points, locator pin slots, and latch release holes in conjunction with the disk drive's carrier and disk handling devices shall enable the disk drive to maintain a common centreline between the disk and the disk drive spindle during disk release from the carrier and during disk centring and clamping to the disk drive spindle.

The separated carrier and the spindle mounted and clamped optical disk shall allow unobstructed access to the recording zone by a recording head scanning in from the outer edge.

The mating carrier shall recapture the optical disk upon dismount of the optical disk from the spindle by the disk drive.

The carrier label shall indicate the optical disk Side A and Side B and the proper orientation shall be maintained between the optical disk side and the carrier label.

The main elements of the carrier are tooth racks, latch points, locator pin slots, Side A and Side B hole, write protect holes, latch release holes, disk type sensor notches, disk capacity hole, and a label area.

11.2 Carrier drawings

The carrier is represented schematically by the following drawings:

Figure 10	shows a typical carrier,
Figure 11	shows the optical disk centre location in the carrier,
Figure 12	shows the carrier dimensions,
Figure 13	shows the write protect definition,
Figure 14	shows the side A and side B sensor hole and disk capacity sensor hole,
Figure 15	shows the carrier location within the case,
Figure 16	shows the carrier locator slot locations when the carrier is inside the case,
Figure 17	shows carrier latch point locations when the carrier is inside the case,
Figure 18	shows carrier latch release hole locations,
Figure 19	shows the unlatched carrier latch release hole locations when the optical disk is released,
Figure 20	shows carrier locator pin slot locations,
Figure 21	shows the carrier label location,
Figure 22	shows the carrier label.

11.3 Sides, reference axes and reference planes

11.3.1 Relationship between Side A and Side B (figure 10)

The carrier label shall indicate the optical disk Side A and Side B and the proper orientation shall be maintained between the optical disk side and the carrier label.

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The Side A of the optical disk shall face downwards when the carrier label Side A is correctly seen when viewed through the case window.

11.3.2 Reference axes and reference features (figure 13)

Datum A is the top or bottom carrier rail surface. Datum B consists of carrier latch points. Datum C is a carrier locator pin slot. The two carrier latch points at either end of the carrier define the datum B dependent upon which carrier end is inserted first into automated library storage equipment. Any one of the four locator pin slots defines the C datum dependent upon carrier orientation.

11.4 Materials

The carrier shall be constructed from any suitable materials such that it meets the requirements of this International Standard.

11.5 Mass

The mass of the carrier without the optical disk shall not exceed 600 g.

11.6 Location of the optical disk centre in the carrier (figure 11)

The carrier shall locate the optical disk centre with respect to the carrier latch points and the carrier locator pin slot as follows:

L_{12} = 199,42 mm ± 0,51 mm

L_{13} = 112,98 mm ± 0,51 mm

11.7 Overall dimensions of the carrier (figure 12)

The overall length of the carrier shall be:

L_{14} = 423,62 mm ± 0,90 mm

The overall width of the carrier shall be:

L_{15} = 406,25 mm ± 0,51 mm

The width of the carrier guide rail shall be:

L_{16} = 396,14 mm ± 0,51 mm

The location of the carrier lead edge from datum B shall be:

L_{17} = 12,40 mm ± 0,25 mm

The width of the carrier lead edge shall be:

L_{18} = 5,08 mm ± 0,25 mm

The length of the carrier lead edge shall be:

L_{19} = 70,60 mm min.

The location of the lead edge from datum C shall be:

L_{20} = 44,50 mm max.

11.8 Cutouts (figure 12)

The carrier shall have cutouts to provide clearance for disk drive devices for handling of the optical disk during spindle mounting and dismounting operations.

The location of the cutouts shall be:

L_{21} = 102,40 mm min.

L_{22} = 87,60 mm min.

L_{23} = 68,80 mm max.

L_{24} = 172,0 mm min.

The cutout angle shall be:

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A_1 = 30 ° max.

11.9 Carrier latch points and latch actuation force (figure 12)

The carrier latch point location from datum C shall be:

L_{25} = 56,13 mm ± 0,36 mm

L_{26} = 282,09 mm ± 0,36 mm

The carrier length when the carrier is unlatched and the disk is released shall be:

L_{27} = 438,56 mm ± 1,12 mm

The carrier latch actuation force is applied at the carrier latch release holes as indicated in figure 11. The latch actuation force shall be:

F_3 = 18,0 N min.

11.10 Carrier guide rails and carrier thickness (figure 12)

The carrier features a guide rail on each side for interface with disk drive and automated library carrier handling devices.

The rail lead in angle shall be:

A_2 = 30 ° ± 2 °

The depth of the rail shall be:

L_{28} = 2,92 mm ± 0,13 mm

The pitch of the rail teeth shall be:

L_{29} = 5,08 mm ± 0,25 mm

The clearance of the rail teeth shall be:

L_{30} = 1,27 mm ± 0,13 mm

Except the lead tooth, all teeth shall have a flat top surface:

L_{31} = 1,27 mm ± 0,25 mm

The location of the lead tooth shall be:

L_{32} = 6,22 mm ± 0,25 mm

The location of the lead tooth on one rail relative to the location of the lead tooth on the other rail shall be within ± 0,76 mm.

The flat surface of the lead tooth shall be:

L_{33} = 0,51 mm ± 0,13 mm

The angle of the flanks of the teeth with the rail shall be rounded off by a radius:

R_1 = 0,38 mm ± 0,25 mm

The angle formed by the flanks of two adjacent teeth shall be:

A_3 = 50° ± 2°

The end surfaces of the rail shall be rounded off by a radius:

R_2 = 3,175 mm ± 0,500 mm

Tooth profile tolerances shall not be cumulative.

The thickness of the carrier rail shall be:

L_{34} = 3,81 mm ± 0,13 mm

The carrier thickness shall be:

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L_{35} = 10,29 mm max.

The disk drive force on the carrier rail shall be applied to the carrier rail as indicated in figure 11 and shall be:

F_4 = 9,0 N min.

11.11 Carrier write protect hole (figure 13)

The five write protect holes are located from the carrier centreline and datum C. When the carrier is unlatched and the optical disk is released and clamped to the spindle, the locations shall be:

L_{36} = 193,70 mm ± 0,51 mm

L_{37} = 201,65 mm ± 0,51 mm

L_{38} = 209,60 mm ± 0,51 mm

L_{39} = 204,52 mm ± 0,51 mm

L_{40} = 21,44 mm ± 0,51 mm

The diameter of the five write protect holes shall be:

D_1 = 6,10 mm min.

The "A label side" shall have three holes and the "B label side" shall have only two holes as shown in figure 13.

11.12 25 Gbyte capacity sensor hole (figure 14)

The sensor hole shall be located opposite to the write protect carrier end to enable the disk drive to sense that the disk is a 25 Gbyte disk.

The design centre for the hole diameter and the location from the carrier latch (datum B) and datum C shall be:

D_2 = 6,10 mm min.

L_{41} = 16,51 mm ± 0,51 mm

L_{40} = 21,44 mm ± 0,51 mm

The "A label side" shall have a hole but the corresponding "B label side" position shall not have a hole as shown in figure 14.

No hole shall mean that the ODC is 14,8 Gbyte capacity.

11.13 Carrier Side A or Side B sensor hole (figure 14)

A sensor hole shall be located opposite to the write protect carrier end to enable the disk drive to sense Side A and Side B of the optical disk.

The design centre for the hole diameter and the location from the carrier latch point (datum B) and the carrier location pin slot (datum C) shall be:

D_3 = 6,10 mm min.

L_{42} = 2,24 mm

L_{43} = 204,52 mm

True position shall be within a circle of diameter 0,38 mm at maximum material condition.

The sensor hole shall be open when Side A is down in the carrier and the carrier label A is correctly seen through the case window.

11.14 Carrier disk type sensor notches (figure 14)

Two notches shall be located on each end of the carrier used to capture an optical disk with a 1,2 mm thick protective layer construction. Notches shall not be present or shall be blocked on carriers used to capture an optical disk with a 90 µm thick protective layer.

Note - These notches enable backwards compatibility with ISO/IEC 10885 that allowed both types of disc construction.

The location and size of the notches shall be as follows:

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L_{44} = 59,28 mm ± 0,50 mm

L_{45} = 166,67 mm ± 0,50 mm

L_{46} = 9,53 mm ± 0,50 mm

L_{47} = 6,05 mm ± 0,50 mm

11.15 Carrier location within the case (figure 15)

The carrier shall be located as follows within the case to enable interface with the disk drive, case and carrier handling devices:

The carrier bottom edge to case rail support surface shall be:

L_{48} = 3,80 mm max.

The case rail support location from the case top or bottom surface shall be:

L_{49} = 10,50 mm ± 1,27 mm

11.16 Carrier locator pin slot characteristics and location within the case (figure 16)

The four carrier locator pin slots, when the carrier is in the latched position within the case, shall be positioned from the case side as follows:

L_{50} = 97,94 mm ± 2,25 mm

The carrier registration edge location from the door end of the case shall be:

L_{51} = 21,51 mm max.

The four carrier locator pin slots depth shall be:

L_{52} = 18,60 mm max.

The four carrier locator pin slots width shall be:

L_{53} = 5,46 mm ± 0,05 mm

The carrier locator pin slot lead in location shall be:

L_{54} = 3,45 mm ± 0,13 mm

The carrier locator pin slot lead in angle shall be:

A_4 = 34° ± 6°

11.17 Carrier latch point location when the carrier is inside the case (figure 17)

The carrier latch points at the case door end enable the disk drive to secure the carrier allowing separation and retraction of the case.

The carrier rail to case edge shall be:

L_{55} = 11,96 mm ± 0,38 mm

The carrier latch point location from the case side shall be:

L_{56} = 41,81 mm ± 1,85 mm

The distance between carrier latch points shall be:

L_{57} = 338,23 mm ± 0,76 mm

The latched carrier location from the door end of the case shall be:

L_{58} = 29,21 mm max.

The carrier latch point clearance shall be:

L_{59} = 22,90 mm min.

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The carrier latch point width shall be:

L_{60} = 5,28 mm ± 0,25 mm

The carrier latch clearance shall be:

L_{61} = 17,45 mm ± 0,63 mm

Carrier separation and reinsertion resistance forces shall be 22 N max.

11.18 Carrier latch release hole locations (figure 18)

The carrier latch release hole locations from datum B shall be:

L_{62} = 50,72 mm min.

L_{63} = 37,77 mm max.

L_{64} = 348,87 mm max.

L_{65} = 360,30 mm min.

The carrier latch release hole locations from datum C shall be:

L_{66} = 24,26 mm max.

L_{67} = 33,91 mm min.

L_{68} = 250,47 mm max.

L_{69} = 259,61 mm min.

A clearance for an optional carrier latch-lock feature is required. Such a feature shall be retractable upon contact with disk drive release pins. The required clearance shall be:

L_{70} = 3,38 mm max.

The carrier latch release hole angle shall be:

A_5 = 30° ± 2°

11.19 Carrier latch release hole locations for unlatched carrier (figure 19)

The pair of carrier latch release holes at the write protect end of the carrier are a greater distance from the pair of release holes at the other end of the carrier when the carrier is unlatched to release the disk. The distance shall be:

L_{71} = 339,725 mm ± 0,510 mm

11.20 Location of carrier locator pin slots (figure 20)

The carrier locator pin slots are datum C.

The carrier edge location from datum C shall be:

L_{72} = 85,09 mm ± 0,25 mm

The distance between locator pin slots shall be:

L_{73} = 225,95 mm ± 0,25 mm

The carrier locator pin slot lead in shall be located from the latch point as follows:

L_{74} = 7,32 mm ± 0,38 mm

11.21 Carrier label location (figure 21)

The carrier label shall be located on the write protect end of the carrier as follows:

L_{75} = 78,49 mm ± 1,52 mm

L_{76} = 12,07 mm ± 1,52 mm

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11.22 Carrier label (figure 22)

The carrier label size shall be as follows:

L_{77} = 78,0 mm max.

L_{78} = 22,61 mm max.

11.23 Carrier label characteristics (figure 22)

Field 1 shall be the Side A designator. Field 2 shall be the Side B designator.

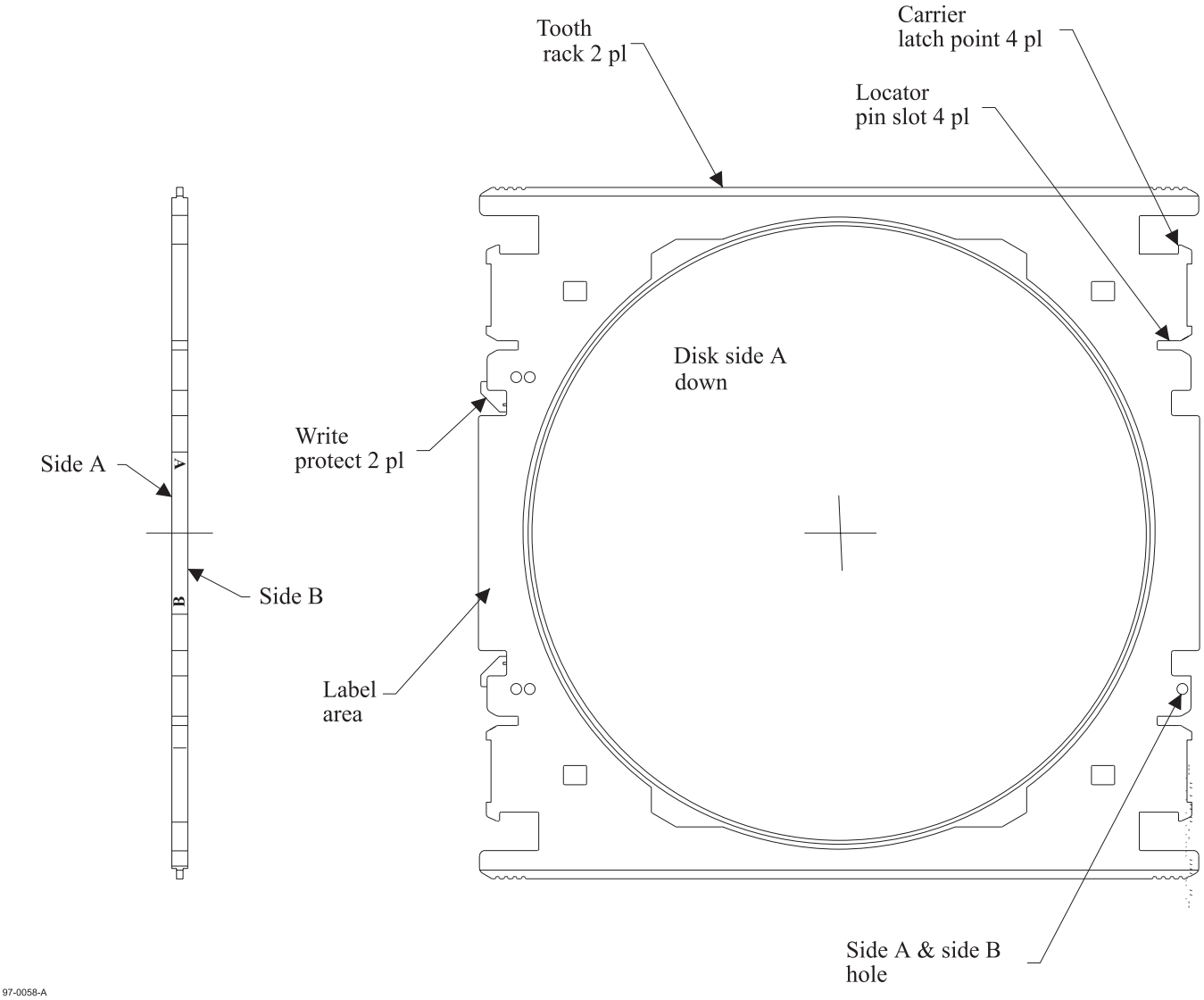


Figure 10 - Typical carrier

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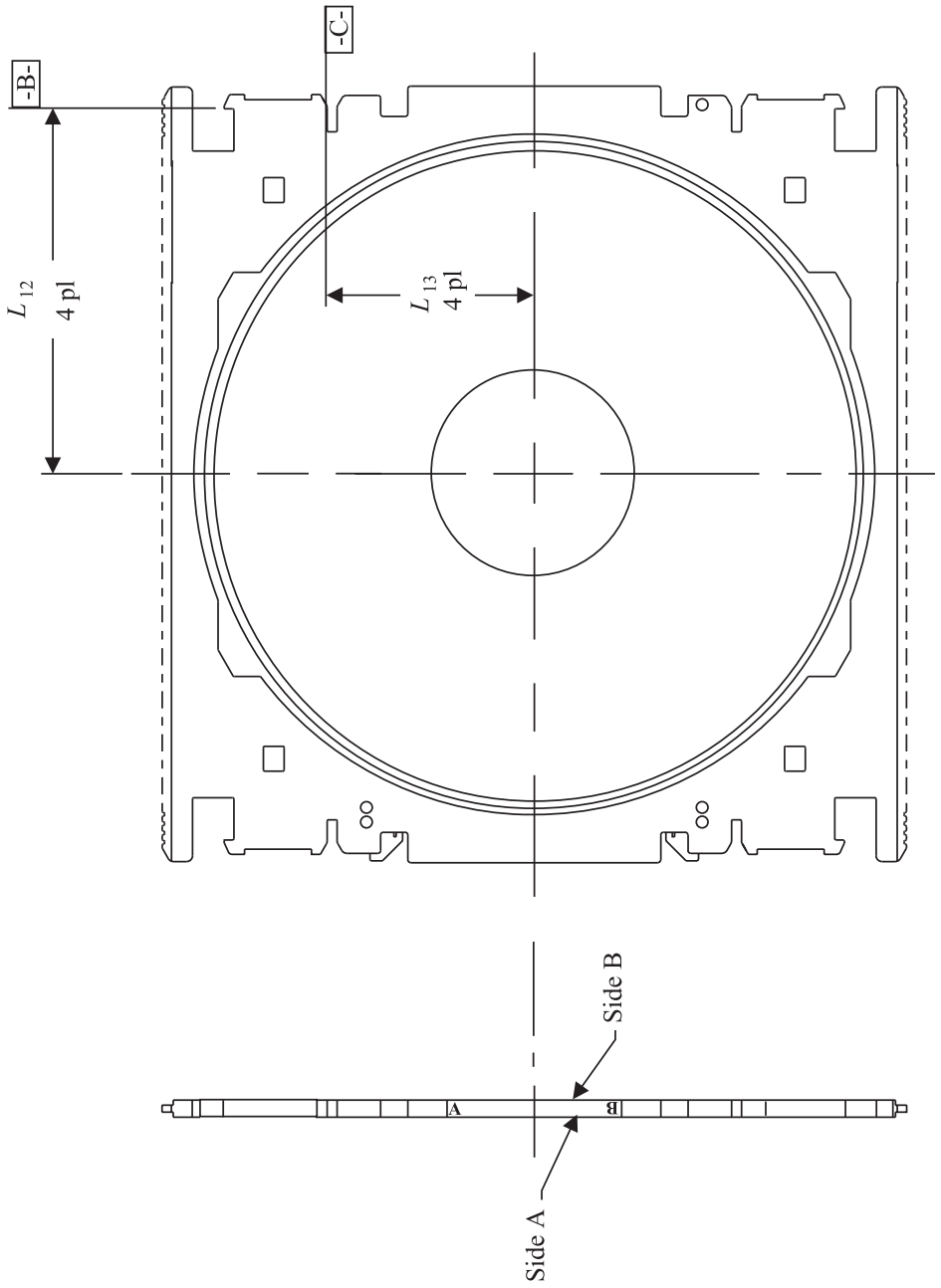


Figure 11 - Optical disk centre location in carrier

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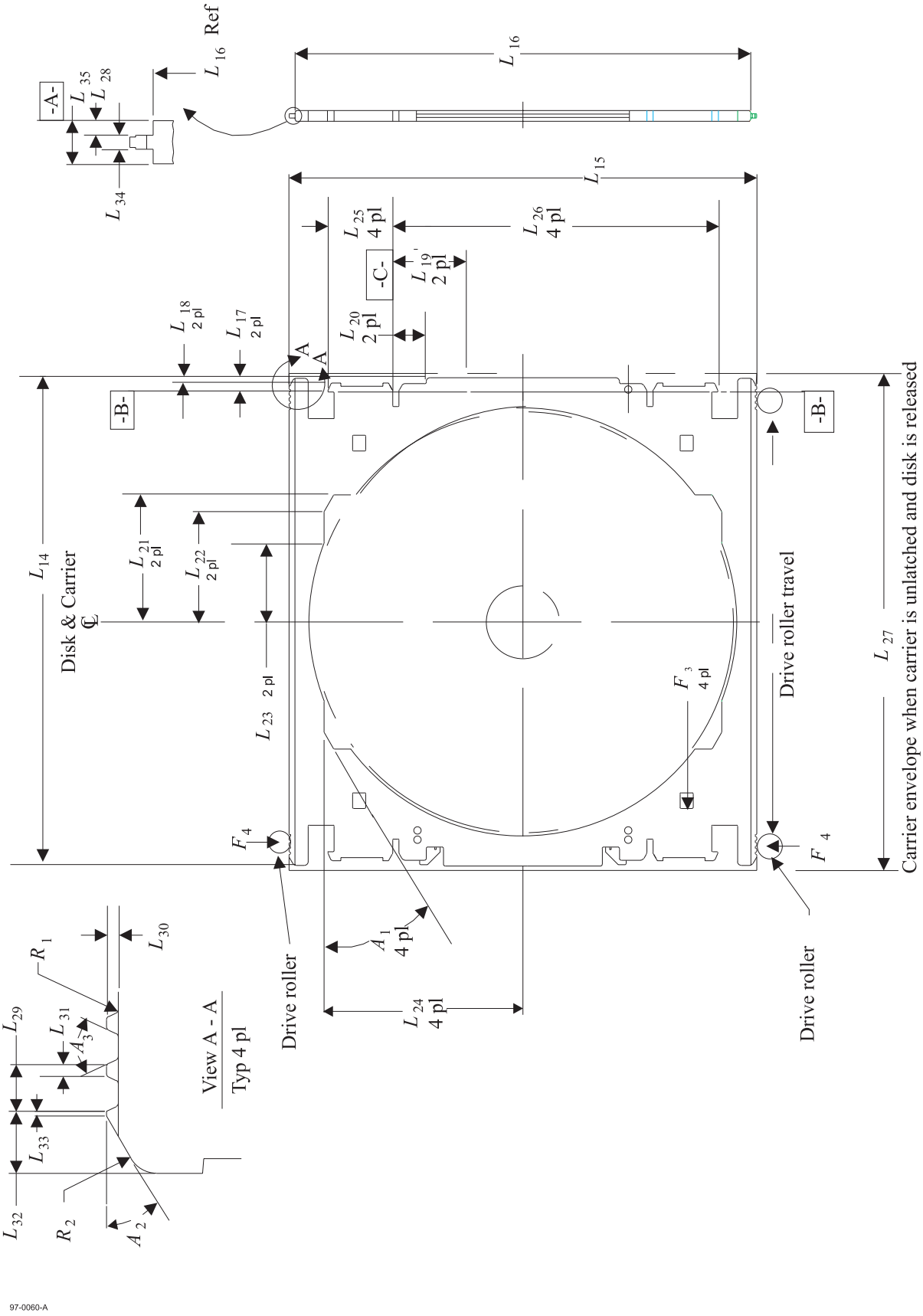


Figure 12 - Carrier dimensions

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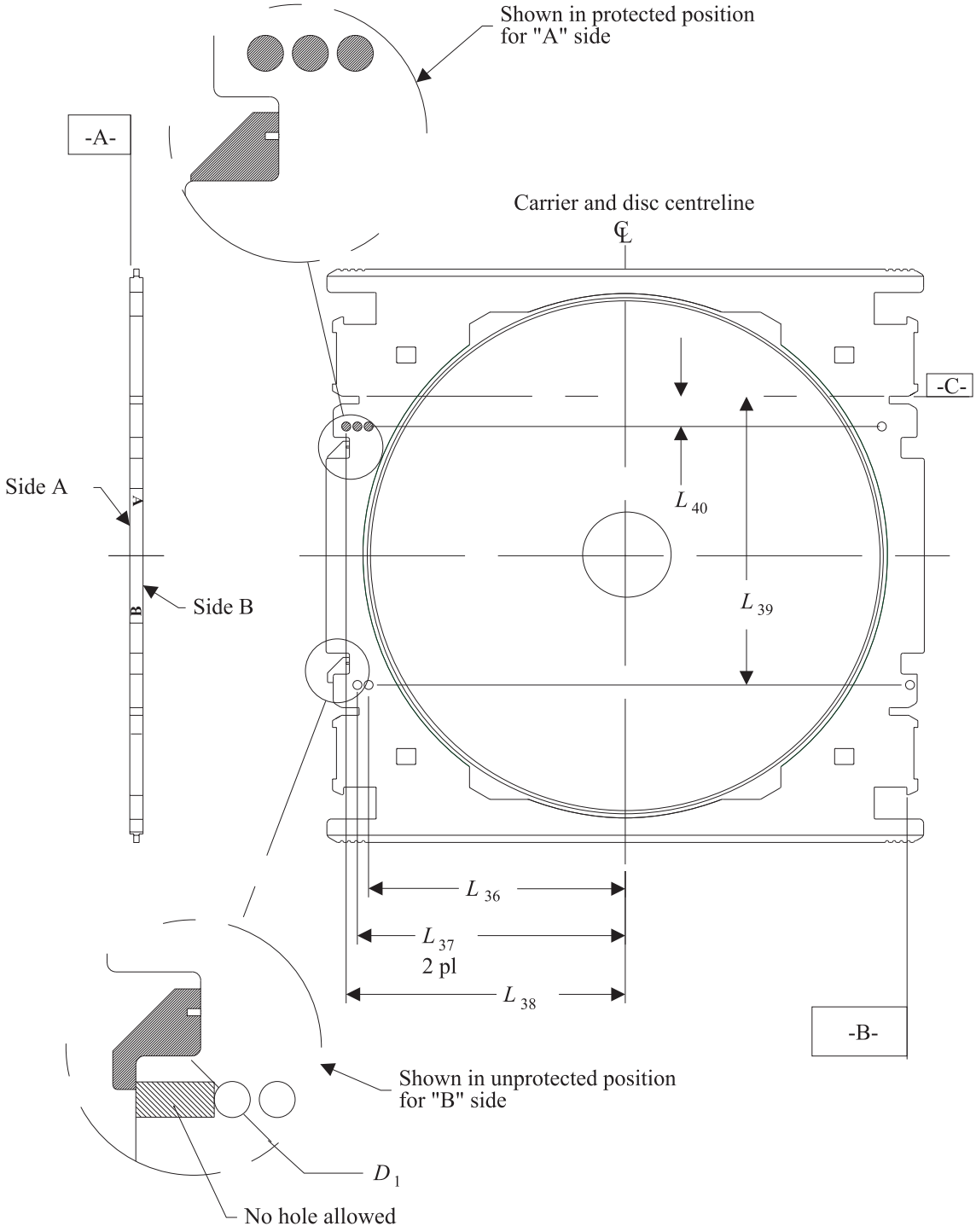


Figure 13 - Write protect definition carrier unlatched, disk clamped

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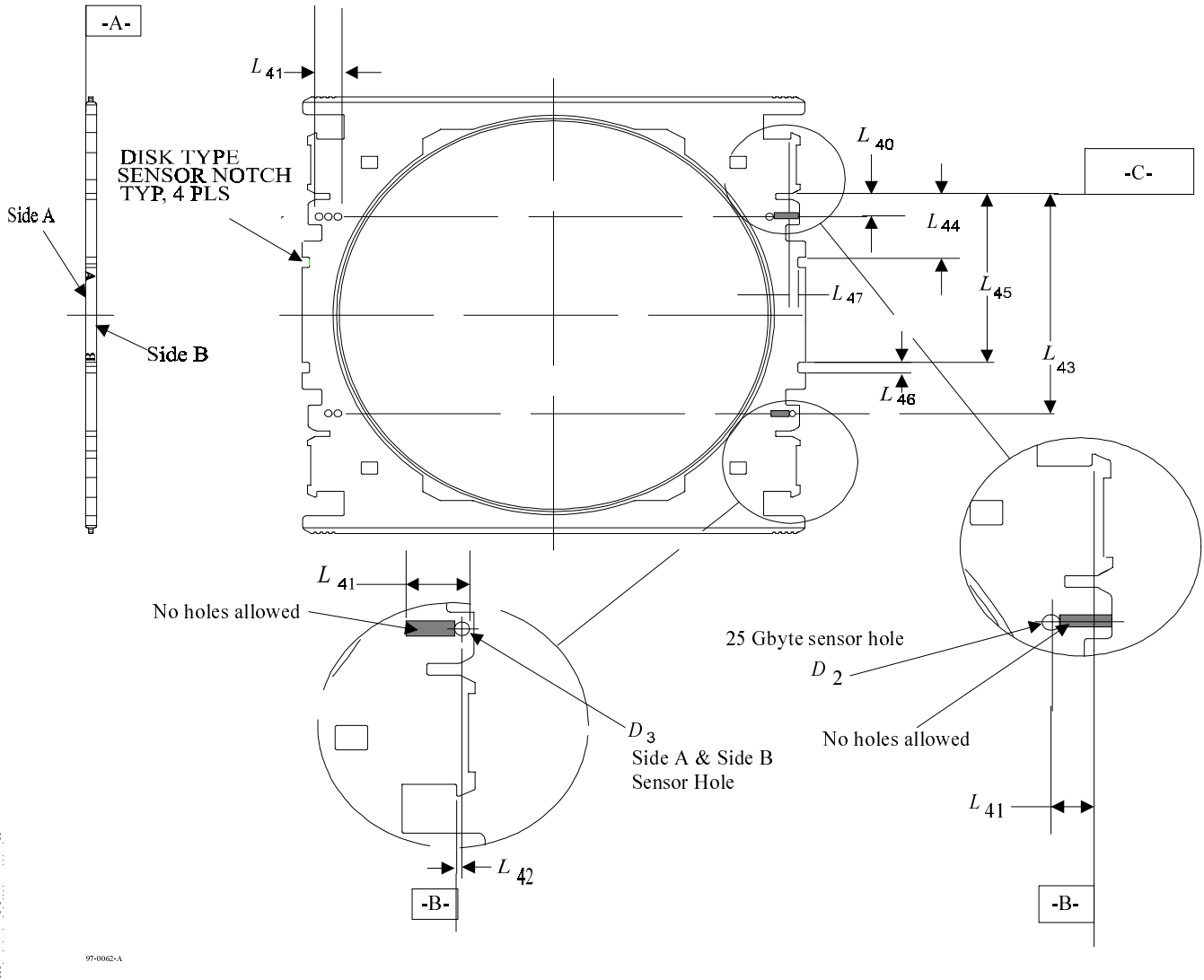
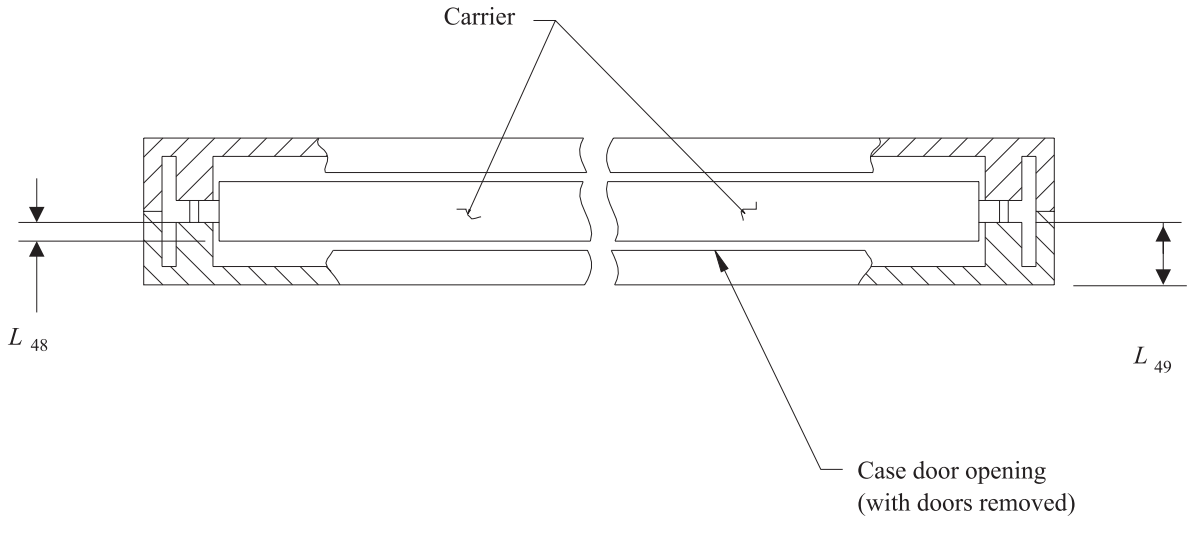


Figure 14 - Side A and Side B sensor hole, disk type sensor notches, and disk capacity sensor hole



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Figure 15 - Carrier location within case

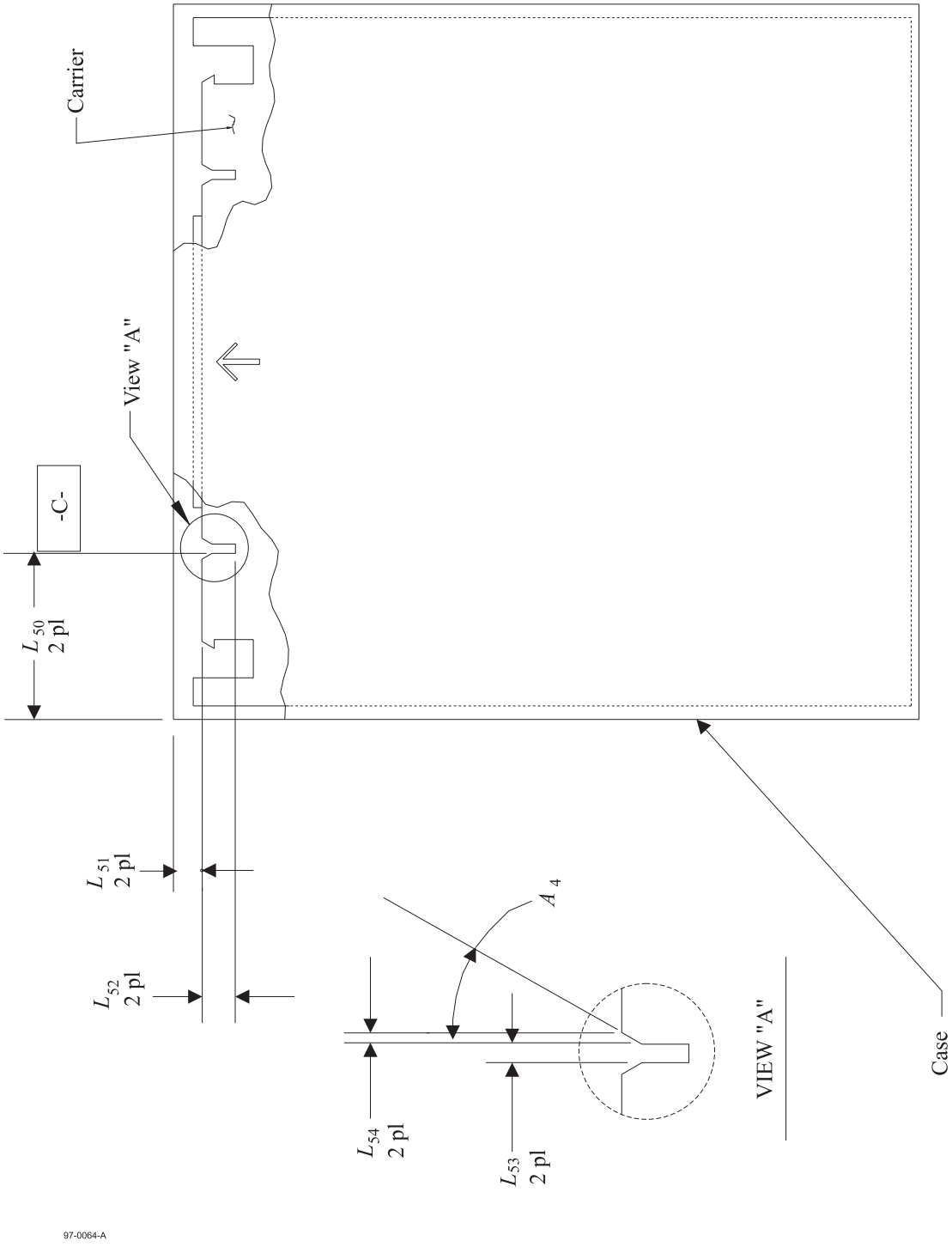


Figure 16 - Carrier locator slot locations (when carrier is inside case)

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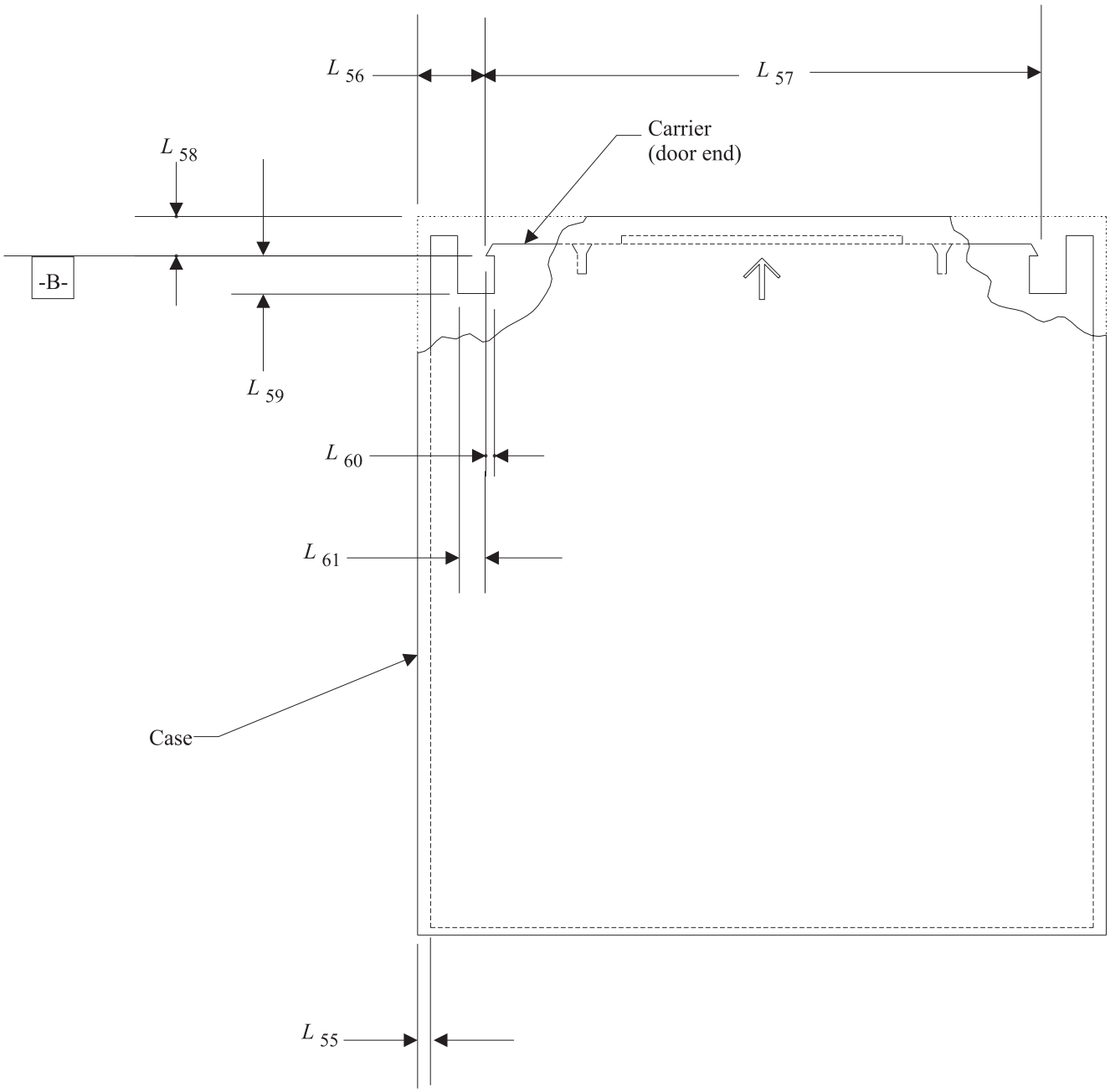


Figure 17 - Carrier latch point locations (when carrier is inside case)

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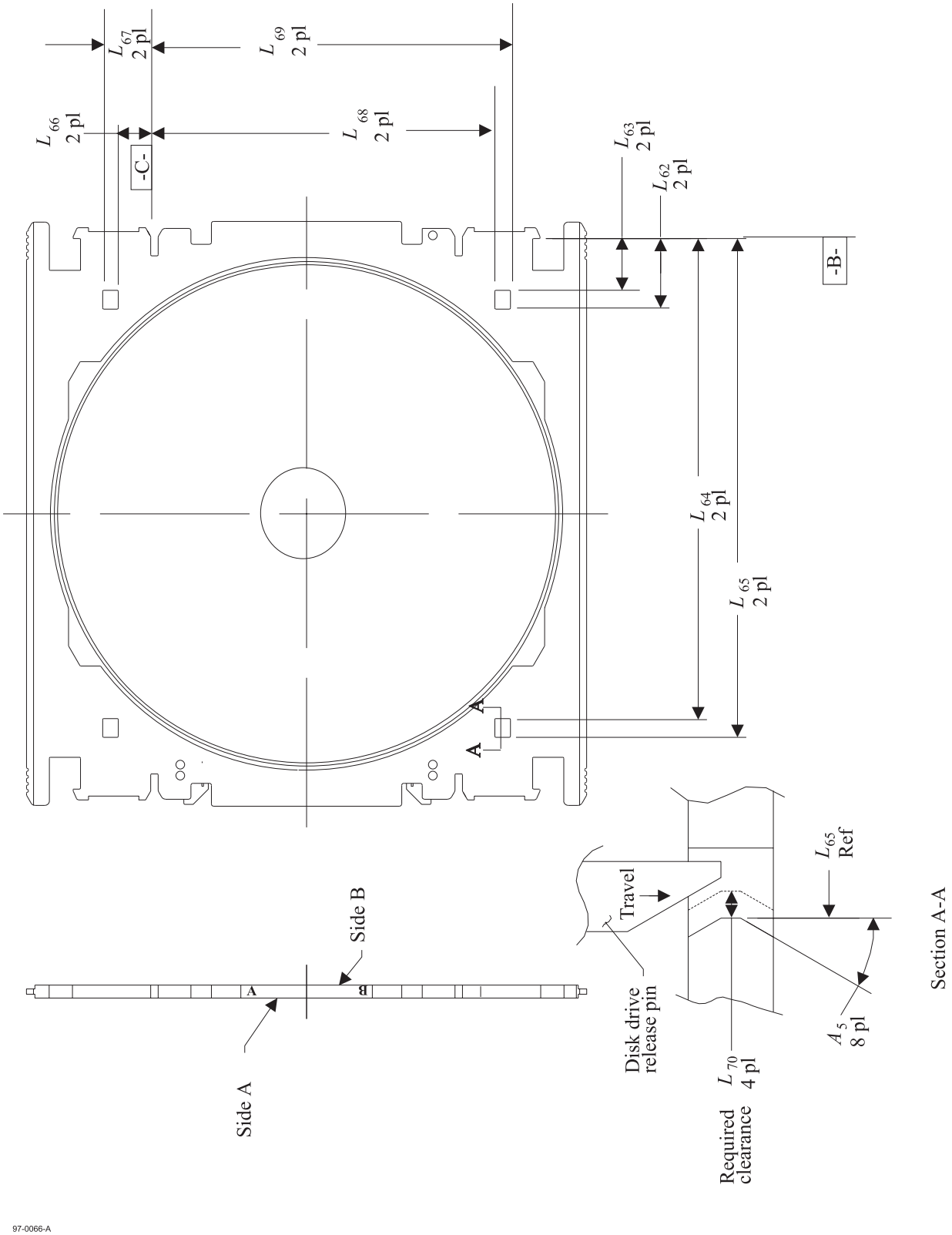


Figure 18 - Carrier latch release hole locations (carrier latched and disk captured in carrier)

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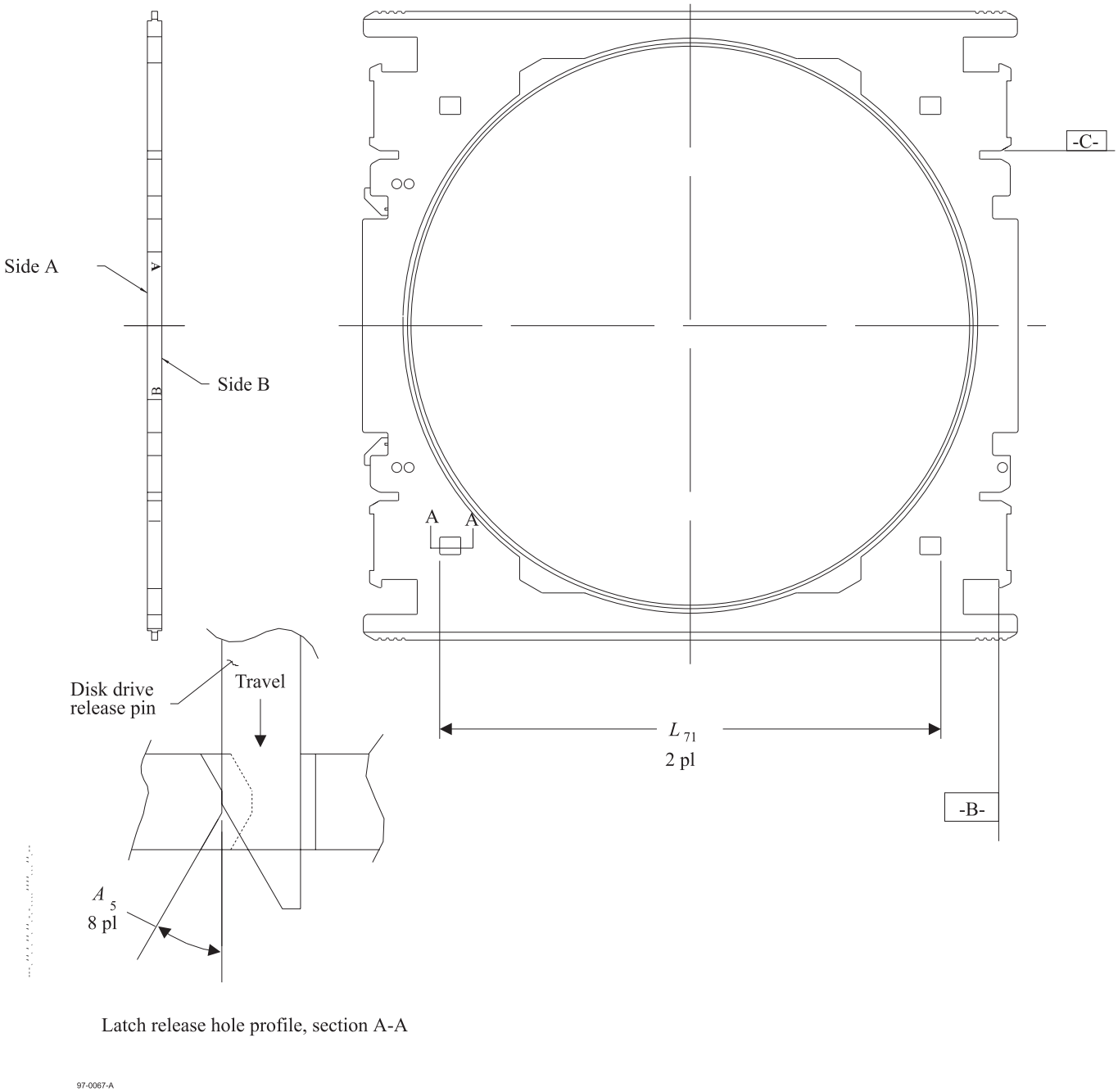


Figure 19 - Unlatched carrier latch release hole location (with disk released, mounted and clamped on spindle)

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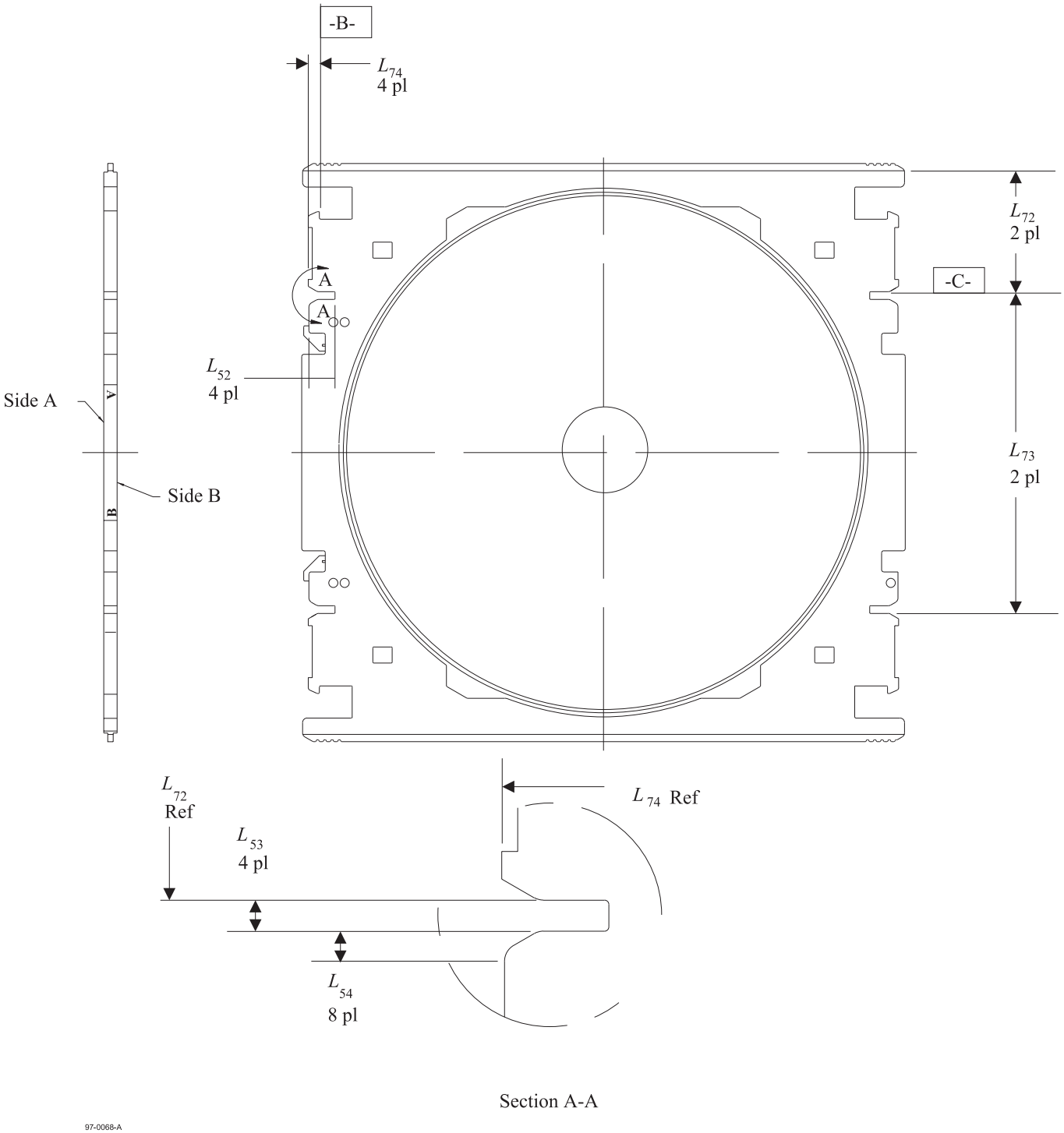


Figure 20 - Carrier locator pin slot locations

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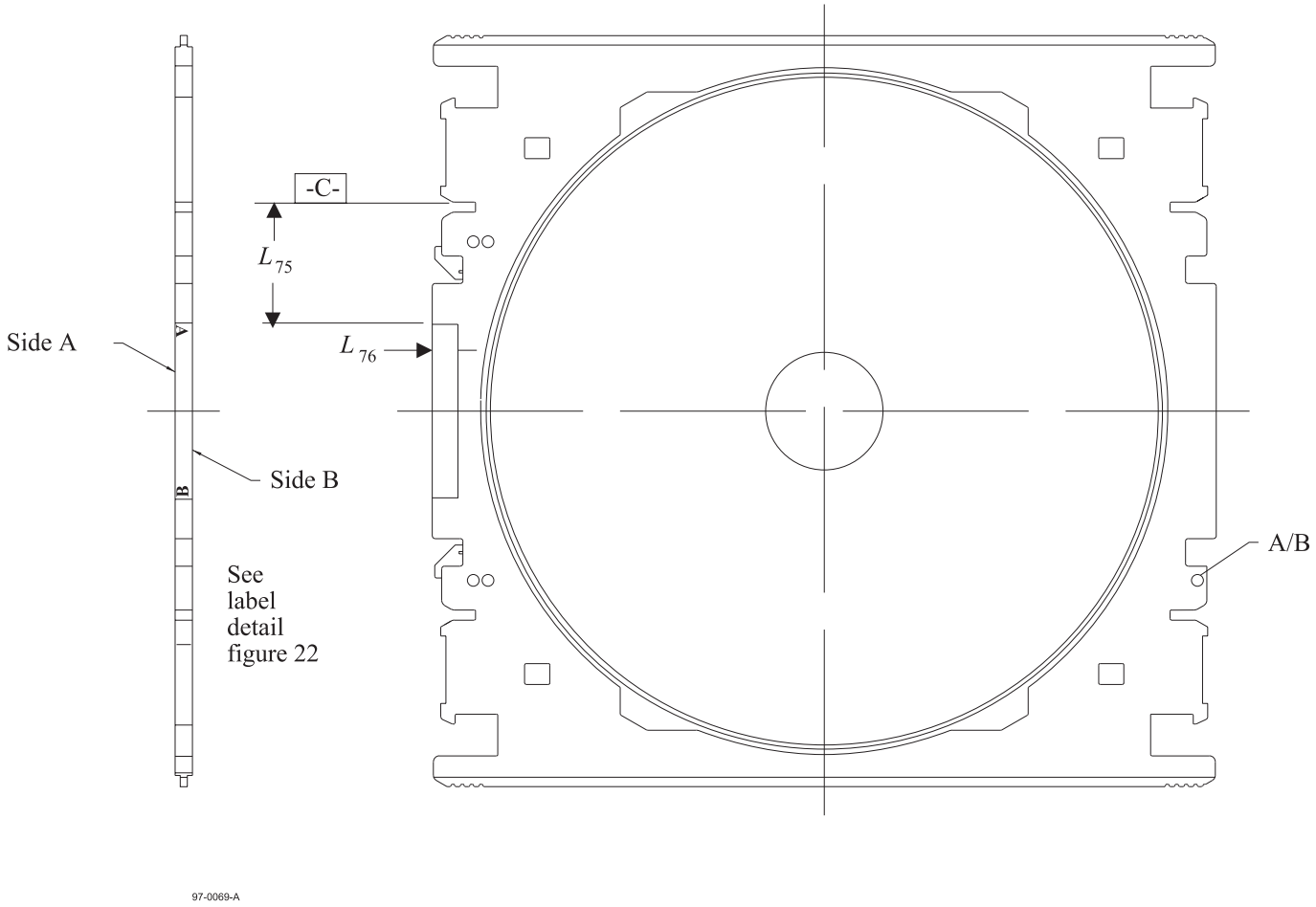


Figure 21 - Carrier label location

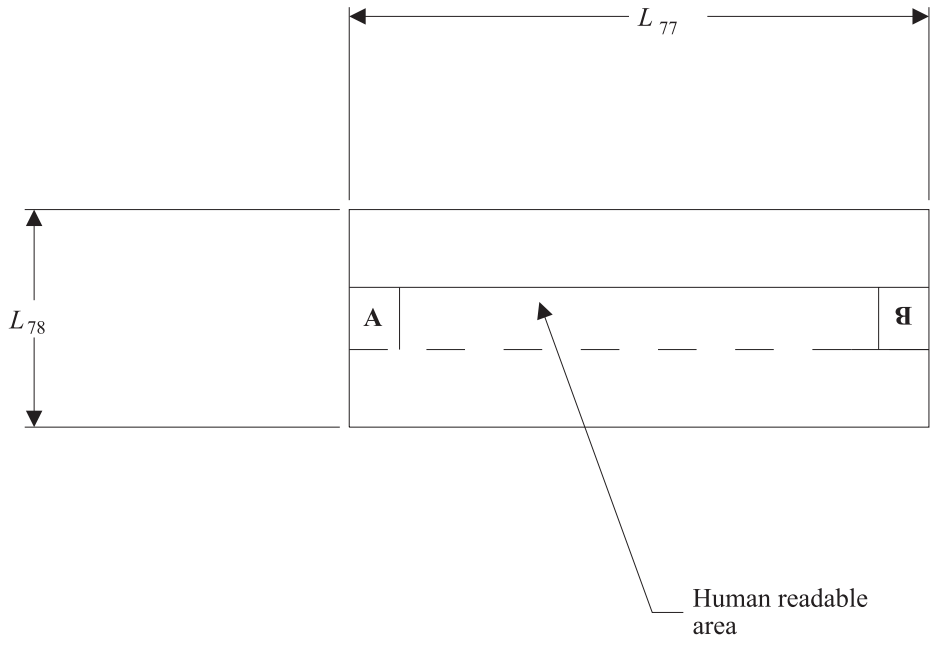


Figure 22 - Carrier label

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12 Dimensional and physical characteristics of the disk

12.1 General

12.1.1 Protective layer

This International Standard accommodates optical disks having a 90 μm thick protective layer configuration.

The main elements of a typical 356 mm optical disk with 90 μm thick protective layer are represented in figure 23 as follows:

- Substrate
- Coated information layers on each side of substrate
- Spacers at the inside diameter on each side
- Perimeter ring at the outside diameter
- Transparent 90 μm thick protective layer on each side bonded to the spacer and perimeter ring.

12.1.2 Unobstructed access

The optical disk, when loaded and clamped, shall allow unobstructed access to the recording zone by a recording head scanning in from the outer edge.

12.2 Disk drawings

Figure 23	shows the main elements of the optical disk
Figure 24	shows the outside diameter, clamp and recording zones
Figure 25	shows the optical disk characteristics
Figure 26	shows the maximum apparent axial runout

12.3 Sides, reference axes, reference plane

12.3.1 Relationship of Sides A and B

The optical disk cartridge consists of an optical disk, a carrier and a case. The optical disk is the two-sided optical recording medium on which information is recorded once and read many times. The optical disk is captured by the carrier and both the optical disk and carrier are contained inside the case . The characteristics described in the following clauses apply to each side of the optical disk.

12.3.2 Reference axes and reference planes (figure 25)

Unless specified otherwise, the optical disk dimensions are related to a cylindrical datum reference frame consisting of datum reference plane A and datum diameter B, perpendicular to plane A.

Datum A is the primary datum and is defined as the plane of the optical disk in contact with the reference surface. For measurement purposes, the reference surface is the plane defined by a sleeve contacting the optical disk at the datum target. See annex C.

12.4 Dimensions of the disk

All dimensions related to datum A and datum B shall be measured in conformance to annex C.

12.4.1 Outer diameter (figure 24)

The optical disk outer diameter feature provides an interface to optical disk handling devices of a disk drive.

The outer diameter of the optical disk shall be:

$$D_4 = 365{,}43 \text{ mm} \pm 0{,}25 \text{ mm}$$

12.4.2 Outer diameter of the recording zone (figure 24)

The recording zone outside diameter on each side of the optical disk shall be:

$$D_5 = 350{,}00 \text{ mm min.}$$

12.4.3 Inner diameter of the recording zone (figure 24)

The recording zone inside diameter on each side of the optical disk shall be:

$$D_6 = 140{,}00 \text{ mm max.}$$

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12.4.4 Outer diameter of the clamping zone (figure 24)

The clamping zone is the datum target, its outside diameter shall be:

D_7 = 76,45 mm min.

12.4.5 Inner diameter of the clamping zone (figure 24)

The inner diameter of the clamping zone shall be:

D_8 = 66,09 mm max.

12.4.6 Centre hole diameter of the optical disk (figure 25)

The diameter of the centre hole of the disk shall be:

D_9 = 63,540 mm ± 0,076 mm

12.4.7 Centre hole roundness (figure 25)

The inside diameter roundness shall be:

D_{10} = 102 μm

12.4.8 Location of the recording surface (figure 25)

The location of the recording surface from datum A shall be:

L_{79} = 6 μm max.

12.4.9 Thickness of the clamping zone (figure 25)

The thickness of the clamping zone is determined by the substrate thickness and shall be:

L_{80} = 1,905 mm ± 0,025 mm

12.4.10 Inner diameter of the chamfer (figure 25)

The inner diameter edges shall be uniformly chamfered or rounded off and a sufficient bore height shall remain to withstand the centring process.

The inner diameter chamfer shall be:

L_{81} = 1,02 mm ± 0,38 mm

12.4.11 Inner diameter chamfer angle (figure 25)

The inner diameter chamfer angle shall be:

A_6 = 15° ± 2°

12.4.12 Outer diameter of the chamfer (figure 25)

The outer diameter edges should be uniformly chamfered or rounded off to avoid excessive wear to the carrier interface areas in contact with the optical disk.

The outer diameter chamfer shall be:

L_{82} = 0,51 mm ± 0,07 mm

12.4.13 Chamfer angle of the outer diameter (figure 25)

The chamfer angle of the outer diameter shall be:

A_7 = 45° ± 2°

12.4.14 Dimensional characteristics of the protective layer

a) Under the operating conditions of 8.1.2 and the data rate of 30 Mega channel bits per second specified in 9.1, the range of distances from the recording layer to the designated surface of the coversheet shall be as follows:

   - The distance from the recording surface to the interior of the 90 μm thick protective layer shall be:

L_{83} = 250 μm min.

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- The distance from the recording surface to the exterior of the 90 μm thick protective layer shall be:

L_{84} = 938 μm max.

b) The 90 μm thick protective layer relief shall be:

L_{85} = 1,78 mm ± 0,53 mm

c) The 90 μm thick protective layer static location with respect to the recording surface at the outer diameter of the optical disk is determined by the perimeter ring and shall be:

L_{86} = 0,483 mm ± 0,025 mm

12.5 Mass

The mass of the optical disk shall not exceed 615 g.

12.6 Moment of inertia

The moment of inertia of the optical disk shall not exceed 10,0 g•m^2.

12.7 Imbalance

The optical disk imbalance, measured according to annex D, relative to a secondary fixture axis, which is the centreline of the optical disk inside diameter perpendicular to datum A shall not exceed 0,1 g•m.

12.8 Apparent axial runout (figure 26)

The optical deviation of the recording surface from the plane defined by datum surface A and measured according to annex E shall be:

L_{87} = 150 μm max.

The optical deviation of the recording surface of any optical disk shall be:

L_{87} = 150 μm max.

12.9 Residual focus error

The residual focus error of the optical disk shall not exceed 0,25 μm, zero to peak. The residual focus error shall be measured according to annex F.

13 Handling requirements

13.1 Drop test

The optical disk cartridge shall withstand dropping on each surface and on each corner from a height of 760 mm on to a concrete floor covered with a vinyl layer 2 mm thick without loss of data integrity. Measurement shall be according to annex G.

13.2 Dead weight strength

The case shall support a load of 132,3 N maximum, applied at any point. Measurement shall be according to annex H.

14 Interface between disk and drive

14.1 Clamping technique

A mechanical clamping technique shall be used.

14.2 Radial positioning

Radial positioning of the optical disk on the disk drive spindle shall be provided by the centring of the axle of the spindle in the centre hole of the optical disk.

14.3 Reference surface

The reference surface for the optical disk shall be provided by the rotating reference surface of the disk drive spindle. The spindle reference surface shall support the optical disk in the specified clamp zone and determines the relative axial position of the optical disk in the disk drive relative to the optical head.

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The location of the recording surface is specified in 12.4.8.

14.4 Clamping force

The clamping force F_5 applied after centring shall not exceed 125 N.

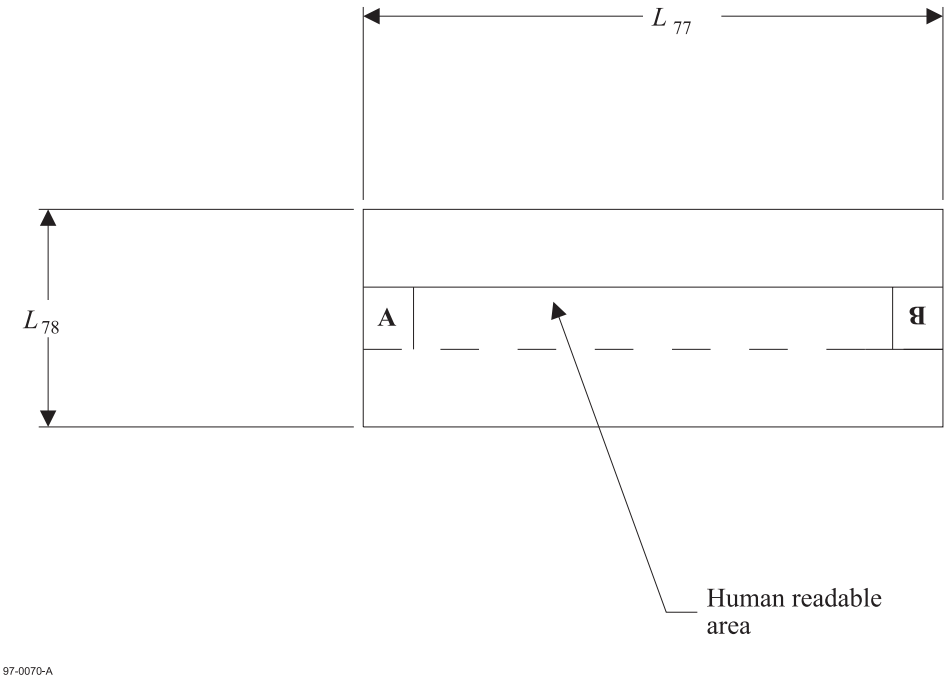


Figure 23 - Main elements of the optical disk

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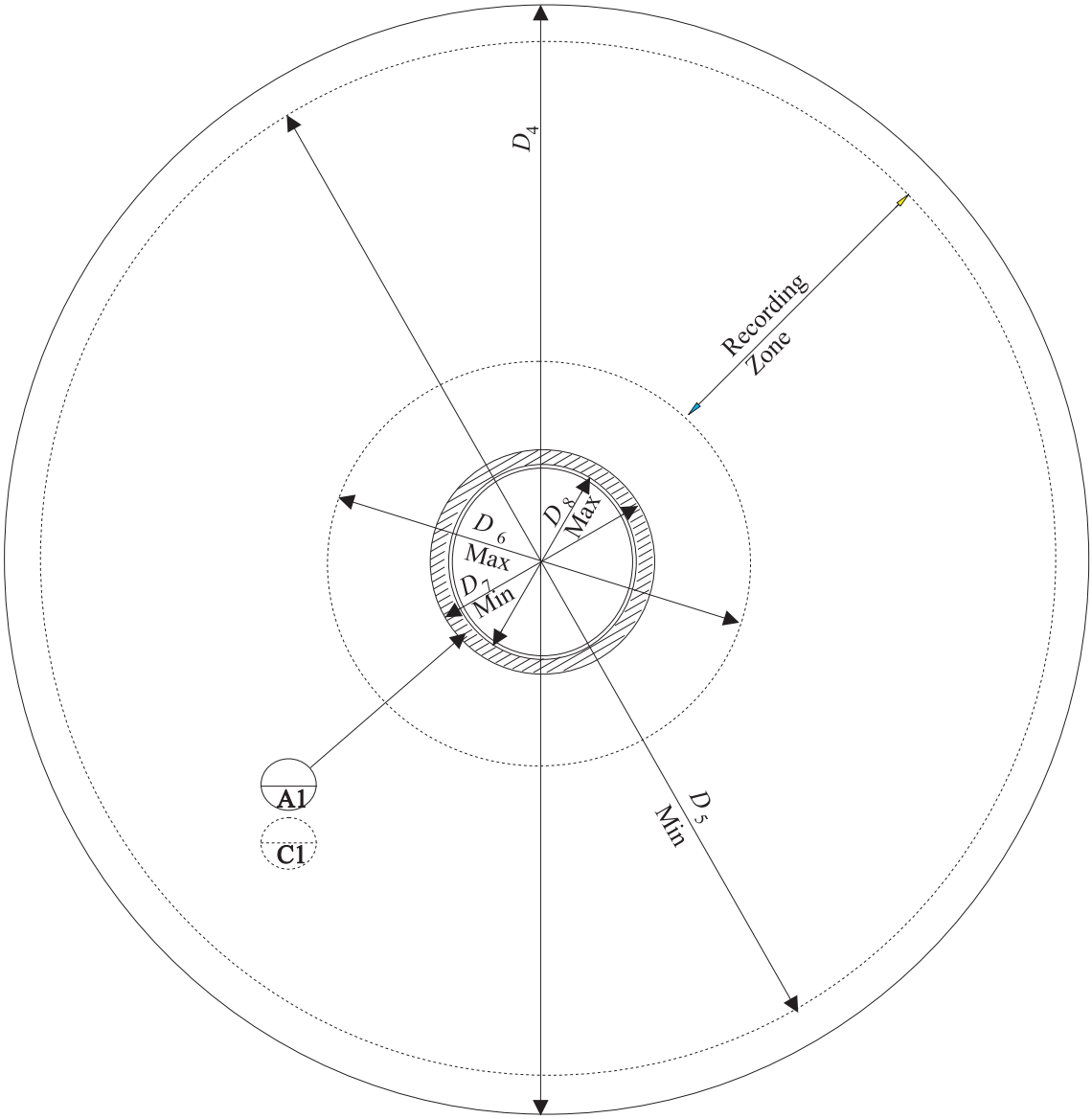


Figure 24 - Outer diameter, clamping and recording zones

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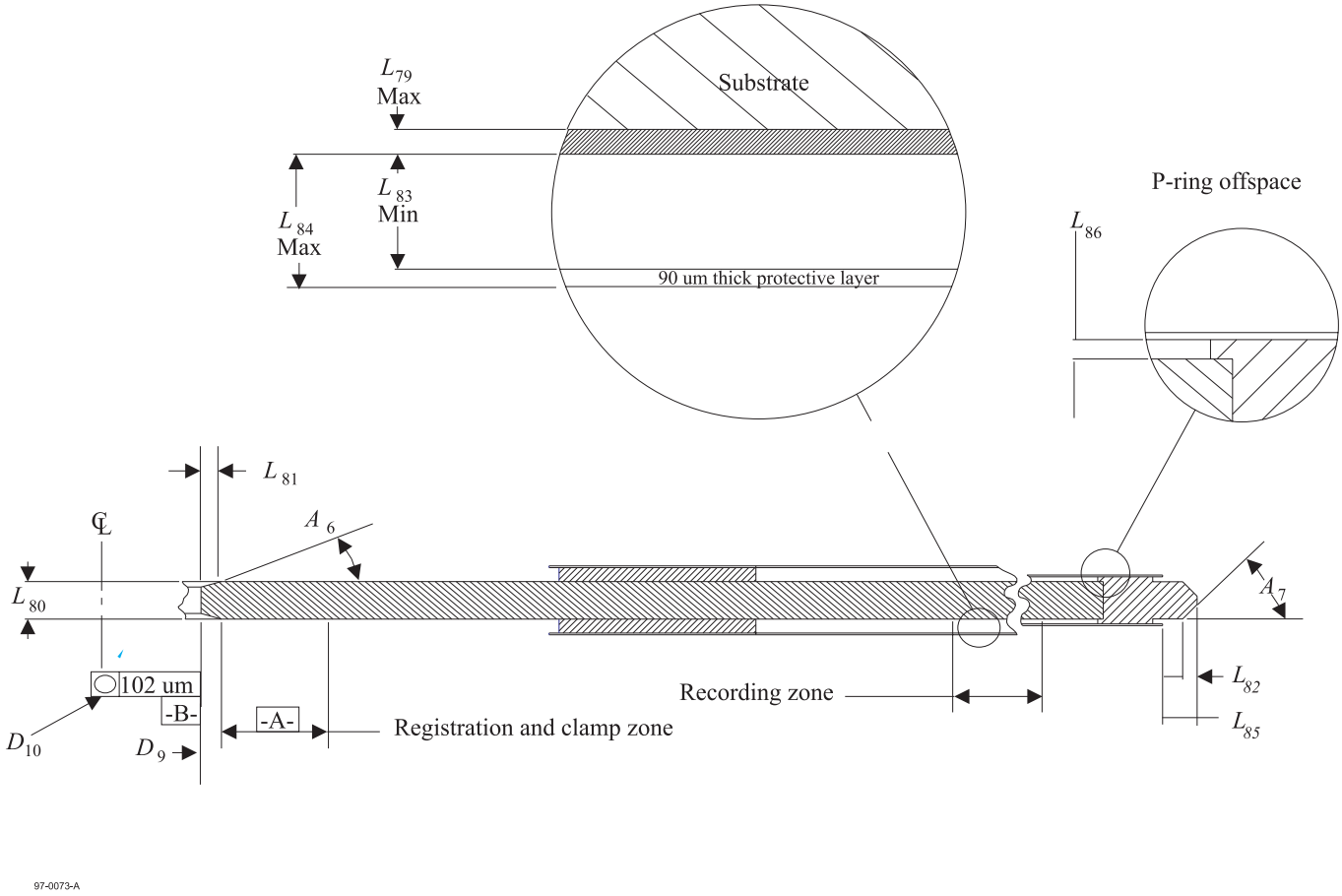


Figure 25 - Optical disk characteristics

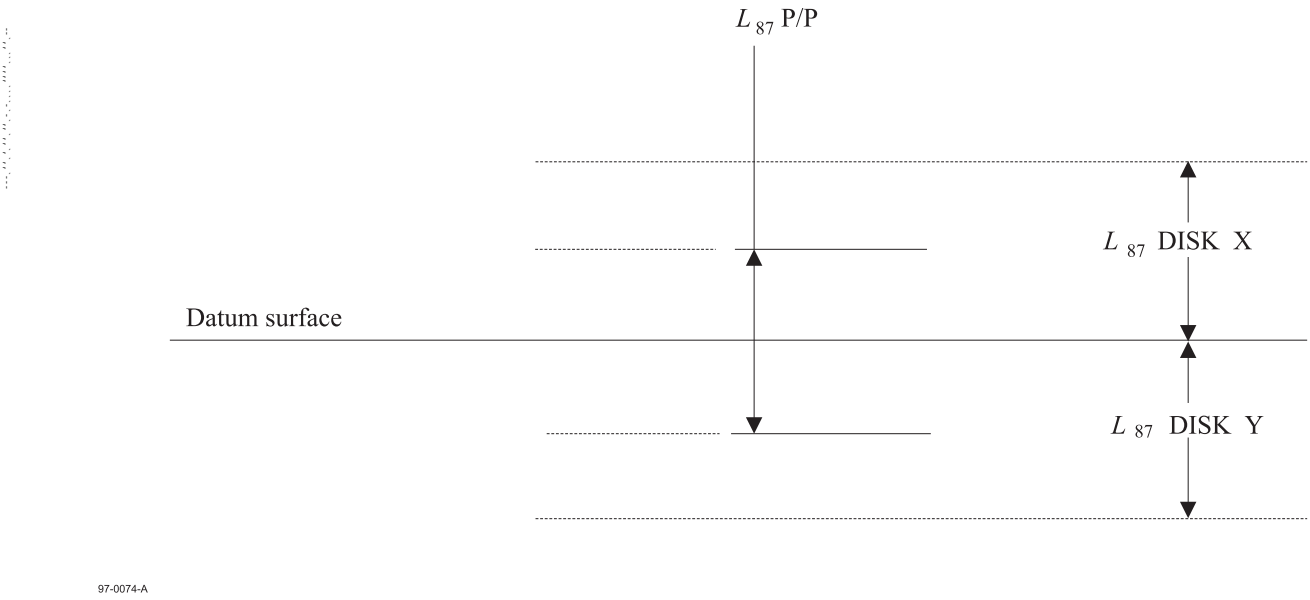


Figure 26 - Maximum axial apparent runout

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15 Characteristics of the protective layer

15.1 Index of refraction

The index of refraction shall be 1,55 ± 0,05.

15.2 Thickness

The physical thickness of the cover sheet shall be 90 μm ± 10 μm.

15.3 Optical characteristics

a) Optical transmittance shall be greater than 89 %

b) Reflectivity shall not exceed 10 %

c) Double-pass retardation measured according to annex J shall be less than 83 nm.

15.4 Tilt

The tilt shall be less than 16 mrad.

16 Characteristics of the recording layer

16.1 Conformance tests

The read and write characteristics of this clause shall be measured using the reference drive described in clause 9.0 and in conformance to the test methods specified in the annexes. The tests to measure conformance to this clause shall be carried out under the conditions of 8.1.1, 9.1, 9.2, 9.3, 9.4, and 9.5.

16.2 Baseline reflectance

16.2.1 General

The baseline reflectance is the reflectance of the blank area of the optical disk in the recording zone including the protective layer.

The baseline reflectance shall be within 37 % to 47 %.

16.2.2 Actual value

The baseline reflectance shall be measured according to annex K with a 0,5 numerical aperture beam at a wavelength of 680 nm ± 10 nm.

16.2.3 Requirement

The uniformity of baseline reflectance in the recording zone of the optical disk shall be ± 5 % of the actual value.

16.3 Write power requirement

The write power measured according to annex L shall be between 3 mW and 7,0 mW.

16.4 Read power requirement

The read power measured according to annex M at the entrance surface of the optical disk shall not exceed 1,0 mW or the value specified in byte 88 of the Identification Sector.

16.5 Prerecorded marks

The characteristics of the pre-written information are given in 16.6.2 and clause 24.

16.6 Data written in user area

16.6.1 Reflectivity characteristics of written marks

The written marks shall have higher reflectivity than the not written areas of the record zone.

16.6.2 Signals

Reflected light signals from recorded areas are detected by the central aperture method and time interval boundaries are determined by the gated second derivative method (see annex K). Thus, the absolute value of the peak of the first derivative of the a.c. read signal obtained from recorded marks is the relevant signal. The *dI/dt* notation used in 16.6.2 represents the absolute value of the peak of the first derivative of a read signal.

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All signals referred to below are currents through the photo diode detector and hence are linearly related to the optical power falling on the detector provided the RF channel is d.c. coupled up to that state. Measure according to annex K.

IB is the d.c. signal obtained from an unrecorded (blank) area of the disk with baseline reflectance R1.

ILO is the a.c. signal obtained from marks written at the lowest repetition rate at the outside diameter of the band. The lowest frequency is 3,75 MHz for 14,8 Gbyte capacity and 1,875 MHz for 25 Gbyte capacity.

ILI is the a.c. signal obtained from marks written at the lowest repetition rate at the inside diameter of the band.

IHO is the a.c. signal obtained from marks written at the highest repetition rate at the outside diameter of the band. The highest frequency is 7,5 MHz.

IHI is the a.c. signal obtained from marks written at the highest repetition rate at the inside diameter of the band.

The marks associated with *ILO*, *ILI*, *IHO*, and *IHI* shall be written under the conditions given in 8.1.1, 9.1, 9.2, 9.3, 9.4, and 9.5.

16.6.2.1 *dRSN/dt*

The recorded marks produce a reflectivity change during read which is transformed into a change in a.c. read signals. Optical disk reflectance signal normalization to a 100 % reflector (RSN) shall be defined as the ratio of the a.c. signal at the output of the read cell when reading data to the DC signal measured at the read cell with the optical disk replaced by a 100 % reflector.

dRSN/dt shall be equal to, or greater than 4 % per nanosecond.

16.6.2.2 Symmetry

The absolute value of the peak of the first derivative of the read signal obtained from the rising edge of the low frequency user data pattern is *dILR / dt*. The absolute value of the peak of the first derivative of the read signal obtained from the falling edge of the low frequency user data pattern is *dILF / dt*. The ratio of the rising edge signal to the falling edge signal is symmetry.

The symmetry shall be between 0,8 and 1,20.

16.6.2.3 Resolution

Resolution is the ratio of the signal from marks written at high frequency to the signal from marks written at low frequency. The resolution at both the outside and inside diameters of each band shall be:

$0{,}8 \leq dIH / dIL \leq 1{,}2$

16.6.3 Narrow-band signal-to-noise ratio

The narrow-band signal-to-noise ratio measured according to annex N shall be greater than 55 dB for all tracks in the user zone.

16.6.4 Cross-talk

The track-to-track cross-talk when measured according to annex P at a track pitch of 1,0 μm shall be less than - 22 dB.

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Section 3 - Format of information

17 General description

The 356 mm optical disk is two-sided and designed to allow for use in a drive with optical access from both sides simultaneously. Side A rotates in the counterclockwise direction as seen from the optical head of the disk drive. Side B rotates in a clockwise direction. The recording area on each side is partitioned into bands. The format of the optical disk is constant angular velocity within each band. Within each band, the pre-formatted data, and disk drive recorded pre-written and user data are all recorded on a common spiral track centreline intended for the sampled servo tracking method.

18 Band organization

18.1 Number of bands on each side of the disk (figure 27)

Each side shall have a pre-formatted format organized as 5 bands for 14,8 Gbyte capacity and 10 bands for 25 Gbyte capacity**.**

18.2 Band numbers (figure 27)

The bands on each side are numbered with band 0 at the outer radius of the recordable area.

18.3 Recordable area in each band

The recordable area within each band shall be per the radii specified in table 1 for 14,8 Gbyte capacity and table 2 for 25 Gbyte capacity**.**

Positional tolerance shall be ± 0,009 mm.

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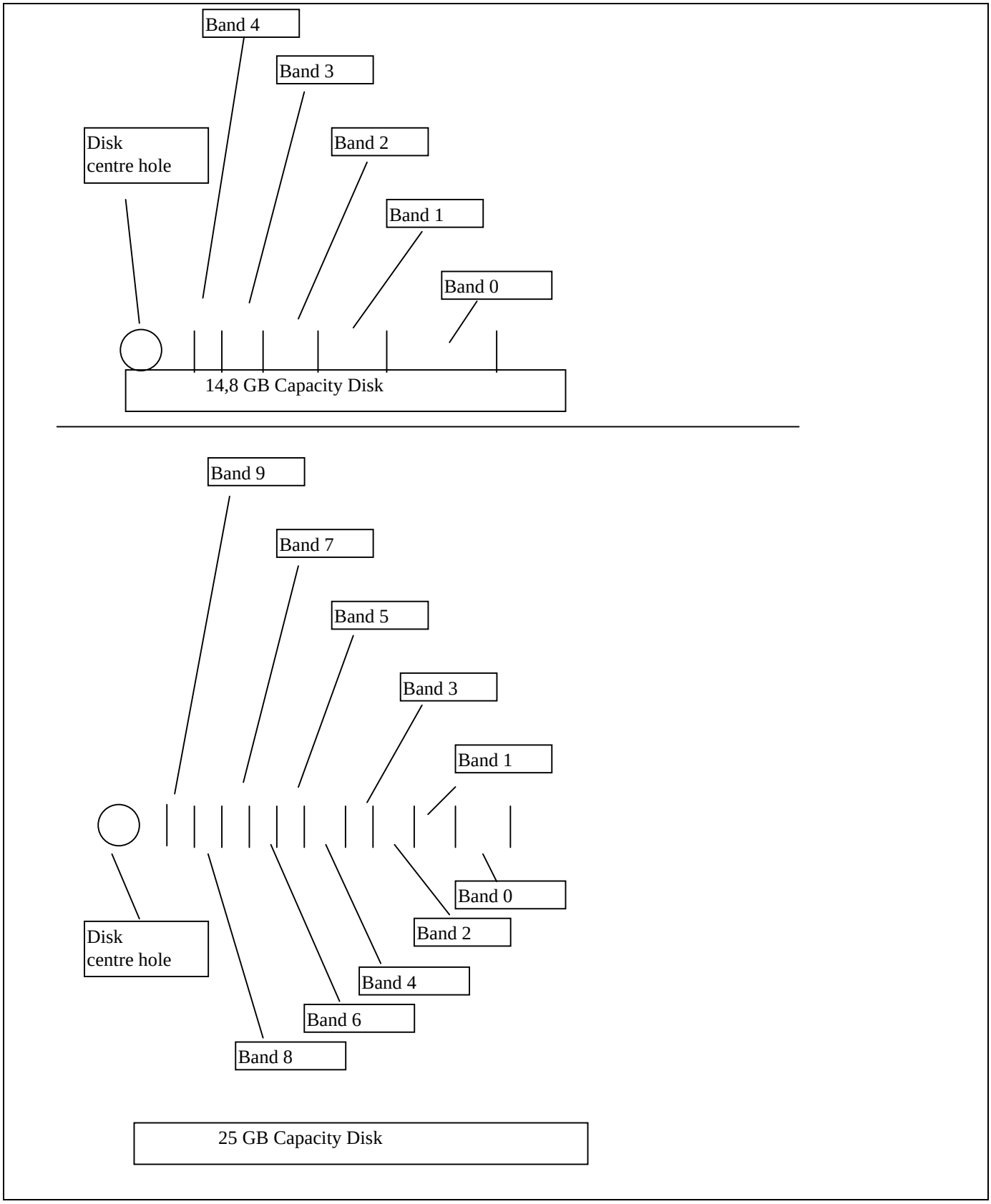


Figure 27 - Band organization

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Table 1 - Recordable area radii for 14,8 Gbyte capacity

Radii, mm	Band 0	Band 1	Band 2	Band 3	Band 4
Outer radius	174,991	145,751	121,686	101,061	84,101
Inner radius	145,760	121,695	101,070	84,110	70,130

Table 2 - Recordable area radii for 25 Gbyte capacity

Radii, mm	Band 0	Band 1	Band 2	Band 3	Band 4
Outer radius	174,991	164,491	153,991	143,491	132,991
Inner radius	164,500	154,000	143,500	133,000	122,500

Radii, mm	Band 5	Band 6	Band 7	Band 8	Band 9
Outer radius	122,491	111,991	101,491	90,991	80,491
Inner radius	112,000	101,500	91,000	80,500	70,000

19 Track geometry in each band

19.1 Track shape

The pre-formatted and disk drive recorded pre-written and user-recorded data are all recorded on a common spiral track centreline within each band on both Side A and Side B and shall be organized into a spiral with radius decreasing by the track pitch per revolution. The tracks shall spiral inward when the disk rotates as viewed by the objective lens.

19.2 Direction of track spiral and disk rotation

The optical disk is designed to allow for use in a drive with optical access from both sides simultaneously. Use with a drive with optical access from only one side requires the disk to be rotated in opposite directions for Side A versus Side B.

Side A of the optical disk shall rotate in the counterclockwise direction as seen from the optical head of the disk drive.

Side B of the optical disk shall rotate in the clockwise direction as seen from the optical head of the disk drive.

19.3 Track pitch

The radius of the spiral track shall decrease either by 1,0 µm ± 0,1 µm per revolution or by the values specified in bytes 103 and 104 of the identification sectors for 14,8 and 25 Gbyte capacities.

19.4 Radial eccentricity of pre-formatted information

All requirements shall apply when the optical disk is mounted on the support spindle (see annex C). The testing conditions shall be as specified in the test methods in the annexes. Radial eccentricity does not include disk drive induced centring errors.

Pre-formatted information shall be concentric relative to datum B of the optical disk within 10 µm (see figure 28).

The distance between any two non-adjacent tracks on a side, shall be as specified in 19.3 with a maximum cumulative error less than ± 2 µm.

Any spiral track shall be concentric with any other spiral track on the same side within 2 µm (see figure 28).

The deviation of the pre-formatted tracking pads and headers from the desired spiral shape shall be less than 0,07 µm with disk drive decentre removed (see figure 29).

The residual tracking error signal shall be measured as specified in annex B and shall not exceed 0,1 µm.

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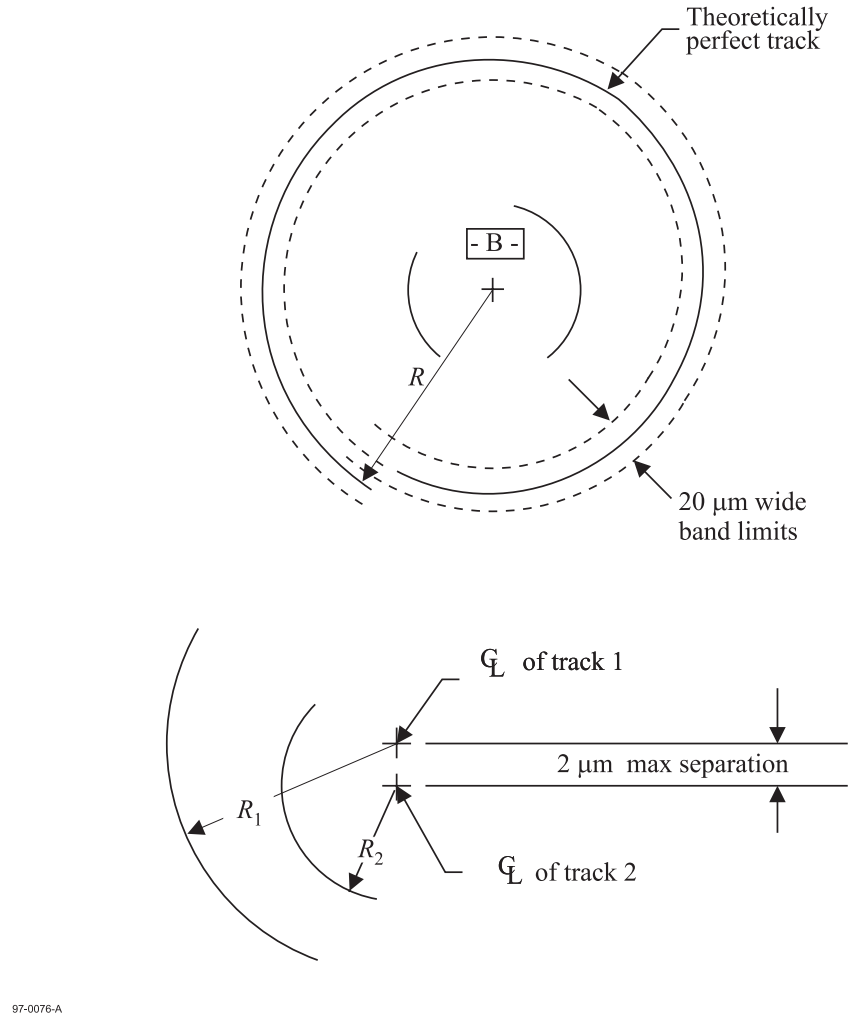


Figure 28 - Track concentricity

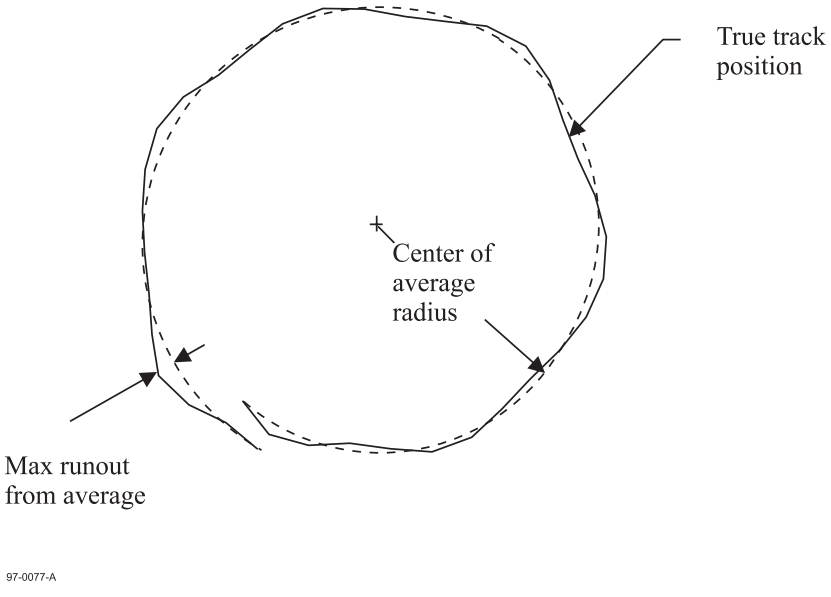


Figure 29 - Track runout

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20 Track format

20.1 Pre-formatted physical track in-track bit spacing

The minimum in-track data bit length at the inside diameter of a band shall be 1,00 μm for 14,8 Gbyte capacity and 0,64 μm for 25 Gbyte capacity.

20.2 Pre-formatted physical track layout

20.2.1 Track layout

Pre-formatted data as well as the disk drive recorded pre-written and user data are all recorded on a common spiral track centreline.

20.2.2 Tracking

The format is characterized by sampled servo tracking. The pre-formatted information is preformed or pre-recorded on the disk by the manufacturer and includes tracking pads. The tracking servo uses the signals from the tracking pads to perform the tracking function.

20.2.3 Tracking pads

Each user sector contains 20 tracking pads for 14,8 Gbyte capacity and 12 tracking pads for 25 Gbyte capacity.

A tracking pad consists of a 3-byte pattern of one unrecorded byte followed by a 1-byte long mark or groove, followed by one unrecorded byte.

The tracking pads shall be aligned so that the leading edge of the mark or groove is an integer multiple of 60 bytes for 14,8 Gbytes capacity and 102 bytes for 25 Gbyte capacity from the other tracking pads.

Figure 30 shows the location of tracking pads in each user sector.

	Pre-written user sector header	User data field preamble and one pre-formatted tracking pad	User data field and pre-formatted tracking pads
14,8 Gbyte capacity: Address mark zero leading edge	60 bytes	60 bytes	and so on
25 Gbyte capacity: Leading edge of tracking pad adjacent to address mark A	102 bytes	102 bytes	and so on

Figure 30 - User sector with tracking pads

20.2.4 Tracking pad tolerances

The distance from the last data edge before a tracking pad mark or groove to the first data edge after a tracking pad mark shall be 3 bytes ± 0,5 bit.

The distance from the end of the user data marked area before a tracking pad to the leading edge of a tracking pad mark or groove shall be > 0,75 byte.

The length of the tracking pad mark or groove shall be 1 byte ± 0,5 bit.

20.2.5 Tracking push-pull ratio

The push-pull ratio $(I_1 - I_2) / IB$ shall be between 0,035 and 0,28.

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(I_1 - I_2) is the absolute value of the peak amplitude of the differential output of the split photodiode detector when the beam crosses tracking pads. *IB* is the signal obtained from an unrecorded blank area of the recording surface.

20.3 Rotational velocity

The spacing and location of the pre-formatted, pre-written, and user recorded data shall be:

- as specified in 20.1.
- consistent with an average rotational velocity of ± 0,1 % of nominal rotational velocity.
- consistent with a peak-to-peak velocity variation of less than 0,05 %.

20.4 Focus

Focus may be obtained by any method.

20.5 Number of sectors in each band

The number of sectors in each band is depending on the track pitch. The Identification Sector specifies the actual addresses of the sectors in each band.

Table 3 for 14,8 Gbyte capacity and table 4 for 25 Gbyte capacity show, as an example for a track pitch of 1,0 µm, the absolute address number in decimal notation for the first sector in each band, and the number of sectors that are formatted in each band.

Table 3 - Number of sectors in each band for 14,8 Gbyte capacity

Start address:

Band 0	Band 1	Band 2	Band 3	Band 4
1	268 435 457	536 870 913	805 306 369	1 073 741 825

Number of sectors formatted:

2 661 292	1 821 734	1 302 602	889 438	609 917

Table 4 - Number of sectors in each band for 25 Gbytes capacity

Start address:

Band 0	Band 1	Band 2	Band 3	Band 4
1	268 435 456	536 870 912	805 306 368	1 073 741 824

Number of sectors formatted:

1 726 283	1 616 025	1 505 767	1 395 782	1 285 524

Start address:

Band 5	Band 6	Band 7	Band 8	Band 9
1 342 177 280	1 610 612 736	1 879 048 192	2 147 483 648	2 415 919 104

Number of sectors formatted:

1 175 540	1 065 282	955 298	845 039	734 781

21 Sector format

1 024 byte user data sector size

21.1 Organization of the sectors in each band

Each band includes lead-in sectors, manufacturing test sectors, identification sector, sectors with a primary defect list of the bad sectors, usable sectors, inside diameter test and write calibration sectors, and trailer sectors. The organization of each band

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is the same, except that the outer and inner radii, quantity of sectors, and sector addresses vary as shown in tables 1,2,3,4,5, and 6.

The sector organization of each band is shown in figure 31.

The allocation of sectors for 14,8 Gbyte and 25 Gbyte capacity is shown in tables 5 and 6.

The Identification Sector and the Primary Defect List Sectors shall always be recorded at the addresses specified in table 5 for 14,8 Gbytes capacity and table 6 for 25 Gbyte capacity.

Organization of the sectors for 14,8 Gbyte capacity

a	b	c	d	e	f	g	h	i	j	k	l	m	n

a = Lead-in tracking sectors
b = Outside diameter manufacturing test sectors
c = Manufacturing Control sector
d = Identification Sector
e = Sectors for the primary defect list
f = Supplemental and configuration sectors
g = Outside diameter manufacturing test sectors #2
h = Outside diameter write calibration sectors
i = Automatic rewrite sectors
j = User data sectors
k = Allowance for maximum number of bad sectors in the PDL
l = Inside diameter write calibration sectors
m = Inside diameter manufacturing test sectors
n =Spin-out tracking sectors

Organization of the sectors for 25 Gbyte capacity

a	b	c	d	e	f	g	h	i	j	k	l	m	n

a = Lead-in tracking sectors
b = Outside diameter manufacturing test sectors
c = Manufacturing Control sector
d = Outside diameter write calibration sectors
e = Automatic rewrite sectors
f = Identification Sectors
g = Sectors for the primary defect list
h = Supplemental and configuration sectors
i = Guard sector
j = User data sectors
k = Allowance for maximum number of bad sectors in the PDL
l = Inside diameter write calibration sectors
m = Inside diameter manufacturing test sectors
n =Spin-out tracking sectors

Figure 31 - Organization of the sectors in each band

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Table 5 - Allocation of sectors for 14,8 Gbyte Capacity

Sectors	Band 0	Band 1	Band 2	Band 3	Band 4
Lead-in:					
Address	1	268 435 457	536 870 913	805 306 369	1 073 741 825
Quantity	276	228	192	159	132
OD Test					
Address	277	268 435 685	536 871 105	805 306 528	1 073 741 957
Quantity	101	149	185	218	245
Manu. Cntrl.					
Address	378	268 435 834	536 871 290	805 306 746	1 073 742 202
Quantity	1	1	1	1	1
Identification					
Address	379	268 435 835	536 871 291	805 306 747	1 073 742 203
Quantity	1	1	1	1	1
PDL					
Address	380	268 435 836	536 871 292	805 306 748	1 073 742 204
Quantity	63	63	63	63	63
Supl & Config					
Address	443	268 435 899	536 871 355	805 306 811	1 073 742 267
Quantity	2	2	2	2	2
OD Test #2					
Address	445	268 435 901	536 871 357	805 306 813	1 073 742 269
Quantity	612	430	296	189	108
OD Write Cal					
Address	1 057	268 436 331	536 871 653	805 307 002	1 073 742 377
Quantity	2 660	1 799	1 404	889	756
Auto Rewrite					
Address	3 717	268 438 130	536 873 057	805 307 891	1 073 743 133
Quantity	4 595	3 926	2 815	1 861	944
User data					
Address	8 312	268 442 056	536 875 872	805 309 752	1 073 744 077
Quantity	2 644 972	1 810 136	1 293 994	883 660	605 605
Allowable Bad					
Address	2 653 284	270 252 192	538 169 866	806 193 412	1 074 349 682
Quantity	6 405	4 074	2 985	2 139	1 856
ID Write Cal					
Address	2 659 689	270 256 266	538 172 851	806 195 551	1 074 351 538
Quantity	2 660	1 799	1 404	889	756
ID Test					
Address	2 662 349	270 258 065	538 174 255	806 196 440	1 074 352 294
Quantity	828	684	572	476	396
Spin-out					
Address	2 663 177	270 258 749	538 174 827	806 196 916	1 074 352 690
Quantity	92	76	64	53	44

Note - The Identification Sector (see table 9) specifies the actual address information for each optical disk.

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Table 6 - Allocation of sectors for 25 Gbyte capacity

Sectors	Band 0	Band 1	Band 2	Band 3	Band 4
Lead-in:					
Address	1	268 435 456	536 870 912	805 306 368	1 073 741 824
Quantity	165	155	144	134	123
OD Test					
Address	166	268 435 611	536 871 056	805 306 502	1 073 741 947
Quantity	517	527	538	548	559
Manu. Cntrl.					
Address	683	268 436 138	536 871 594	805 307 050	1 073 742 506
Quantity	1	1	1	1	1
OD Write Cal.					
Address	684	268 436 139	536 871 595	805 307 051	1 073 742 507
Quantity	1 898	1 777	1 656	1 535	1 414
Auto Rewrite					
Address	2 582	268 437 916	536 873 251	805 308 586	1 073 743 921
Quantity	4 314	4 038	3 762	3 487	3 211
Identification					
Address	6 896	268 441 954	536 877 013	805 312 073	1 073 747 132
Quantity	2	2	2	2	2
PDL					
Address	6 898	268 441 956	536 877 015	805 312 075	1 073 747 134
Quantity	48	48	48	48	48
Supl & Config					
Address	6 946	268 442 004	536 877 063	805 312 123	1 073 747 182
Quantity	2	2	2	2	2
Guard Sector					
Address	6 948	268 442 006	536 877 065	805 312 125	1 073 747 184
Quantity	1	1	1	1	1
User data					
Address	6 949	268 442 007	536 877 066	805 312 126	1 073 747 185
Quantity	1 715 030	1 605 442	1 495 857	1 386 542	1 276 956
Allowable Bad					
Address	1 721 979	270 047 449	538 372 923	806 698 668	1 075 024 141
Quantity	1 726	1 616	1 505	1 395	1 285
ID Write Cal					
Address	1 723 705	270 049 065	538 374 428	806 700 063	1 075 025 426
Quantity	1 898	1 777	1 656	1 535	1 414
ID Test					
Address	1 725 603	270 050 842	538 376 084	806 701 598	1 075 026 840
Quantity	517	484	451	418	385
Spin-out					
Address	1 726 120	270 051 326	538 376 535	806 702 016	1 075 027 225
Quantity	165	155	144	134	123

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Table 6 - Allocation of sectors for 25 Gbyte capacity; (concluded)

Sectors	Band 5	Band 6	Band 7	Band 8	Band 9
Lead-in:					
Address	1 342 177 280	1 610 612 736	1 879 048 192	2 147 483 648	2 415 919 104
Quantity	113	102	92	81	71
OD Test					
Address	1 342 177 393	1 610 612 838	1 879 048 284	2 147 483 729	2 415 919 175
Quantity	569	580	590	601	611
Manu. Cntrl.					
Address	1 342 177 962	1 610 613 418	1 879 048 874	2 147 484 330	2 415 919 786
Quantity	1	1	1	1	1
OD Write Cal.					
Address	1 342 177 963	1 610 613 419	1 879 048 875	2 147 484 331	2 415 919 787
Quantity	1 293	1 171	1 050	929	808
Auto Rewrite					
Address	1 342 179 256	1 610 614 590	1 879 049 925	2 147 485 260	2 415 920 595
Quantity	2 936	2 661	2 368	2 110	1 834
Identification					
Address	1 342 182 192	1 610 617 251	1 879 052 311	2 147 487 370	2 415 922 429
Quantity	2	2	2	2	2
PDL					
Address	1 342 182 194	1 610 617 253	1 879 052 313	2 147 487 372	2 415 922 431
Quantity	48	48	48	48	48
Supl & Config					
Address	1 342 182 242	1 610 617 301	1 879 052 361	2 147 487 420	2 415 922 479
Quantity	2	2	2	2	2
Guard Sector					
Address	1 342 182 244	1 610 617 303	1 879 052 363	2 147 487 422	2 415 922 481
Quantity	1	1	1	1	1
User data					
Address	1 342 182 245	1 610 617 304	1 879 052 364	2 147 487 423	2 415 922 482
Quantity	1 167 642	1 058 057	948 743	839 156	729 570
Allowable Bad					
Address	1 343 349 887	1 611 675 361	1 880 001 107	2 148 326 579	2 416 652 052
Quantity	1 175	1 065	955	845	734
ID Write Cal					
Address	1 343 351 062	1 611 676 426	1 880 002 062	2 148 327 424	2 416 652 786
Quantity	1 293	1 171	1 050	929	808
ID Test					
Address	1 343 352 355	1 611 677 597	1 880 003 112	2 148 328 353	2 416 653 594
Quantity	352	319	286	253	220
Spin-out					
Address	1 343 352 707	1 611 677 916	1 880 003 398	2 148 328 606	2 416 653 814
Quantity	113	102	92	81	71

Note - The Identification Sector (see table 9) specifies the actual address information for each optical disk.

21.2 Organization of the usable sectors

The organization of the usable sectors is shown in figure 32.

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The usable sectors have the same organization in each band, except for the addresses and quantities as specified in table 7 for 14,8 Gbyte capacity and table 8 for 25 Gbyte capacity.

Note - Usable sectors start with sectors depicted as d in figure 31.

14,8 Gbyte Capacity

d	**e**	**f**	**g**	**h**	**i**	**j**	**k**	**l**

d = Identification Sector
e = Primary defect list sectors
f = Supplemental and configuration sectors
g = OD manufacturing test sectors #2
h = OD write power calibration sectors
i = Auto-re-write sectors
j = User data sectors
k = allowance for bad sectors in the PDL
l = ID write power calibration sectors

25 Gbyte Capacity

d	**e**	**f**	**g**	**h**	**i**	**j**	**k**	**l**

d = Outside diameter write calibration sectors
e = Automatic rewrite sectors
f = Identification Sectors
g = Sectors for the primary defect list
h = Supplemental and configuration sectors
i = Guard sector
j = User data sectors
k = Allowance for maximum number of bad sectors in the PDL
l = Inside diameter write calibration sectors

Figure 32 - Organization of the usable sectors

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Table 7 - Usable sectors for 14,8 Gbyte capacity

Identification					
Address	379	268 435 835	536 871 291	805 306 747	1 073 742 203
Quantity	1	1	1	1	1
PDL					
Address	380	268 435 836	536 871 292	805 306 748	1 073 742 204
Quantity	63	63	63	63	63
Supl & Config					
Address	443	268 435 899	536 871 355	805 306 811	1 073 742 267
Quantity	2	2	2	2	2
OD Test #2					
Address	445	268 435 901	536 871 357	805 306 813	1 073 742 269
Quantity	612	430	296	189	108
OD Write Cal					
Address	1 057	268 436 331	536 871 653	805 307 002	1 073 742 377
Quantity	2 660	1 799	1 404	889	756
Auto Rewrite					
Address	3 717	268 438 130	536 873 057	805 307 891	1 073 743 133
Quantity	4 595	3 926	2 815	1 861	944
User data					
Address	8 312	268 442 056	536 875 872	805 309 752	1 073 744 077
Quantity	2 644 972	1 810 136	1 293 994	883 660	605 605
Allowable Bad					
Address	2 653 284	270 252 192	538 169 866	806 193 412	1 074 349 682
Quantity	6 405	4 074	2 985	2 139	1 856
ID Write Cal					
Address	2 659 689	270 256 266	538 172 851	806 195 551	1 074 351 538
Quantity	2 660	1 799	1 404	889	756

Note - The Identification Sector (see table 9) specifies the actual address information for each optical disk.

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Table 8 - Usable sectors for 25 Gbyte capacity

	Band 0	Band 1	Band 2	Band 3	Band 4
OD Write Cal.					
Address	684	268 436 139	536 871 595	805 307 051	1 073 742 507
Quantity	1 898	1 777	1 656	1 535	1 414
Auto Rewrite					
Address	2 582	268 437 916	536 873 251	805 308 586	1 073 743 921
Quantity	4 314	4 038	3 762	3 487	3 211
Identification					
Address	6 896	268 441 954	536 877 013	805 312 073	1 073 747 132
Quantity	2	2	2	2	2
PDL					
Address	6 898	268 441 956	536 877 015	805 312 075	1 073 747 134
Quantity	48	48	48	48	48
Supl & Config					
Address	6 946	268 442 004	536 877 063	805 312 123	1 073 747 182
Quantity	2	2	2	2	2
Guard Sector					
Address	6 948	268 442 006	536 877 065	805 312 125	1 073 747 184
Quantity	1	1	1	1	1
User data					
Address	6 949	268 442 007	536 877 066	805 312 126	1 073 747 185
Quantity	1 715 030	1 605 442	1 495 857	1 386 542	1 276 956
Allowable Bad					
Address	1 721 979	270 047 449	538 372 923	806 698 668	1 075 024 141
Quantity	1 726	1 616	1 505	1 395	1 285
ID Write Cal					
Address	1 723 705	270 049 065	538 374 428	806 700 063	1 075 025 426
Quantity	1 898	1 777	1 656	1 535	1 414

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Table 8 - Usable sectors for 25 Gbyte capacity; (concluded)

	Band 5	Band 6	Band 7	Band 8	Band 9
OD Write Cal.					
Address	1 342 177 963	1 610 613 419	1 879 048 875	2 147 484 331	2 415 919 787
Quantity	1 293	1 171	1 050	929	808
Auto Re-write					
Address	1 342 179 256	1 610 614 590	1 879 049 925	2 147 485 260	2 415 920 595
Quantity	2 936	2 661	2 386	2 110	1 834
Identification					
Address	1 342 182 192	1 610 617 251	1 879 052 311	2 147 487 370	2 415 922 429
Quantity	2	2	2	2	2
BSM					
Address	1 342 182 194	1 610 617 253	1 879 052 313	2 147 487 372	2 415 922 431
Quantity	48	48	48	48	48
Supl & Config					
Address	1 342 182 242	1 610 617 301	1 879 052 361	2 147 487 420	2 415 922 479
Quantity	2	2	2	2	2
Guard Sector					
Address	1 342 182 244	1 610 617 303	1 879 052 363	2 147 487 422	2 415 922 481
Quantity	1	1	1	1	1
User data					
Address	1 342 182 245	1 610 617 304	1 879 052 364	2 147 487 423	2 415 922 482
Quantity	1 167 642	1 058 057	948 743	839 156	729 570
Allowable Bad					
Address	1 343 349 887	1 611 675 361	1 880 001 107	2 148 326 579	2 416 652 052
Quantity	1 175	1 065	955	845	734
ID Write Cal					
Address	1 343 351 062	1 611 676 426	1 880 002 062	2 148 327 424	2 416 652 786
Quantity	1 293	1 171	1 050	929	808

Note - The Identification Sector (see table 9) specifies the actual address information for each optical disk.

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21.3 User sector organization

The user sectors have the same organization in each band with pre-formatted tracking pads dispersed throughout the user sector. A user sector comprises

1 260 bytes for 14,8 Gbyte capacity and 1 224 bytes for 25 Gbyte capacity of which 1 024 are for user data for both capacity disks. See figure 33.

Note - User sectors were depicted as j in figure 31.

14,8 Gbytes and 25 Gbytes	j-1	j-2	j-3	j-4	j-5

j-1 = Pre- formatted user sector header
j-2 = Pre-written user data field preamble
j-3 = User data field
j-4 = EDAC
j-5 = Interface sector gap

Figure 33 - User sector organization

21.4 Lead-in and OD manufacturing test sectors

The lead-in and manufacturing test sectors of the spiral track in each band shall be in conformance to the radial eccentricity requirements of 19.4.

The manufacturing test sectors of each band are provided for use by the optical disk manufacturer.

21.5 Manufacturing control sector

The manufacturing control sector is for manufacturers use and shall be ignored in interchange.

21.6 Disk identification sector(s)

One identification sector per band for 14,8 Gbyte capacity disks and two identification sectors per band for 25 Gbyte capacity disks contain the unique identifier for the optical disk and an identifier indicating the Side A and Side B of the two sided optical disk (see figure 31).

The Identification Sector(s) is comprised of a header and band records. The format of the identification sector is shown in table 9 for 14,8 Gbyte capacity and table 10 for 25 Gbyte capacity.

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Table 9 - Identification Sector format for 14,8 Gbyte Capacity

Byte number	Length (bytes)	Identification Sector header description
0	10	Disk IDENT. The number which is on the carrier label (IRV of Standard ECMA-6 aannnnnnnn, where "aa" are two letters and "nnnnnnnn" are eight digits).
10	1	Supplemental type; 0 = original IDENT sector; 3 = new IDENT sector written in the position of the first supplemental sector.
11	1	Reserved, set to (FF)
12	1	This byte shall be set to (00) for Side A, and to (01) for side B
13	8	Date: The date that disk formatting was completed by the manufacturer (MMDDYYYY)
21	1	Number of bands formatted.
22	1	Number of bytes per band record. This byte shall be set to 128
23	51	(Reserved for manufacturing production use).
74	2	Size in sectors of PDL excluding the IDENT sector.
Note		For bytes 76 to 104, n is a signed binary number with ONE as the most significant bit in the MSB indicating a negative number.
76	1	This byte shall specify the testing wavelength L_1 in nanometres as a number n such that n = 0,5 (L_1-830). This byte shall be set to n= 0
77	1	This byte shall specify the baseline reflectance R_1 at wavelength L_1 as a number n such that n=100(R_1-0,11).
78	2	This byte shall specify the rotational frequency N_0 in hertz, for band 0 testing, as a number n such that n = 10(N_0-13,1). This byte shall be set to n=0.
80	2	This byte shall specify the rotational frequency N_1 in hertz, for band 1 testing, as a number n such that n=10(N_1-15,7). This byte shall be set to n=0.
82	2	This byte shall specify the rotational frequency N_2 in hertz, for band 2 testing, as a number n such that n=10(N_2-18,9). This byte shall be set to n=0.
84	2	This byte shall specify the rotational frequency N_3 in hertz, for band 3 testing, as a number n such that n=10(N_3-22,7). This byte shall be set to n=0.
86	2	This byte shall specify the rotational frequency N_4 in hertz, for band 4 testing, as a number n such that n=10(N_4-27,2). This byte shall be set to n=0.
88	1	This byte shall specify the maximum read power *Pr* in milliwatts for the user zone as a number n between 0 and 255 such that n=20(*Pr*-0,8).
89	1	This byte shall specify the write power *Pwo* in milliwatts, for the outside diameter of a band, as a number n=20(*Pwo* -11).
90	1	This byte shall specify the write power *Pwi* in milliwatts, for the inside diameter of a band, as a number n=20(*Pwi* - 8,8).
91	1	This byte shall specify the pre-emphasis in nanoseconds required at the outside diameter of a band as a number n=10(PE_o-10).
92	1	This byte shall specify the pre-emphasis in nanoseconds required at the inside diameter of an band as a number n=10(Pe_i-10).
93	1	This byte shall specify the post-emphasis in nanoseconds required at the outside diameter of a band as a number n=10(Ep_o-6).

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		Table 9 continued:
94	1	This byte shall specify the post-emphasis in nanoseconds required at the inside diameter of a band as a number *n*=10(*Epi*-6).
95	1	This byte shall be set to all ZEROs to specify delay modulation mark (DM-M).
96	1	This byte shall be set to all ZEROs to specify the ECC code R-S LDC degree 16 and 5 interleaves.
97	2	These two bytes shall be set to all ZEROs to specify the number of user bytes per sector as 1024.
99	1	This byte shall specify the ratio of the signal obtained from marks written at the lowest repetition rate at the outside diameter of a band to the signal obtained from the blank area as a number *n*=100(*dRSn/dt*).
100	1	This byte shall specify the polarity of the pre-formatted information. If the byte is set to all ZEROs, the polarity is from dark to bright. If the byte is set to all ONEs, the polarity is from bright to dark.
101	1	This byte shall specify the ratio of the signal obtained from the user data to the signal obtained from the pre-written information for the lowest repetition rate marks at the outside of a band as a number n=[20(*dILO* user data / *dILO* prewritten-data)-18]
102	1	This byte shall specify the polarity of the user data. If the byte is set to all ZEROs, the polarity is from dark to bright. If the byte is set to all ONEs, the polarity is from bright to dark.
103	1	This byte shall specify the nominal track pitch *TP* as a number *n*=20(*TP*-1,8).
104	1	This byte shall specify the ± tolerance *TPT* of the nominal track pitch as a number *n*=100(*TPT*-0,2).
105 to 123	19	Reserved, shall be ignored in interchange.
124 to 125	2	(00) for PDLs with a length of 21 sectors. (01) for PDLs with a length of up to 38 sectors. (02) for PDLs with a length of up to 48 sectors.
126 to 127	2	Drive version, set to ZERO for this standard.
Note		The following fields describe a band record which is repeated for each band n (n=0 to 4 for 14,8 Gbyte capacity). The "byte number" in the identification sector may be calculated by adding [(n+1)128] to the byte number in the following band record (i.e., sequential 128-byte band records follow the 128-byte header in the disk identification sector.
Byte number	**Length (bytes)**	**Band record description**
0 to 3	4	Band *n* first address formatted, the address of the first lead-in sector.
4 to 7	4	Band *n* first trackable address, indicates the first sector of the band which can be reliably tracked by the drive. Note that sectors between here and the following field are used for manufacturing test area.
8 to 11	4	Band *n* disk Identification Sector address, the location of the sector that contains this identification information.
12 to 15	4	Starting address of the PDL in band *n*.
16 to 19	4	Band *n* drive supplemental data address, specifies the location of a sector which is written by the drive.

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		Table 9 (concluded)
20 to 23	4	Band *n* user supplemental data address, included to support future scenarios which would require drive software to be aware of user configuration/usage of an optical disk.
24 to 27	4	Band *n* first available drive address. The drive maps the usage of the disk from this point to the first trailer sector for this band. Note that the disk identification contains default, but not necessarily actual pointers to the drive calibration sectors, reserved sectors, or user data sectors.
28 to 31	4	Band *n* maintenance / calibration starting address. This is the default value used by the drive for maintenance / calibration sector mapping.
32 to 35	4	Band *n* reserved sector starting address. This is the default value used by the drive for reserved sector mapping.
36 to 39	4	Band *n* user data starting address. This is the default value used by the drive for user sector mapping.
40 to 43	4	Band *n* last trackable address. Sectors between this address and the end of the band are not addressable by the drive.
44 to 47	4	Band *n* last address formatted, the address of the last trailer sector.
48 to 51	4	Band *n* number of guaranteed user sectors. This is the default value used by the drive for logical address mapping (i.e., how many user logical addresses get mapped to this band).
52 to 55	4	Band *n* number of guaranteed available sectors for drive (from first available drive address to "train start address", minus the number of start of life defects, minus anticipated growth defects). This indicates to the drive how many sectors it can anticipate to successfully write in this band. From this, the drive can decide how to allocate calibration sectors, reserved sectors and user data sectors.
56 to 59	4	Outer radius of band *n* expressed as the number of tenths of micrometers, truncated off to integer.
60 to 63	4	Inner radius of band *n* expressed as the number of tenths of micrometers, truncated off to integer.
64 to 111	48	Reserved for manufacturers use.
112 to 115	4	Band *n* maintenance / calibration starting address. This is the default value used by the drive for maintenance / calibration sector mapping at the inner band diameter. If these bytes are set to all ZEROs, there is no inner diameter test area.
116 to 127	12	Reserved, set to (FF)

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Table 10 - Identification Sector format for 25 Gbyte Capacity

Byte number	Length (bytes)	Identification Sector header description
0	10	Disk IDENT. The number which is on the carrier label (IRV of ISO/IEC 646 aannnnnnnn, where "aa" are two letters and "nnnnnnnn" are eight digits).
10	1	Supplemental type; same as 14,8 Gbyte capacity.
11	1	Disk type; (0)=WORM; (1)=WORM with overwrite protection; (2) = Rewritable.
12	1	This byte shall be set to (00) for Side A, and to (01) for side B
13	8	Date: The date that disk formatting was completed by the manufacturer (MMDDYYYY).
21	1	Number of bands formatted.
22	1	Number of bytes per band record. This byte shall be set to 128.
23	51	(Reserved for manufacturing production use).
74	2	Size in sectors of PDL excluding the IDENT sector.
Note:		For bytes 76 to 104, *n* is a signed binary number with ONE as the most significant bit in the MSB indicating a negative number.
76	1	This byte shall specify the testing wavelength L_1 in nanometres as a number *n* such that $n = 0,5\ (L_1\text{-}830)$.
77	1	This byte shall specify the baseline reflectance R_1 at wavelength L_1 as a number *n* such that $n=100(R_1\text{-}0,11)$.
78	2	Reserved for manufacturing production use, ignored in interchange.
80	2	Reserved for manufacturing production use, ignored in interchange.
82	2	Reserved for manufacturing production use, ignored in interchange.
84	2	Reserved for manufacturing production use, ignored in interchange.
86	2	Reserved for manufacturing production use, ignored in interchange.
88	1	This byte shall specify the maximum read power P_r in milliwatts for the user zone as a number *n* between 0 and 255 such that $n=20(P_r - 0,8)$.
89	1	This byte shall specify the write power *Pwo* in milliwatts, for the outside diameter of a band, as a number $n=20(Pwo\text{-}11)$.
90	1	This byte shall specify the write power *Pwi* in milliwatts, for the inside diameter of a band, as a number $n=20(Pwi\text{-}8,8)$.
91	1	Reserved for manufacturing production use, ignored in interchange.
92	1	Reserved for manufacturing production use, ignored in interchange.
93	1	Reserved for manufacturing production use, ignored in interchange.
94	1	Reserved for manufacturing production use, ignored in interchange.
95	1	This byte shall be set to all ZEROs to specify delay modulation mark (DM-M) and to ONE to specify the (1,7) code.
96	1	This byte shall be set to all ZEROs to specify the ECC code R-S LDC degree 16 and 5 interleaves.
97	2	These two bytes shall be set to all ZEROs to specify the number of user bytes per sector as 1024.
99	1	This byte shall specify the ratio of the signal obtained from marks written at the lowest repetition rate at the outside diameter of a band to the signal obtained from the blank area as a number $n=100(dRSn/dt)$.

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		Table 10 continued:
100	1	This byte shall specify the polarity of the pre-formatted information. If the byte is set to all ZEROs, the polarity is from dark to bright. If the byte is set to all ONEs, the polarity is from bright to dark.
101	1	This byte shall specify the ratio of the signal obtained from the user data to the signal obtained from the pre-written information for the lowest repetition rate marks at the outside of a band as a number n=[20(*dILO* user data / *dILO* prewritten-data)-18]
102	1	This byte shall specify the polarity of the user data. If the byte is set to all ZEROs, the polarity is from dark to bright. If the byte is set to all ONEs, the polarity is from bright to dark.
103	1	This byte shall specify the nominal track pitch *TP* as a number n=20(*TP*-1,8).
104	1	This byte shall specify the ± tolerance *TPT* of the nominal track pitch as a number n=100(*TPT*-0,2).
105	1	Number of Identification Sectors.
106	18	Reserved
124	2	Disk version: 0 for 21 fixed sector size PDL; 1 for 38 variable sector size PDL; 2 for 48 variable sector size PDL; 3 for new IDENT sector format.
126	2	Drive version, set to ZERO for this standard.
Note		The following fields describe a band record which is repeated for each band n (n=0 to 9 for 25 Gbyte capacity). The "byte number" in the first or second identification sector may be calculated by adding [(n+1)128] to the byte number in the following band record (i.e., sequential 128-byte band records follow the 128-byte header in the first disk identification sector and carryover into the second disk identification sector for 25 Gbyte capacity)
Byte number	**Length (bytes)**	**Band record description**
0	4	First formatted address
4	4	First trackable address
8	4	Manufacturing and control sector address
12	4	Outside diameter test area start address
16	4	First available drive address
20	4	Outside diameter calibration area address
24	4	Reallocation area address
28	4	Diagnostic area address
32	4	Identification Sector address
36	4	Split sector(s) address
40	4	Drive supplemental sector address
44	4	Configuration sector address
48	4	Guard sector
52	4	User data area address
56	4	ID calibration area address
60	4	ID test area start address
64	4	Last trackable address
68	4	Last address formatted
72	4	Number of guaranteed user sectors

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		Table 10 (concluded):
76	4	Number of guaranteed available sectors
80	4	Outer radius of band
84	4	Inner radius of band
88	2	Reserved for manufacturing production use, ignored in interchange.
90	2	Reserved for manufacturing production use, ignored in interchange.
92	2	Reserved for manufacturing production use, ignored in interchange.
94	2	Reserved for manufacturing production use, ignored in interchange.
96	2	Reserved for manufacturing production use, ignored in interchange.
98	2	Reserved for manufacturing production use, ignored in interchange.
100	10	Reserved for manufacturing production use, ignored in interchange.
110	18	Reserved for manufacturing production use, ignored in interchange.

21.7 Primary Defect List sectors

The manufacturer of the optical disk should scan the entire surface of the optical disk and determine any unusable (bad) sectors at time of manufacture. The sectors of the Primary Defect List provide a location for the optical disk manufacturer to record such information for use by the disk drive (see figure 31).

The format and structure of the Primary Defect List shall be as defined in tables 11 (format) and 12 (structure) respectively.

The maximum number of bad (unusable) sectors in the recording zone shall not exceed the limits specified in tables 7 and 8.

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Table 11 - Primary Defect List format for 14,8 Gbyte and 25 Gbyte capacity

Field name	Byte number	length	Function
PDLHEADER 14,8 & 25 Gbytes			To present the index to the start of data for each band. PDLHeader has the subfields given below.
(INDEX0)	0 to 1	2	The relative address index from this sector to the header for Band 0.
(INDEX1)	2 to 3	2	The relative address index from this sector to the header for Band 1.
(INDEX2)	4 to 5	2	The relative address index from this sector to the header for Band 2.
(INDEX3)	6 to 7	2	The relative address index from this sector to the header for Band 3.
(INDEX4)	8 to 9	2	The relative address index from this sector to the header for Band 4.
(INDEX5) 25 Gbytes only	10 to 11	2	The relative address index from this sector to the header for band 5
(INDEX6) 25 Gbytes only	12 to 13	2	The relative address index from this sector to the header for band 6
(INDEX7) 25 Gbytes only	14 to 15	2	The relative address index from this sector to the header for band 7
(INDEX8) 25 Gbytes only	16 to 17	2	The relative address index from this sector to the header for band 8
(INDEX9) 25 Gbytes only	18 to 19	2	The relative address index from this sector to the header for band 9
RESERVED 14,8 Gbytes	10 to 15	6	Reserved
25 Gbytes	20 to 25	6	Reserved
BANDHEADER 14,8 Gbytes	16 to 23	8	Counts of the number of sectors and records in the Bad Sector Map. BANDHEADER has the two subfields listed below:
25 Gbytes	26 to 33	8	Counts of the number of sectors and records in the Bad Sector Map. BANDHEADER has the two subfields listed below:
(SECCOUNT) 14,8 Gbytes	24 to 27	4	Count of the number of sectors used by the current band.
25 Gbytes	34 to 37	4	Count of the number of sectors used by the current band.
(DEFCOUNT) 14,8 Gbytes	28 to 31	4	Count of the number of defective sectors on the current band. This count indicates the total number of BADSECADD records.
25 Gbytes	38 to 41	4	Count of the number of defective sectors on the current band. This count indicates the total number of BADSECADD records.
BADSECADD 14,8 Gbytes	32 to 35	4	Absolute address of a bad sector. This field is repeated for every defective sector in the band.
25 Gbytes	42 to 45	4	Absolute address of a bad sector. This field is repeated for every defective sector in the band.

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Table 11 (concluded)

Note 1. The field BADSECADD is repeated for each defective sector in the band. It is a sequential listing of all defective sectors. It is likely that these repeated BADSECADD records will span contiguously several sequential sectors.

Note 2. No defective sectors shall be skipped within the Primary Defect Lists.

Note 3. The Primary Defect List shall be located near the start of each band as defined by the contents of the disk Identification Sector. Each Primary Defect List (in each band) will contain information about all sectors of that surface of the optical disk that are bad.

Note 4. The record PDLHEADER will appear at the start of each Primary Defect List and before each bandheader. It is the first record of the sector pointed to by the disk Identification Sector.

Note 5. The PDL does not necessarily have to be written contiguously. There can be blank sectors preceding the BANDHEADERs. However, if the PDL is written contiguously then the values of the SECCOUNT fields can be computed from the INDEXi fields.

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Table 12 - Structure of the primary defect list (PDL)

PDLHEADER and BANDHEADER are records that always are at the start of a band.

For each Primary Defect List in a band for both 14,8 Gbyte and 25 Gbyte capacities, the following applies:

PDLHEADER		(Sector number given in the Identification Sector)
BANDHEADER	Band 0	(sector index 0)
BADSECADD		
*		
*		
BADSECADD		
PDLHEADER		
BANDHEADER	Band 1	(sector index 1)
BADSECADD		
*		
*		
BADSECADD		
PDLHEADER		
BANDHEADER	Band 2	(sector index 2)
BADSECADD		
*		
*		
BADSECADD		
PDLHEADER		
BANDHEADER	Band 3	(sector index 3)
BADSECADD		
*		
*		
BADSECADD		
PDLHEADER		
BANDHEADER	Band 4	(sector index 4)
BADSECADD		

For each Primary Defect List in a band for only 25 Gbyte capacity, the following applies:

(Note: in the second sector of the Identification Sectors)

*		
BADSECADD		
PDLHEADER		
BANDHEADER	Band 5	(sector index 5)
BADSECADD		
*		
*		

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Table 12 (concluded)

BADSECADD		
PDLHEADER		
BANDHEADER	Band 6	(sector index 6)
BADSECADD		
*		
*		
BADSECADD		
PDLHEADER		
BANDHEADER	Band 7	(sector index 7)
BADSECADD		
*		
*		
BADSECADD		
PDLHEADER		
BANDHEADER	Band 8	(sector index 8)
BADSECADD		
*		
*		
BADSECADD		
PDLHEADER		
BANDHEADER	Band 9	(sector index 9)
BADSECADD		

For each Primary Defect List in a band for both 14,8 Gbyte and 25 Gbyte capacities, the following applies:

*		
*		
BADSECADD		

21.8 Supplemental and configuration sectors

The usable sectors in each band include two sectors that are provided for use by the disk drive to record any supplemental data desired (see figure 32). These sectors shall be contiguous to the Primary Defect List Sectors. For this standard, the contents of these sectors shall be ignored in interchange.

21.9 OD write power calibration sectors

Reserved sectors are provided for use by the disk drive for outside diameter of a band write power calibration (see tables 7 and 8).

21.10 Automatic rewrite sectors

The usable sectors in each band include reserved sectors for automatic rewrite of user data which is detected by the disk drive to be marginal with respect to data integrity (see tables 7 and 8).

21.11 User sector format for 14,8 Gbyte capacity

The user sector format is summarized in tabular form in table 13 for 14, Gbytescapacity.

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Table 13 - User sector format for 14,8 Gbyte capacity

	Length	Field
	(bytes)	
Pre-formatted user	19	VFO sync
sector header	4	Phase sync
	1	VFO sync
	1	Address mark 0
	1	Reserved
	4	Sector address
	2	CRC-16
User data field preamble	1	Gap
and pre-formatted	20	VFO sync
pad	4	Phase sync
	1	Address mark 1
	7	Data control field
	4	Phase sync
	1	Address mark 2
	4	Phase sync
	1	Address mark 3
	4	Phase sync
	4	Data control field
	3	Pad
	3	Data control field
	1	Address mark 4
	1	Phase sync
User data field and	52	data bytes 1 to 52
pre-formatted tracking	3	Pad
pads	57	Data bytes 53 to 109
	3	Pad
	57	Data bytes 110 to 166
	3	Pad
	57	Data bytes 167 to 223
	3	Pad
	57	Data bytes 224 to 280
	3	Pad
	57	Data bytes 281 to 337
	3	Pad
	57	Data bytes 338 to 394
	3	Pad
	57	Data bytes 395 to 451
	3	Pad
	57	Data bytes 452 to 508P
	3	Pad
	57	Data bytes 509 to 565

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		Table 13 concluded
	3	Pad
	57	Data bytes 566 to 622
	3	Pad
	57	Data bytes 623 to 679
	3	Pad
	57	Data bytes 680 to 736
	3	Pad
	57	Data bytes 737 to 793
	3	Pad
	57	Data bytes 794 to 850
	3	Pad
	57	Data bytes 851 to 907
	3	Pad
	57	Data bytes 908 to 964
	3	Pad
	57	Data bytes 965 to 1021
	3	Pad
	57	Data bytes 1021 to 1024
EDAC and one tracking	54	EDAC 1 - 54
pad	3	Pad
	26	EDAC 55 -80
Interface sector gap	8	Gap
Total:	1260	

21.11.1 Pre-formatted user sector header

21.11.1.1 VFO sync

A fixed pattern, 19 bytes in length, that allows the variable frequency oscillator (VFO) of the channel decoder to synchronize to the incoming bit stream. The field shall consist of bytes set to (FF).

21.11.1.2 Phase sync

A fixed pattern, 4 bytes in length, used by the decoder to resolve the phase ambiguity of the DM-M code. The field shall consist of bytes set to (AA).

21.11.1.3 VFO sync

One byte set to (FF).

21.11.1.4 Address Mark 0

A fixed pattern, 1 byte in length, used by the decoder to identify the byte boundaries for the sector header. See figure 34 which defines the address marks for 14,8 Gbyte capacity.

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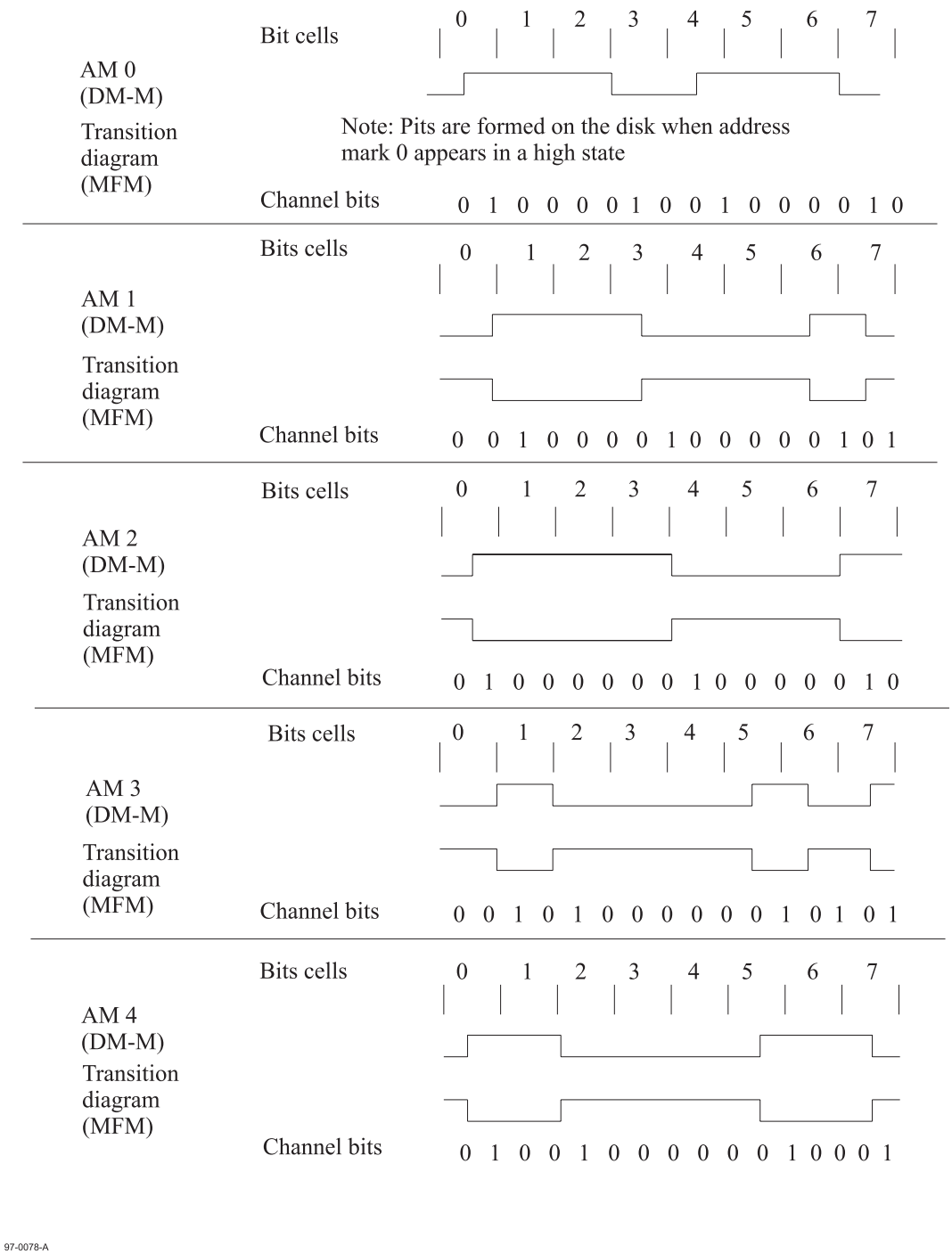


Figure 34 - Address mark definition for a 14,8 Gbyte disk

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21.11.1.5 Reserved

One byte set to (FA).

21.11.1.6 Sector address

A four-byte field that contains the sector address. The sectors are numbered sequentially from the outside of the disk (see table 5). Sector number 0 is the first sector in the five tracks preceding the first user available sector in Band 0.

21.11.1.7 CRC field

A two-byte field that contains a two-byte cyclic redundancy check, CRC-16, on the reserved byte and the address field.

21.11.2 User data field preamble and pre-formatted tracking pad

The pre-written user data field preamble is 59 bytes long.

21.11.2.1 Gap

A gap, 1 byte in length, is a blank area between the user sector header and the pre-written data field preamble.

21.11.2.2 VFO sync

The field shall consist of 20 bytes set to (FF).

21.11.2.3 Phase sync

The field shall consist of 4 bytes set to (AA). This phase sync pattern is repeated four times in the user data field preamble as listed in table 13.

21.11.2.4 Address Mark 1,2,3, and 4

Each address mark 1, 2, 3 and 4 is a unique fixed pattern, 1 byte in length. One each of the four address marks are contained in the user data field preamble per table 13. The address marks 1, 2, 3 and 4 shall be as defined by figure 34.

21.11.2.5 Data control field

The data control field (DCF) is 7 bytes in length as follows:

The DCF in the user data field preamble contains the physical address. The first four bytes are the physical address, the next byte is set to all ZEROs, and the last two bytes are CRC-16.

The DCF in the Identification Sector and in the Primary Defect List Sectors consists of five bytes set to all ZEROs followed by two bytes CRC-16 calculated on the reserved bytes.

21.11.3 Pre-formatted tracking pads

A tracking pad consists of a 3-byte pattern of one unrecorded byte followed by a 1-byte long mark or groove, followed by 1 unrecorded byte. The locations of tracking pads throughout the user sector format is given in table 13. The tracking pads shall be aligned so that the leading edge of the mark is an integer multiple of 60 bytes from the leading edge of the first bit cell for the Address Mark 0.

21.11.4 User data field

The user data field shall be 1 024 bytes in length. The user data field shall contain 18 pre-formatted tracking pads dispersed throughout the user data field consistent with 20.2.3. The quantity of user sectors in each band is given in table 5.

21.11.5 Error detection and correction (EDAC)

The EDAC field is 80 bytes in length containing the error detection and correction information for the user data field. (see table 13).

One pre-formatted tracking pad is included in the EDAC field (see table 13).

21.11.6 Interface sector gap

The interface sector gap is 8 bytes in length.

21.12 User sector format for 25 Gbyte capacity

The user sector format is summarized in tabular form in table 14 for 25 Gbyte capacity.

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Table 14 - User sector format for 25 Gbyte capacity

	Length	Field
	(bytes)	
Pre-formatted	11	VFO (must be recorded to maintain 3 byte tracking pad)
user	3	Tracking pad
sector	2	Address mark A
header	4	Preformatted address
	2	CRC
	1	Guard byte
	2	Gap
User data field preamble	4	Reserved
	18	VFO
	2	Address mark B
	6	VFO
	2	Address mark C
	6	Data control field 1
	6	VFO
	2	Address mark D
	6	VFO
	2	Address mark E
	6	Data control field 2
User data field and	28	Data bytes 1 to 28
pre-formatted	3	Pad
tracking pads	99	Data bytes 29 to 127
	3	Pad
	99	Data bytes 128 to 226
	3	Pad
	99	Data bytes 227 to 325
	3	Pad
	99	Data bytes 326 to 424
	3	Pad
	99	Data bytes 425 to 523
	3	Pad
	99	Data bytes 524 to 622
	3	Pad
	99	Data bytes 623 to 721
	3	Pad
	99	Data bytes 722 to820
	3	Pad
	99	Data bytes 821 to 919

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		Table 14 (concluded)
	3	Pad
	99	Data bytes 920 to 1018
	3	Pad
	6	Data bytes 1019 to 1024
EDAC	80	EDAC bytes 1 to 80
	1	Guard byte
Interface sector gap	1	
Total:	1224	

21.12.1 Pre-formatted User sector header

21.12.1.1 VFO sync

A fixed pattern, 11 bytes in length, that allows the variable frequency oscillator (VFO) of the channel decoder to synchronize to the incoming bit stream. The field will consist of 11 bytes comprised of a mark 6T in length followed by a land 6T in length where T is the channel clock time in nanoseconds.

21.12.1.2 Tracking pad

A tracking pad consists of a 3-byte pattern of one unrecorded byte followed by a 1-byte long mark or groove, followed by 1 unrecorded byte. The locations of tracking pads throughout the user sector format is given in table 14. The tracking pads shall be aligned so that the leading edge of the mark is an integer multiple of 102 bytes from the leading edge of the preceding mark and the following mark.

21.12.1.3 Address mark A

A fixed pattern, 2 bytes in length, used by the decoder to identify the byte boundaries for the sector header. See figure 35 which defines the address marks.

	1T Channel Data
Address Mark A	100 000 000 010 010 010 000 000
Address Mark B	100 000 000 010 000 000 100 100
Address Mark C	100 000 000 010 010 000 010 000
Address Mark D	100 000 000 010 000 100 000 100
Address Mark E	100 000 000 010 010 100 010 100

Figure 35 - Address mark definition for 25 Gbyte disk

21.12.1.4 Pre-formatted address

A four-byte field that contains the sector address. The sectors are numbered sequentially from the outside of the disk (see table 6). Sector number 0 is the first sector in the five tracks preceding the first user available sector in Band 0.

21.12.1.5 CRC

A two-byte field that contains a two-byte cyclic redundancy check, CRC-16, on the reserved byte and the address field.

21.12.1.6 Guard byte

The guard byte, 1 byte in length, is a pre-formatted area provided to end the RLL (1,7) CRC information. Shall be set to (30).

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21.12.1.7 Gap

21.12.2 User data field preamble

A gap, 2 bytes in length, is a blank area between the user sector header and the pre-written data field preamble.

21.12.2.1 Reserved

This area, 4 bytes in length, is reserved for future use and will be left blank for this standard.

21.12.2.2 VFO

A fixed pattern, 18 bytes in length, that allows the variable frequency oscillator (VFO) of the channel decoder to synchronize to the incoming bit stream. The field will consist of 18 bytes comprised of a mark 6T in length followed by a land 6T in length where T is the channel clock time in nanoseconds.

21.12.2.3 Address mark B

A fixed pattern, 2 bytes in length, used by the decoder to identify byte boundaries for the sector header. See figure 35 which defines the address marks.

21.12.2.4 VFO

A fixed pattern, 6 bytes in length, that allows the variable frequency oscillator (VFO) of the channel decoder to synchronize to the incoming bit stream. The field will consist of 6 bytes comprised of a mark 6T in length followed by a land 6T in length where T is the channel clock time in nanoseconds.

21.12.2.5 Address mark C

A fixed pattern, 2 bytes in length, used by the decoder to identify byte boundaries for the sector header. See figure 35 which defines the address marks.

21.12.2.6 Data control field 1

The data control field (DCF) is 6 bytes in length as follows:

The DCF in the user data field preamble contains the physical address. The first four bytes contain the address and the last two bytes are CRC-16.

21.12.2.7 VFO

A fixed pattern, 6 bytes in length, that allows the variable frequency oscillator (VFO) of the channel decoder to synchronize to the incoming bit stream. The field will consist of 6 bytes comprised of a mark 6T in length followed by a land 6T in length where T is the channel clock time in nanoseconds.

21.12.2.8 Address mark D

A fixed pattern, 2 bytes in length, used by the decoder to identify byte boundaries for the sector header. See figure 35 which defines the address marks.

21.12.2.9 VFO

A fixed pattern, 6 bytes in length, that allows the variable frequency oscillator (VFO) of the channel decoder to synchronize to the incoming bit stream. The field will consist of 6 bytes comprised of a mark 6T in length followed by a land 6T in length where T is the channel clock time in nanoseconds.

21.12.2.10 Address mark E

A fixed pattern, 2 bytes in length, used by the decoder to identify byte boundaries for the sector header. See figure 35 which defines the address marks.

21.12.2.11 Data control field 2

The data control field 2 is a copy of the data control field 1. The data control field (DCF) is 6 bytes in length as follows:

The DCF in the user data field preamble contains the physical address. The first four bytes contain the address and the last two bytes are CRC-16.

21.12.3 Pre-formatted tracking pads

A tracking pad consists of a 3-byte pattern of one unrecorded byte followed by a 1-byte long mark or groove, followed by 1 unrecorded byte. The locations of tracking pads throughout the user sector format is given in table 14. The tracking pads shall

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be aligned so that the leading edge of the mark is an integer multiple of 102 bytes from the leading edge of the preceding mark and the following mark.

21.12.4 User data field

The user data field shall be 1 024 bytes in length. The user data field shall contain 11 pre-formatted tracking pads dispersed throughout the user data field consistent with 20.2.3 and locations as given in table 14

21.11.5 Error detection and correction (EDAC)

The EDAC field is 80 bytes in length containing the error detection and correction information for the user data field.

21.12.6 Guard byte

The guard byte is a pre-written area, 1 byte in length, to ensure the RLL (1,7) encoded EDAC bytes do not impinge upon the interface sector gap.

Shall be set to (30)**.**

21.12.7 Interface sector gap

The interface sector gap is a blank area, 1 bytes in length, between the end and the beginning of physically adjacent sectors. It is used to prevent run over from one sector into an adjacent sector.

21.13 Sectors following the user sectors in each band

21.13.1 Allowance for the maximum number of bad sectors in the PDL

The number of sectors provided in each band to replace any sectors specified in the Primary Defect List Sectors.

21.13.2 ID write power calibration sectors

Reserved sectors are provided for use by the disk drive for write power calibration at the inside diameter of a band. (see table 6)

21.13.3 ID manufacturing test sectors

The manufacturing test sectors at the inside diameter of a band are provided for use by the optical disk manufacturer.

21.13.4 Spin out tracking sectors

The spin out tracking sectors must be pre-formatted but their addresses do not need to be accessible by the drive.

22 Coding method

22.1 Coding method for 14,8 Gbyte capacity

All data except the address marks and the tracking pads shall be delay modulation mark (DM-M) encoded.

DM-M code translates data bits to transitions on the media. Each data bit is represented by two DM-M Channel bits. A ONE in a DM-M Channel bit indicates a transition of the record laser power level which produces a transition in reflectivity of the media due to laser marking. The encoding rules for DM-M Channel bits are as follows:

– a ONE data bit shall be represented by two Channel bits set to: ZERO ONE,

– a ZERO data bit preceded by a ZERO data bit shall be represented by two Channel bits set to: ONE ZERO,

– a ZERO data bit preceded by a ONE data bit shall be represented by two Channel bits set to: ZERO ZERO.

The data shall be recorded most significant bit first.

The edges of all data shall be recorded with an accuracy of ± 17,5 % of a data bit.

22.2 Coding method for 25 Gbyte capacity

All data except the address marks and the tracking pads shall be RLL (1,7) encoded. Refer to the following State diagram for the encoding rules.

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State diagram

		X		
Y	00	01	10	11
S0	0/2	2/2	1/2	3/2
S1	0/1	4/1	1/1	4/2
S2	0/4	2/4	1/4	3/4
S3	0/5	4/5	1/5	4/4
S4	0/0	2/0	1/0	3/0
S5	0/1	4/1	1/1	4/0
S6	0/0	2/0	1/0	3/0
S7	0/1	4/1	1/1	4/0

FORMAT: Y'/Z All values except X are in octal

Y'	=	(y'_2,y'_1,y'_0)	=	next state
z	=	(z_2,z_1,z_0)	=	code output
y	=	(y_2,y_1,y_0)	=	present state
x	=	(x_1,x_0)	=	NRZ input

23 Defect management

23.1 Defect management description

Defect sectors on the disk shall be replaced by good sectors according to the defect management scheme described below. Each side of the optical disk is pre-initialized and certified before use in the optical drive. Defective sectors found during pre-initialization certification are handled by a Sector Slipping Algorithm. The total number of defective sectors on a side shall not be greater than 43 059 for the 25 Gbyte capacity disk and 31 600 for the 14,8 Gbyte capacity disk. Note: The total number of defective sectors on a side is the sum of the maximum number of bad sectors allowed for each band during disk certification by the manufacturer plus the sum of the automatic re-write sectors for each band.

23.2 Initialization of the disk

During initialization of the disk, 5 or 10 Defect Management Areas (DMA) per disk side (5 for 14,8 Gbyte capacity and 10 for 25 Gbyte capacity) are recorded prior to the first usage of the disk. Each DMA is 48 sectors in length and each shall contain the primary defect list or PDL. There are also 5 or 10 Reallocation Areas (RA) per disk side The RAs contain the grown defect lists (GDLs) and the reallocated sectors. The contents of the PDLs and GDLs are shown in table 16 and table 17 respectively.

The media is divided into 5 or 10 Bands, each containing user data sectors and reallocation sectors. Media initialization includes certification of the entire disk surface, whereby defective sectors are identified and skipped.

Once the DMAs are recorded, it indicates that the disk is initialized. No further initialization is required or permitted once the media leaves the manufacturer.

23.3 Certification

Defective sectors found during certification shall be handled by the sector Slipping Algorithm. Defective sectors shall not be used for reading or writing. Guidelines for replacing defective sectors are given in 23.9. Table 15 shows the maximum allowed defective sectors during certification.

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Table 15

Maximum Allowed Defective Sectors During Certification by the disk manufacturer

	25 Gbytes	**14,8 Gbytes**
Band	Maximum	Maximum
	number	number
0	1 726	6 405
1	1 616	4 074
2	1 505	2 985
3	1 395	2 139
4	1 285	1 856
5	1 175	
6	1 065	
7	955	
8	845	
9	734	
Totals:	12 301	17 459

23.4 Slipping algorithm

The Slipping Algorithm shall be applied individually to each and every band on the disk at the time the disk is certified.

A defective data sector found during certification shall be replaced by the first good sector following the defective sector, and so causing a slip of one sector towards the end of the band. The user data area is sized to take into account the maximum allowed defective sectors due to slipping to guarantee the user data capacity per disk side. The maximum number of defective sectors allowed during certification can be found in table 15. The address of the defective sector is written in the PDL If no defective sectors are found during certification, no information is recorded in the PDL.

23.5 Write procedure

When writing or reading data in the sectors of a Band, all defective sectors listed in the PDL shall be skipped and the data shall be written in the next data sector according to the sector Slipping Algorithm. If a write failure or a verify failure occurs the failed sector shall be written to the Reallocation Area of that Band and the failed sector added to the new GDL.

If the reallocation area of a Band is full, the defective sector shall be replaced by the first available reallocation area sector of another Band.

The addresses of sectors already recorded in the PDL shall not be recorded in the GDL.

If a replacement sector listed in the GDL is later found to be defective, it shall be written to the Reallocation Area of that Band and the failed sector added to the GDL.

Guidelines for replacing defective sectors are given in 23.9.

23.6 Primary defect list

The PDL shall consist of bytes specifying:

– The relative address location of all PDLs in all Bands.

– A count of the number of sectors in the PDL.

– A count of the number of sectors used by the current band.

– A count of the number of defective sectors, found during certification, in the current band.

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– The pre-formatted sector addresses of all the defective sectors in the band. It is a sequential listing of all defective sectors.

– The PDLHeader and Band Header are repeated for each Band.

Table 16 shows the PDL byte layout. All remaining bytes of the last sector in which the PDL is recorded, shall be set to (00). If no defective sectors are detected, then byte 74 (size in sectors of PDL excluding the ID sector) of the Identification Sector shall be set to 0.

It is likely that the PDL will span several contiguous sectors.

No defective sectors shall be skipped within the PDL.

The PDL shall be located near the start of each band as defined by the contents of the disk Identification Sector. Each PDL (in each band) will contain information about all sectors of that surface of the optical disk that are defective.

The PDLHeader will appear at the start of each PDL and before each BandHeader. It is the first record of the sector pointed to by the disk Identification Sector.

The PDL shall be written contiguously from sector to sector. There can be sectors proceeding the BandHeader's. However, if the PDL is written contiguously then the values of the SecCount fields can be computed from the Index(i) fields.

Table 16 - Content of the Primary Defect List

Byte	Length	Name	Description
0-25	26	PDLHeader	To present the index to the start of data for each band. PDLHeader has 10 subfields given below.
0-1	2	(Index0)	The relative address index from this sector to the header of Band 0.
2-3	2	(Index1)	The relative address index from this sector to the header of Band 1.
4-5	2	(Index2)	The relative address index from this sector to the header of Band 2.
6-7	2	(Index3)	The relative address index from this sector to the header of Band 3.
8-9	2	(Index4)	The relative address index from this sector to the header of Band 4.
10-11	2	(Index5)	The relative address index from this sector to the header of Band 5.
12-13	2	(Index6)	The relative address index from this sector to the header of Band 6.
14-15	2	(Index7)	The relative address index from this sector to the header of Band 7.
16-17	2	(Index8)	The relative address index from this sector to the header of Band 8.
18-19	2	(Index9)	The relative address index from this sector to the header of Band 9.
20-25	6		RESERVED
26-33	8	BandHeader	Counts of the number of sectors and records in the PDL. BandHeader has two subfields listed below.
26-29	4	(SecCount)	Count of the number of PDL sectors used by the current Band.
30-33	4	(DefCount)	Count of the number of defective sectors in the current Band. This count indicates the total number of DefSecAdd.
34-37	4	DefSecAdd.	preformatted sector address of a defective sector. This field is repeated for every defective sector in the band.

23.7 Secondary Defect List (SDL)

An SDL is used to record addresses of data which have become defective after initialization and those of their respective replacements. There is not a SDL in this standard.

23.8 Grown Defect List (GDL)

The GDL is used to record addresses of data which have been detected defective by the optical recording device and automatically reallocated. Eight bytes are used for each entry. The first 4 bytes of the data specify the logical address of the defective sector and the next 4 bytes specify the Preformatted Sector address of the replacement sector.

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In the reallocation area the GDLs are randomly written with the reallocated defective sectors. To identify a GDL the upper nibble of the logical address will contain a hexadecimal F. The remainder of the logical address, starting at the least significant nibble, identifies the number of GDLs written for that Band.

The GDL shall consist of bytes identifying the GDL, specifying the length of the GDL, specifying the GDL page number and total number of GDL pages, a list containing the addresses of defective sectors and those of their replacement sectors. The logical addresses of the defective sectors shall be in ascending order. Table 17 shows the GDL layout. All remaining bytes of the last sector in which the GDL is recorded shall be set to (FF). A GDL will only exist if at least one sector or greater than one sector has been reallocated.

Table 17 - Content of the Grown Defect List

Byte	Length	Descriptions
0	1	GDL LSB Identifier
1	1	GDL MSB Identifier
2	1	(00) Blank
3	1	Length of the GDL in bytes from byte 8 to byte x, MSB
4	1	Length of the GDL in bytes from byte 8 to byte x, LSB (An empty GDL has length 7)
5	1	(00) Blank
6	1	Page number of the GDL. Start count from 1.
7	1	Total number of GDL pages.
8	1	First byte of the logical address of the first defective sector
9	1	Second byte of the logical address of the first defective sector
10	1	Third byte of the logical address of the first defective sector
11	1	Fourth byte of the logical address of the first defective sector
12	1	First byte of the Pre-formatted Sector address of the first replacement sector
13	1	Second byte of the Pre-formatted Sector address of the first replacement sector
14	1	Third byte of the Pre-formatted Sector address of the first replacement sector
15	1	Fourth byte of the Pre-formatted Sector address of the first replacement sector
x-7	1	First byte of the logical address of the last defective sector
x-6	1	Second byte of the logical address of the last defective sector
x-5	1	Third byte of the logical address of the last defective sector
x-4	1	Fourth byte of the logical address of the last defective sector
x-3	1	First byte of the Pre-formatted Sector address of the last replacement sector
x-2	1	Second byte of the Pre-formatted Sector address of the last replacement sector
x-1	1	Third byte of the Pre-formatted Sector address of the last replacement sector
x	1	Fourth byte of the Preformatted Sector address of the last replacement sector

23.9 Sector Retirement Guidelines

This Standard assumes that the total number of sectors in table 15 per disk side may be replaced by the sector Slipping Algorithm in any of the following cases:

– More than 100 of the 160 bits of the VFO field are defective.

– More than one of the four Address Marks are defective.

– Any defect in the user data area of the sector is greater than 100 µm in length.

Also, if the sum of all the defect areas within the user area of the sector exceed 100 µm.

This Standard assumes that the total number of sectors in table 18 per disk side may be reallocated due to a write failure, a verify failure as part of a SCSI "write and verify" command, a read failure, or a verify failure as part of a SCSI "verify" command.

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Table 18 - RA Size

	25 Gbytes	**14,8 Gbytes**
Band	Number	Number
0	4 314	4 595
1	4 038	3 926
2	3 762	2 815
3	3 487	1 861
4	3 211	944
5	2 936	
6	2 661	
7	2 386	
8	2 110	
9	1 834	
Total:	30 739	14 141

a) The sector reallocation criteria due to a write failure or a verify failure during a SCSI "write and verify" command (referred to as Automatic Write Reallocation) shall be:

- A malfunction is detected by the optical recording device during the write or verify process.

- A sector does not have at least one readable pre-formatted sector or data control field sector address.

- The pre-formatted sector address is not readable and the previous two pre-formatted sector addresses were not readable.

- The pre-formatted sector address is readable but neither data control field address is readable and the previous two data control field addresses were not readable.

- Three defective bytes in one ECC interleave of a 1 024-byte sector.

- One Address Mark out of five was detected within the sector.

b) The sector reallocation criteria due to a read failure or a verify failure during a "verify" SCSI command (referred to as Automatic Read Reallocation) shall be:

- A malfunction is detected by the optical recording device during the read or verify process. In order for reallocation to occur, it is assumed that the data is recoverable through retries.

- A sector does not have a least one readable pre-formatted sector or data control field sector address.

- The pre-formatted sector address is not readable and the previous two pre-formatted sector addresses were not readable.

- The pre-formatted sector address is readable but neither data control field address is readable and the previous two data control field addresses were not readable.

- Six defective bytes in one ECC interleave of a 1 024 byte sector. This shall be referred to as EDAC Marginal.

- One Address Mark out of five was detected within the sector. This shall be referred to as Address Mark Marginal.

24 Recorded characteristics

The pre-formed or pre-formatted information shall have the same signal characteristics as the disk drive recorded pre-written and user data.

25 Error detection and correction (EDAC)

25.1 EDAC field

The EDAC field shall be 80 bytes in length containing the error detection and correction information for the user data field (see tables 12 and 13).

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25.2 EDAC type

The EDAC code shall be a long distance Reed-Solomon code, interleaved to depth five, operating on one byte symbols.

The EDAC polynomial shall be as follows:

The algebra used by this code is defined over the Galois field GF 2^8 by α, where α is a root of the primitive binary polynomial:

$x^8 + x^7 + x^2 + x^1 + 1$

The finite field elements are given by $\theta^i = \alpha^{2i}$

The generator polynomial has roots θ^i for $120 \le i \le 135$. This leads to:

$$G(x) = \prod_{i=120}^{i=135} (x + \theta^i)$$

The coefficients of *G(x)* are:

(D4) (75) (BB) (B2) (13) (52) (71) (D4) (9B) (D4) (71) (52) (13) (B2) (BB) (75) (D4)

The EDAC interleaving shall be as follows:

The code is interleaved to depth five. This means that each data byte belongs to one of *n* subcodes, where *n* = 0 to 4.

Subcode 0 has block length 220 bytes, 204 data bytes.
Subcode 1 has block length 221 bytes, 205 data bytes.
Subcode 2 has block length 221 bytes, 205 data bytes.
Subcode 3 has block length 221 bytes, 205 data bytes.
Subcode 4 has block length 221 bytes, 205 data bytes.

The 80 check bytes follow the 1 024 data bytes and are interleaved such that if the data bytes are numbered sequentially B_1 to B_{1024} and the check bytes are B_{1025} to B_{1104}, then the j-th byte in the n-th subcode is given by:

$S_j^n = B_{5j+n}$ j = 0 to 220

Note that S_o^o has no corresponding data byte.

26 Data interchange requirements

An interchanged optical disk cartridge according to this standard shall satisfy the following requirements.

26.1 Requirements for reading

The data recorded on the disk shall be readable under the read conditions specified in 9.2.

26.2 Requirements for writing

Data shall be recorded under the write conditions specified in 9.3.

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Annex A

(normative)

Definition of air cleanliness of class 100 000

The classification of air cleanliness is based on a particle count with a maximum allowable number of specified minimum sized particles per unit volume, and on a statistical average particle size distribution.

A.1 Definition

The particle count shall not exceed a total of 3 500 000 particles per cubic metre of a size 0,5 µm and larger.

The statistical average particle size distribution is given in figure A.1. Class 100 000 means that 3 500 000 particles per cubic metre of a size of 0,5 µm and larger are allowed, but only 25 000 particles per cubic metre of a size of 5,0 µm and larger.

It should be recognized that single sample distribution may deviate from this curve because of local or temporary conditions. Counts below 350 000 particles per cubic metre are unreliable except when a large number of samplings is taken.

A.2 Test method

For particles in the size range of 0,5 µm to 5,0 µm, equipment employing light-scattering principles shall be used. The air in the controlled environment is sampled at a known flow rate. Particles contained in the sampled air are passed through an illuminated sensing zone in the optical chamber of the instrument. Light scattered by individual particles is received by a photo detector which converts the light pulses into electrical current pulses. An electronic system relates the pulse height to particle size and counts the pulses such that the number of particles in relation to particle size is registered or displayed.

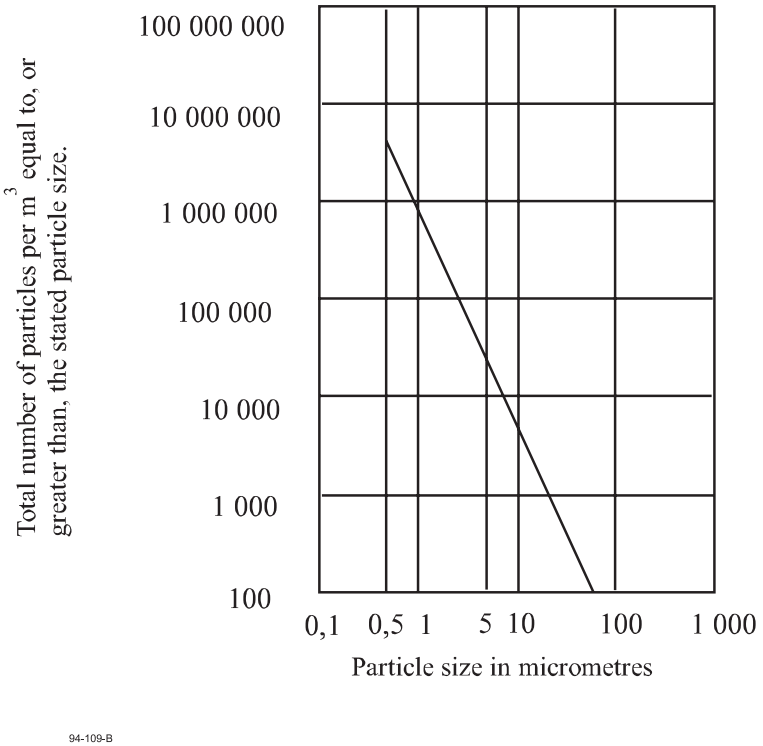


Figure A.1 - Particle size distribution curve

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Annex B

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Residual tracking error signal test method

B.1 Introduction

The residual tracking error signal is the result of the tracking servo system's inability to perfectly reject disturbances. The sources of these disturbances are numerous and include radial runout, radial acceleration, vibration.

Residual tracking error shall be measured using the system shown in concept in figure R.1. The closed-loop tracking servo system shall have sufficient bandwidth so that the residual tracking error signal provides a linear, high-resolution measurement of the track position. A position sensor is used to provide a low resolution measurement of the tracking lens position, therefore also of the track. When the residual tracking error (RTE) signal is added to the lens position sensor signal, an exact measure of the position of the track is achieved. This track position signal is then processed by a digital or analog filter the disturbance rejection transfer function of which is given in the following equation. The output of the filter is a simulation of the residual tracking error produced by such a "standardized" servo system.

$$\frac{\text{RTE}}{\text{Actual deviation}} = \frac{1}{1+\dfrac{G\omega_n^2\left(1+s/a\right)}{(1+s/b)\left(s^2+2sz\omega_n+\omega_n^2\right)}}$$

where:

G = 1.000
ω_n = 2 π 40 rad/s
b = 2 π 5 690 rad/s
z = 0,2 typical
a = 2 π 569 rad/s
s = j2 πf (laplace transform variable)

B.2 Procedure

Measure the residual tracking error in each band of the disk in keeping with the intended rotational speed at each location.

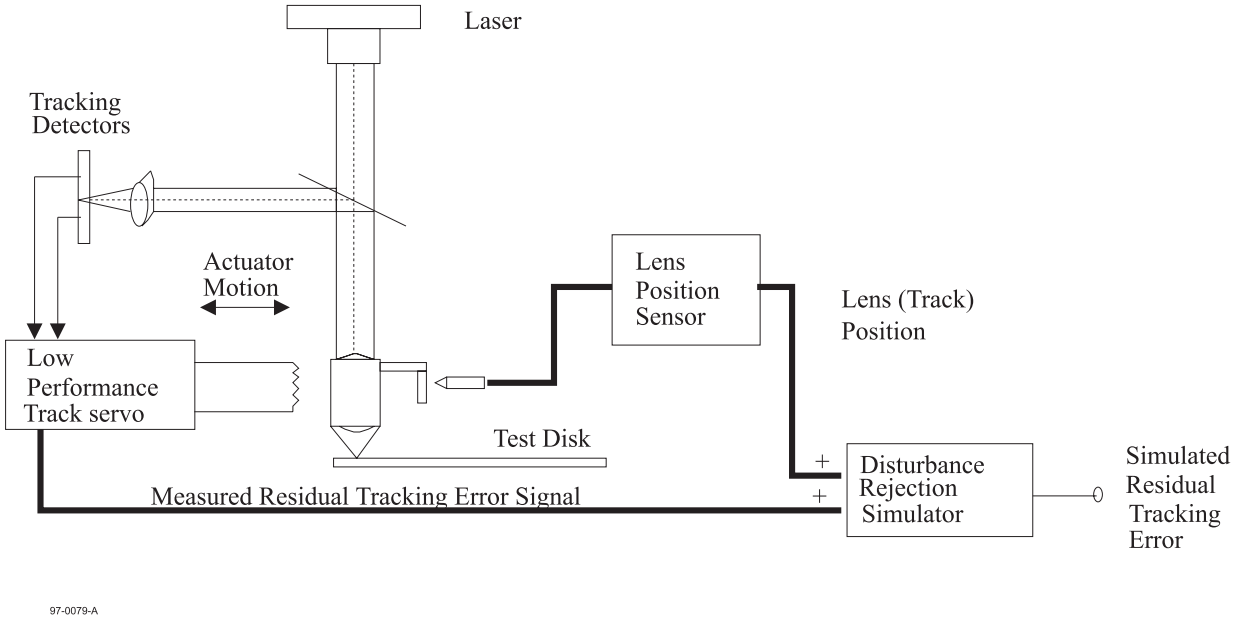


Figure B.1 - Residual tracking error signal

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Annex C

(normative)

Mechanical test method

C.1 Testing environment

Measurements shall be performed in the test environment defined in 8.1.1.

Measurement precision shall conform to the following description of the Performance-Tolerance Ratio (P/T) where P/T < 0,2:

$$P / T = \frac{6\sigma}{\text{tolerance}}$$

where

σ = measurement standard deviation
tolerance = specification upper bound minus specification lower bound

C.2 Mechanical test conditions

a) The surface of the support sleeve which contacts the optical disk at datum target A1 during testing, shall have a maximum peak-to-peak physical displacement perpendicular to the datum target A1 of 0,0025 mm.

b) A clamping force *F*1 smaller than 125 N shall be applied uniformly over the clamping zone.

c) A typical mechanical clamping method is shown in figure C.1

- The centring cone angle (AB) shall be 10° ± 1°

- The centring cone force (*F*2) shall be 15,6 N ± 2,2 N.

C.3 Test procedures

Accepted industry practice shall be used to measure dimensional and physical characteristics unless otherwise specified.

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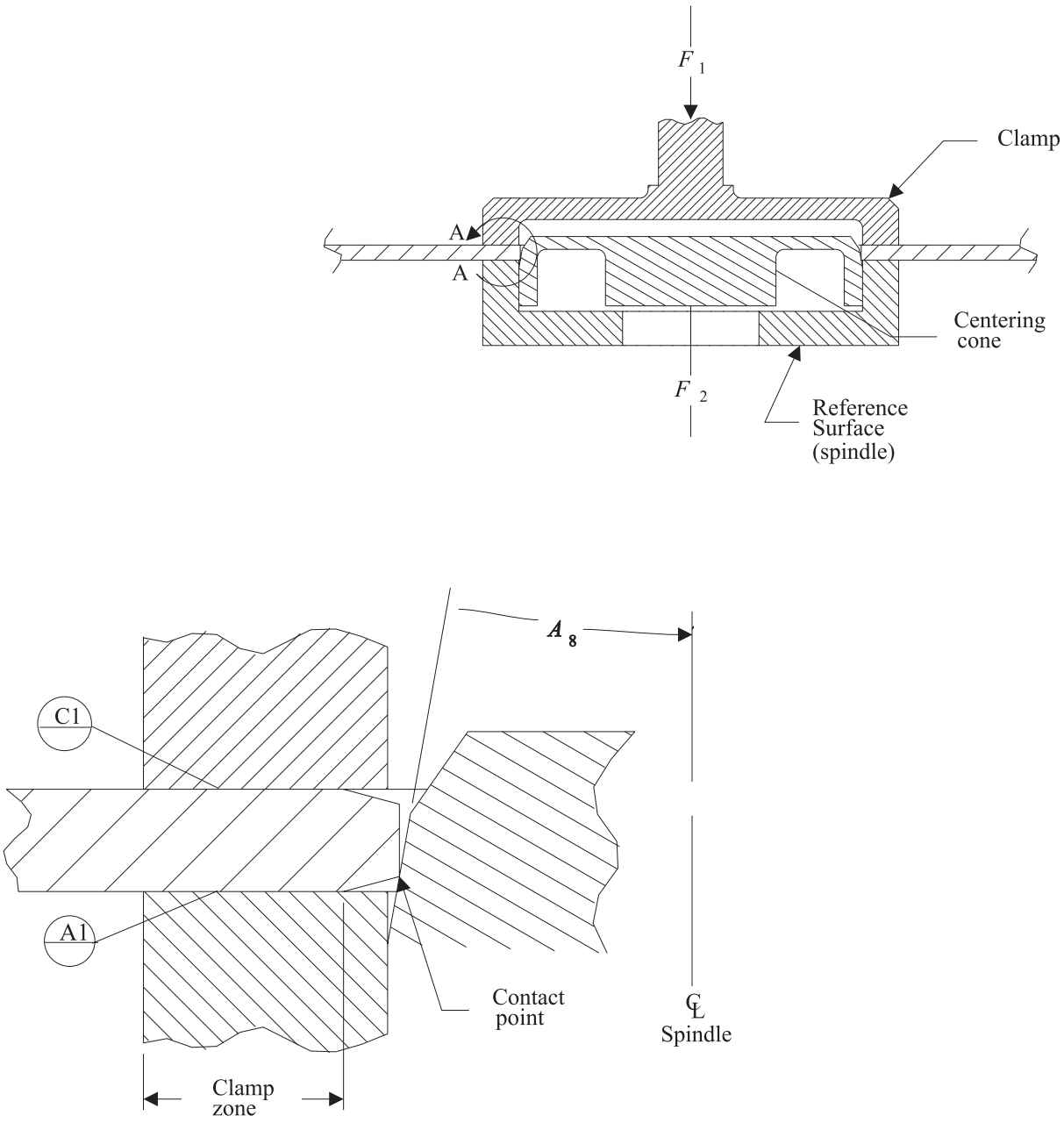


Figure C.1 - Mechanical test conditions

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Annex D

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Imbalance test method

D.1 Introduction

Imbalance of the disk can cause excessive radial runout and corrupt linear velocity uniformity. Testing the imbalance of the disk requires the use of commonly available dynamic balancing equipment.

D.2 Procedure

Imbalance testing should be conducted at the highest intended operating angular velocity for the system.

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Annex E

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Apparent axial runout test method

E.1 Introduction

Apparent axial runout is measured using the nearly paraxial optical lever gauge system shown in concept in figure E.1. This system uses a helium neon laser which is directed toward the surface in question through a focusing lens with a low numerical aperture (e.g. = 0,25). The light is reflected from the surface and directed toward a beam position sensing photodetector. As the distance between the surface and the focusing lens changes, the return beam is deflected along the surface of the photodiode.

This system is sensitive to tilt in the plane of the incident and reflected beams. This tilt sensitivity confounds the axial runout measurement. If the linear position detector is aligned parallel to the tangential direction, then the axial runout measurement is confounded by sensitivity to tilt caused by disk warpage. If the linear position detector is aligned parallel to radial direction then the axial runout measurement is confounded by sensitivity to tilt caused by a bowl-shaped deflection of the disk due to gravity or other sources. Careful selection of the detector orientation will minimize the detrimental sensitivity to tilt.

E.2 Procedure

E.2.1 The system is calibrated using a reflector and translation stage in place of the optical disk.

E.2.2 Record the photodiode output signal as a function of the measured distance of the reflector from the focusing lens.

E.2.3 Replace the reflector/translation stage with the optical disk.

E.2.4 Measure apparent axial runout caused by disk warpage with the detector parallel to the radial direction directly at the outside diameter of Band 0 for the disk rotating at the rates intended for normal use (e.g. ≤ 18,0 m/s). Note that while the average value of the measurement contains a component caused by tilt due to gravity or the "bowl" shape of the disk, etc., the peak-to-peak value is the runout due to warpage.

E.2.5 Measure the axial runout caused by deflection due to gravity with the detector aligned parallel to the tangential direction with the disk stationary. Translate the disk or measurement system along a radius from 70 mm to 175 mm relative to the rotational centre of the disk.

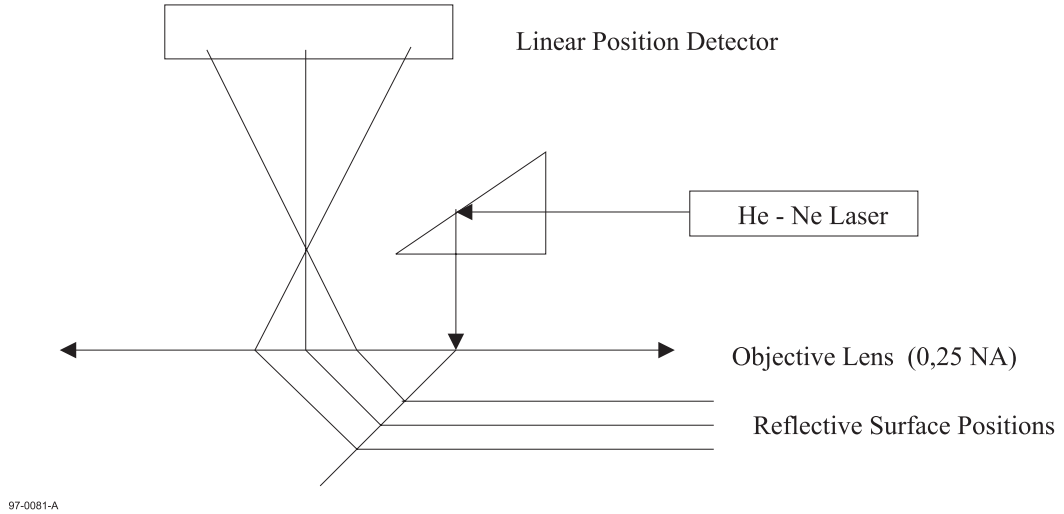


Figure E.1 - Apparent axial runout test method

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Annex F

(normative)

Residual focus error test method

F.1 Introduction

Residual focus errors can be caused by thickness variations in the protective layer as well as axial runout and acceleration of the disk. Furthermore, it is necessary to measure the completed optical disk assembly to assure compliance with the specification for residual focus error. It may also be desirable to measure the protective layer as one component in the optical disk assembly.

Residual focus errors for the completed optical disk assembly must be measured using the system shown in concept in figure F.1. The closed loop focus servo system shall have sufficient bandwidth such that the residual focus error signal provides a linear, high-resolution measurement of disk position. A position sensor is employed to provide a low resolution measurement of the focusing lens position, therefore also the disk. This sensor can be an interferometer, or an optical, capacitive, or electromagnetic device. When the residual focus error signal is added to the lens position sensor signal, an exact measure of the position of the disk is achieved. This disk position signal is then processed by a digital or analog filter whose disturbance rejection transfer function is given in the following equation. The output of the filter is a simulation of the residual focus error produced by such a "standardized" servo system.

Residual focus errors for the protective layer component are measured using the interferometer system shown in concept in figure F.2. The output signal is processed by a filter which represents the disturbance rejection transfer function given in the following equation. The interferometer system is inherently accurate and provides a means of isolating the contribution of the protective layer to the residual focus error (RFE).

$$\frac{\text{RFE}}{\text{Apparent deviation}} = \frac{1}{1+\dfrac{G\omega_n^2\left(1+s/a\right)}{(1+s/b)\left(s^2+2sz\omega_n+\omega_n^2\right)}}$$

where:

G	= 400	ω_n	= 2 π 40 rad/s
b	= 2 π 5 600 rad/s	z	= 0,2 typical
a	= 2 π 700 rad/s	s	= j2 πf (laplace transform variable)

F.2 Calibration of disk position measurement system

F.2.1 A translation stage is employed to move the measurement system relative to a suitable stationary reflector with the appropriate reflectivity and protective layer configuration.

F.2.2 With the measurement system positioned at the centre of the focus error signal range, translate the measurement system a known distance within the linear range of the focus error signal detector to calibrate its output as a function of distance.

F.2.3 Return the measurement system to the centre of the focus signal range and close the focus servo loop.

F.2.4 Translate the measurement system a known amount to calibrate the lens position detection system as a function of distance.

F.2.5 Replace the stationary reflector with the completed optical disk assembly.

F.3 Procedure for completed optical disk assembly

Measure the residual focus error at the centre of each band of the disk while rotating the disk at the intended rotational speed for each location.).

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F.4 Procedure for protective layer component

F.4.1 The sample is held in the system in a manner consistent with its orientation during intended use.

F.4.2 The interferometer system should scan the surface of the sample in predetermined patterns to indicate the effect of apparent thickness variation on the write/read process.

F.4.3 The interferometer output signal is a measure of the double-pass optical path difference induced by apparent protective layer thickness variations. This signal is divided by 2 to give a measure of the apparent position deviation of the disk. This signal is then processed by a filter having the transfer function representing the disturbance rejection capability of the focus servo system as shown above.

F.4.4 The output of the filter above is a measure of the residual focus error caused by the apparent protective layer thickness variations.

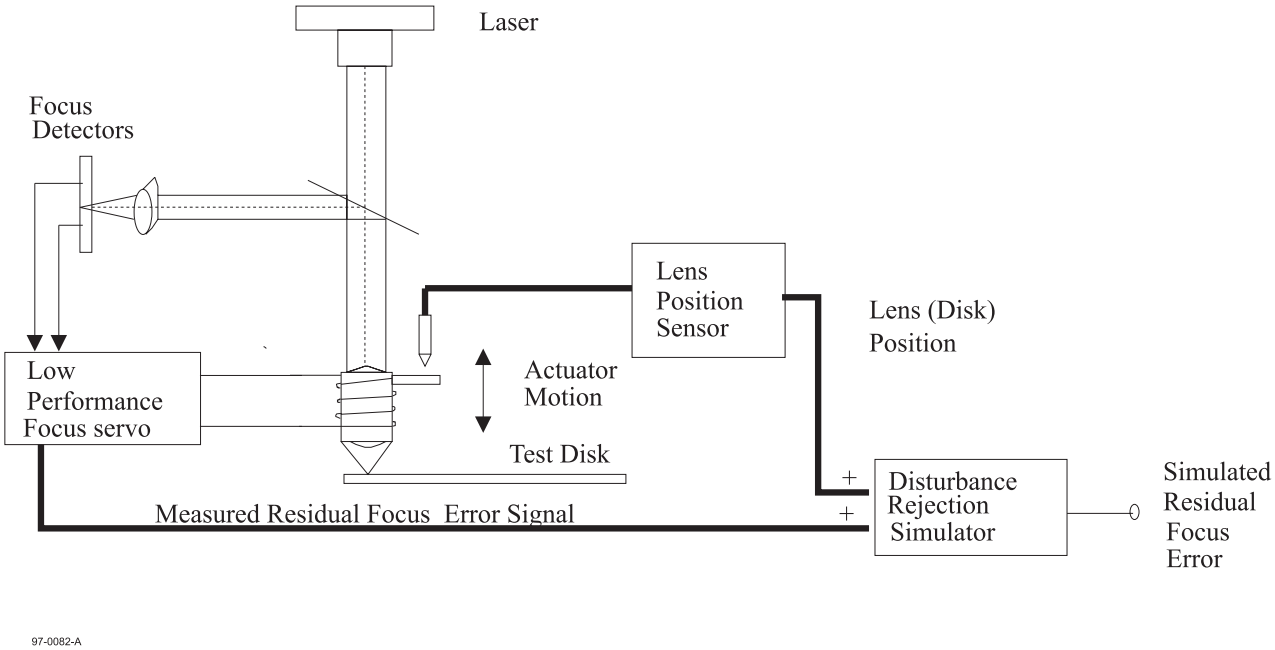


Figure F.1 - Residual focus error text system - completed optical disk assembly

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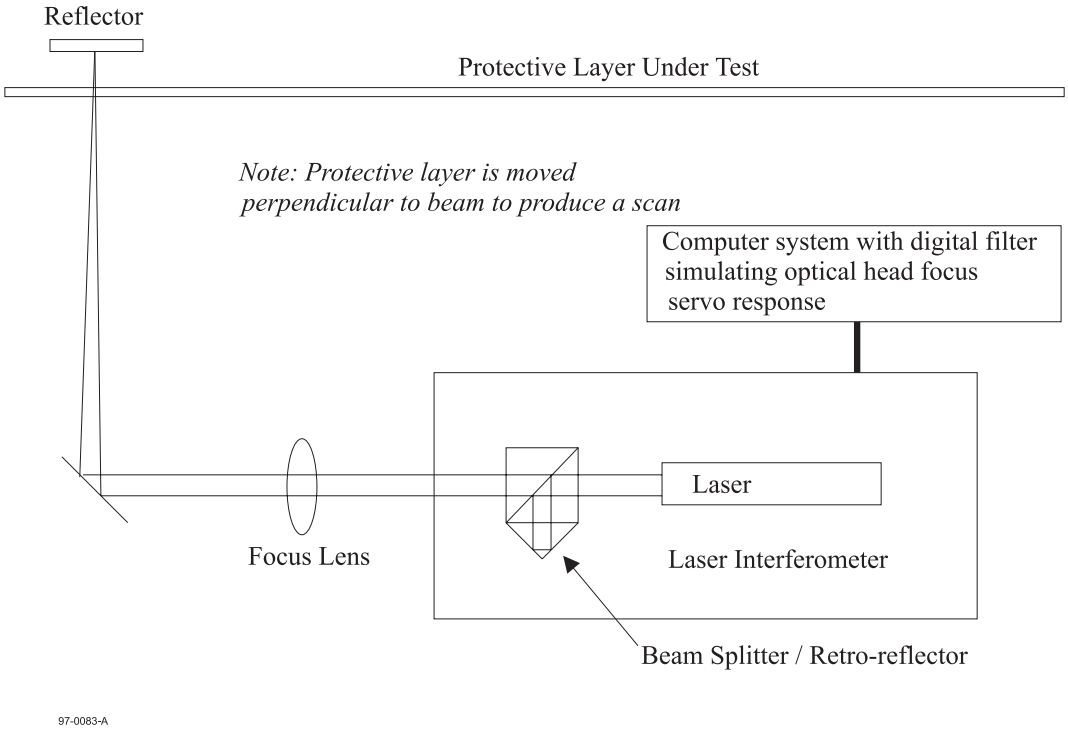


Figure F.2 - Residual focus error gauge - protective layer component

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Annex G

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Drop test method

G.1 Introduction

The purpose of the drop test is to determine the success with which data can be recovered from an optical disk cartridge which has been subjected to the specified fall. This test evaluates conformance with the drop test specification based on preservation of data integrity and cartridge functionality since it is necessary to load and unload the disk in order to recover data.

G.2 Procedure

G.2.1 Record a delay modulation mark encoded test track consisting of random data or a pseudo-random binary sequence of length 2n-1 where n > 9 in each band on both sides of the optical disk.

G.2.2 Determine the integrity of the recorded data by reading the data under nominal operating conditions as given in the related media standard (with EDAC, etc.). Insure that no bad sectors were encountered by reading the bad sector map.

G.2.3 Drop the optical disk cartridge on each surface and on each corner from a height of 760 mm onto a concrete floor covered with a 2 mm thick vinyl layer.

G.2.4 Each surface and corner shall withstand such an impact without any functional failure.

G.2.5 Re-read the recorded test data to verify that data integrity was preserved.

G.2.6 Write and read an additional test track in each band of the optical disk as in G.2.1 and G.2.2 above.

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Annex H

(normative)

Dead weight strength test method

H.1 Introduction

This test shall be conducted by applying a force of 132,3 N, using a 19 mm diameter rod with a flat end having a 1,6 mm radius edge, at any point on the case.

H.2 Procedure

H.2.1 Record a delay modulation mark encoded test track consisting of random data or a pseudo-random binary sequence of length 2n-1 where n > 9 in each band on both sides of the optical disk.

H.2.2 Determine the integrity of the recorded data by reading the data under nominal operating conditions as given in the related media standard (with EDAC, etc.). Ensure that no bad sectors were encountered by reading the Primary Defect List.

H.2.3 Perform the dead weight strength test described in clause H.1.

H.2.4 Re-read the recorded test data to verify that data integrity was preserved.

H.2.5 Write and read an additional test track in each band of the optical disk as in H.2.1 and H.2.2 above.

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Annex J

(normative)

Double-pass retardation test method

J.1 Introduction

The index of refraction of a material can be different for different polarizations of light. Working in a simplified two dimensional space, two indices can exist. One is in the direction called the fast axis, the other in the slow axis. The difference between the two indices of refraction is defined as the birefringence of the material.

Birefringence = | nx - ny |

Retardation is the optical path difference due to the birefringence of the sample. That is, the exiting wave of light polarized in the direction of one axis is behind or retarded relative to light polarized in the direction of the other axis. This retardation is a function of both the birefringence and thickness of the material. Double the thickness of a birefringent material and the retardation is doubled.

Protective layer birefringence is manifest in modulation of the intensity of the light beam returning to the photodetectors and thus causing feedback to the laser. Therefore, a direct measure of optical modulation caused by the protective layer birefringence would serve as a direct and meaningful measurement of the birefringence effect relevant to the detection method. Thus, the only functional quantity which can be used to specify birefringence of an optical disk is the amount of light returning from the disk with incorrect polarization.

J.2 Measurement equipment set-up

The system shown in concept in figure J.1 provides a measurement of the amount of light returning from the disk with incorrect polarization. The basic method requires a beam with a wavelength of 830 nm and equal intensity in all planes of polarization. This can be produced easily by passing a collimated linearly polarized laser beam through a quarter wave plate to produce circularly polarized light. The orderliness of the circular polarization in this beam is not needed, only the equal intensity of all polarizations.

The beam then passes through a linear polarizer which is rotating at a moderate rate. In practice, 1000 rpm seems to be a reasonable rotation rate. This polarizer passes only one polarization thus the beam becomes linearly polarized with the plane of polarization determined by the rotating polarizer.

The beam next passes through the protective layer sample, reflects off the mirror (or reflecting layer of the disk assembly), passes back through the protective layer sample to the rotating linear polarizer. If no retardation is introduced in this path, the return beam will have the same plane of polarization as the original incident beam. Since the polarizing filter is rotating slowly relative to the travel time of the light to the reflector and back, the beam would pass back through the polarizer unimpeded. In reality, some attenuation occurs due to the density characteristics of polarizers. The beam has a constant intensity, unaffected by the angular orientation of the rotating polarizer. The beam is finally directed to a photo-detector. This situation is shown in figure J.1 as Case 1.

If the sample causes some amount of retardation, more interesting events occur. Figure J.1, Case 2 shows a sample which has 1/2 wave of double-pass retardation. When the plane of polarization of the beam is parallel with either optical axis, no retardation occurs and the return beam is unimpeded as in the previous cases. However, when the plane is at a 45 ° angle, to the axes, the plane of polarization is rotated by 90 ° due to the 1/2 wave retardation induced by the sample. As a result, the return beam is completely blocked by the rotating polarizer at this angular position.

The return beam is modulated at four times the rate of revolution and is modulated, in this case, 100 %. (An example of this modulated signal is given in figure J.2). If the sample has 1/4 wave of double pass retardation, the beam would be modulated by 50 %. The modulation level is proportional to the retardation with the following relationship:

$$M = 1 - \cos^2(\pi R / \lambda)$$

$$R = \lambda / \pi \arccos(1 - M)^{0,5} \text{ nm}$$

where:

M = modulation

R = retardation

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The output of the detector is processed by a suitable analog or digital conversion system whose output is a direct measure of retardation.

J.3 Calibration

By using a Soleil-Babinet compensator, known amounts of retardation can be introduced into the beam path to verify the relationship described above. In practice, it is possible to show that the relationship described above is valid down to about 40 nm of retardation where the effects of random noise in the return beam may begin to distort the measurement. System noise of 1 % modulation would limit any detectable retardation to about 20 nm. Additional processing can correct for this distortion extending the accurate lower limit response down to 20 nm of retardation.

J.4 Procedure

Place the sample (protective layer or completed disk assembly) into the system as shown in figure J.1. Rotate the sample at a rate of less than 14 mm/s. Plot the double pass retardation as a function of position throughout the recording zone. The optical disk must meet the double pass retardation specification at all radii in the recording zone (70 mm to 175 mm).

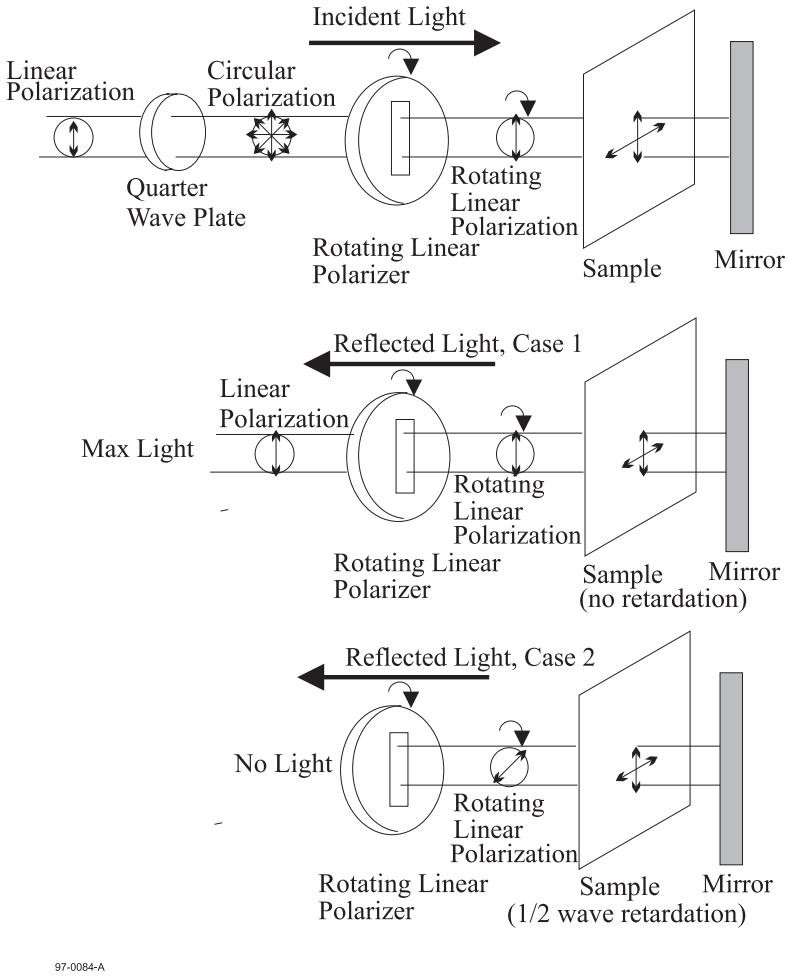


Figure J.1 -Double pass retardation test method

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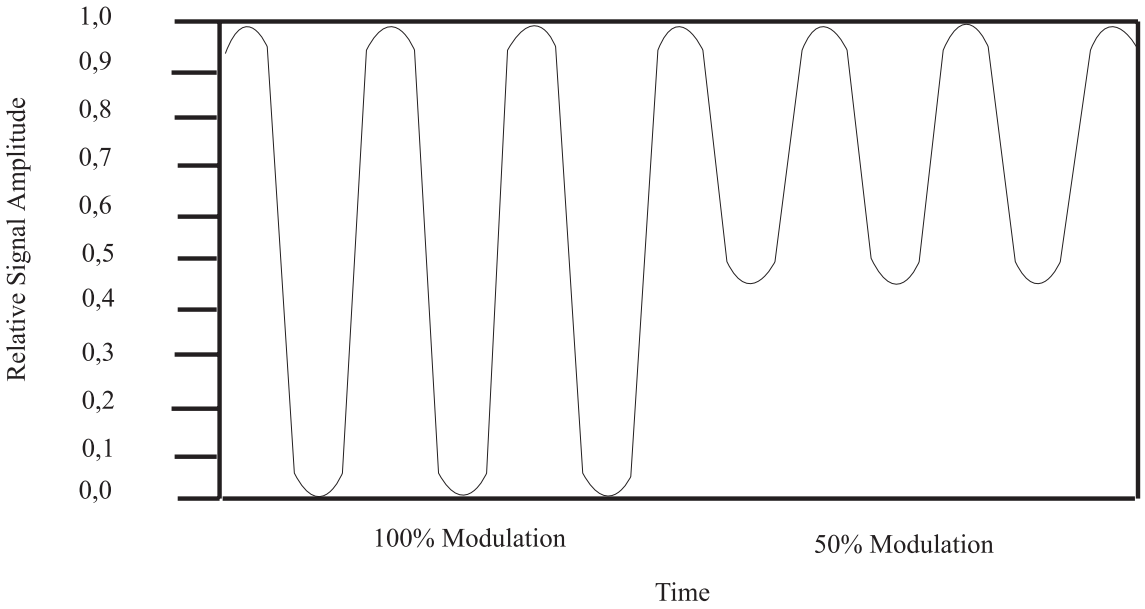


Figure J.2 - Reflected beam modulation

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Annex K

(normative)

Signal characteristics test method

K.1 Introduction

Measurement of the reflectance characteristics of the pre-recorded and user recorded marks is necessary to insure conformance to the requirements for pre-recorded marks and data written in the user area. The signal parameters *Ib, dILO/dt, dILI/dt, dIHO/dt, dIHI/dt,* Symmetry, Resolution, and Tracking Push-Pull amplitudes are measured using this test method.

K.2 Definitions

K.2.1 Central aperture method

The reflected light is collected by the same objective lens through which the illumination was focused. This light is then directed onto a detector by an optical system with the same or larger aperture as the objective. The detector is larger than the redirected spot and the total light power in this spot is the reflected light signal.

K.2.2 Gated second derivative method

The reflected light signal is low pass filtered by a 5-pole Bessel filter with bandwidth at 0,75 times the bit rate. A transition is detected when the absolute value of the first derivative of the signal is greater than one third of the illumination power multiplied by the bit rate and the absolute value of the second derivative of the signal is less than 1 % of the illumination power multiplied by the square of the bit rate.

K.2.3 Pre-emphasis

The time interval that the recording optical pulses are lengthened (or shortened) as measured at the 50 % amplitude level. If the encoder generates a 100 ns pulse, 10 ns of pre-emphasis would cause the laser to emit a pulse 110 ns long, both pulses being measured at the 50 % amplitude levels. The purpose of pre-emphasis is to align the optimum write power with the recording power that produces the best combination of signal level, non-linearity, signal to noise ratio, track to track cross talk and recording power latitude.

K.2.4 Post-emphasis

The time interval that the digitized readback signal is lengthened (or shortened) as measured at its 50 % amplitude level. The purpose of post-emphasis is to correct for a systematic shortening (or lengthening) of the mark lengths read back. This effect is due to the convolution of the geometries of the read spot and the mark ends. The proper amount of post-emphasis is determined by comparing the detected mark lengths with a highly resolving read back technique.

K.3 Calibration

Measure the output of the d.c. coupled RF preamplifier to determine the d.c. voltage corresponding to 0 % reflectance (i.e. laser off) and to samples of known reflectance while in focus under the head to calibrate the system.

K.4 Procedure

K.4.1 Measure the d.c. voltage at the output of the RF preamplifier while focused over an unwritten section of the rotating disk. This measurement gives both the absolute level and uniformity of baseline reflectance, *Ib.* Determine conformance with the baseline reflectance specification.

An alternative method of determining baseline reflectance is to measure the sum of the preamplified focus cell outputs which have been calibrated against samples of known reflectance.

K.4.2 Write encoded tracks at the lowest and highest repetition rates at the outside diameter of a band of the record area. The lowest frequency is specified in 16.6.2. The highest frequency is specified in 16.6.2. The linear velocity at the outside diameter of the band is maximum. Measure the a.c. voltages from the lowest frequency and highest frequency using an analog or digital differentiator and time base sufficient for resolving individual marks. The write power shall be in conformance to the write power specification.

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K.4.3 Write encoded tracks at the lowest and highest repetition rates at the inside diameter of a band of the record area. The linear velocity at the inside diameter of the band is minimum. Measure the a.c. voltages.

K.4.4 Mathematically process the data from K.4.1 through K.4.3 above to calculate the absolute value of the peak of the first derivative of the read signal from both the rising and falling edges of the low frequency pattern. Alternatively, the first derivative data may be measured directly at the output of the disk drive first differentiator provided the RF channel is d.c. coupled up to that stage.

K.4.5 The tracking push-pull signal, *Ipp*, shall be measured using the d.c. coupled tracking photo detector preamplifier outputs, *I1* and *I2*. The tracking push-pull signal is normalized to the baseline reflectance measured using *I1* and *I2* over an unrecorded area of the disk as in the following relationship:

$$Ipp = \frac{I1 - I2}{(I1 + I2)\text{base}}$$

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Annex L

(normative)

Optical disk write power test method

L.1 Introduction

Since the pre-recorded information is an integral part of the optical disk, it is necessary to determine the required write power such that consistent data recovery can be achieved. Consistent data recovery requires that the pre-recorded information and the data consist of the same basic waveform properties. In this test method, write power will be determined by comparing data amplitudes with the amplitudes of pre-recorded information.

L.2 Test procedure

The definition of write pulse shape is given in figure L.1.

L.2.1 Record a series of pulse length encoded tracks at various powers which are expected to bracket the write power required. The user data should correspond to 5,0 MHz and marks of 100 ns nominal length (T nom in figure L.1).

L.2.2 Verify that the mean mark lengths recorded are 100 ns ± 2 ns.

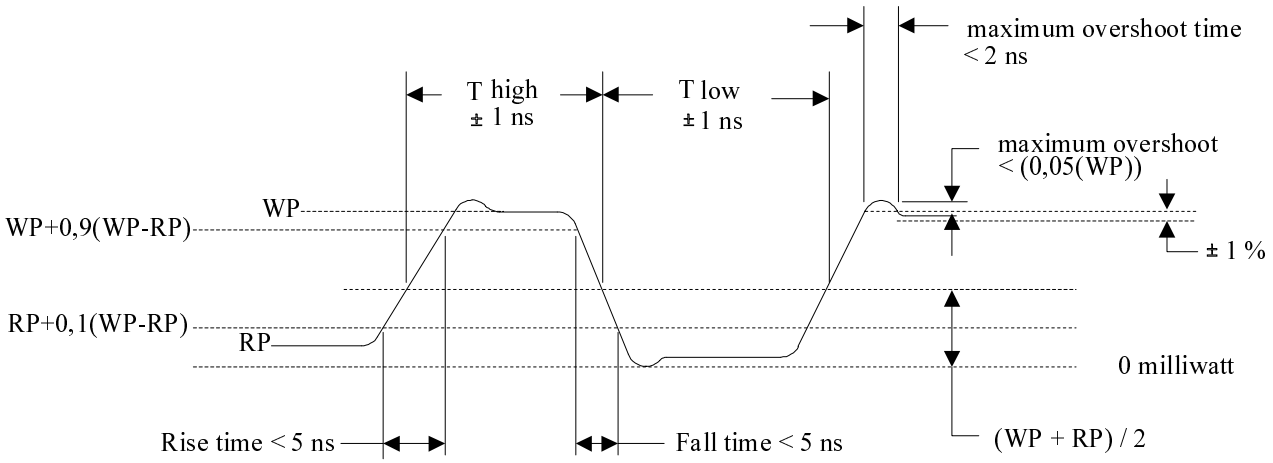
L.2.3 Measure the a.c. voltages from the 5,0 MHz pattern for the various test write powers using a timebase sufficient for resolving individual recorded marks.

L.2.4 Mathematically process the data from L.2.3 above to calculate the absolute value of the peak of the first derivative of the read signals obtained for the various test write powers. Alternatively, the first derivative data may be measured directly at the output of the disk drive first differentiator.

L.2.5 Similarly, measure the a.c. voltages and calculate the absolute value of the peak of the first derivative of the read signals obtained from the 5,0 MHz data contained in the preformatted sector headers.

L.2.6 The write power required for the test optical disk is that power at which the amplitude of the first derivative output signal is equal to 90 % of the amplitude of the first derivative output signal from the 5,0 MHz data in the pre-formatted headers.

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RP = Read power

T nom = Ideal time for pulse length encoding at the data rate specified

WP = Write power

T low = (T nom) - (pre-emphasis)

T high = (T nom) + (pre-emphasis)

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Figure L.1 -- Definition of write pulse shape

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Annex M

(normative)

Read power test method

M.1 Introduction

The optical disk shall be capable of withstanding the specified read power without loss of data integrity. This test method shall be used to determine conformance of the optical disk to the read power requirement.

M.2 Procedure

M.2.1 Write an encoded test track consisting of random data or a pseudo-random binary sequence of length 2n-1 where n > 9.

M.2.2 Read the test track under nominal operating conditions to confirm that the user data recorded in the test track is error free.

M.2.3 Perform one million re-reads of the test track at 1,0 mW read power.

M.2.4 Measure the signal characteristics as described in annex K and also re-read the test track to confirm that the user data is error free.

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Annex N

(normative)

Narrow-band signal-to-noise ratio test method

N.1 Introduction

N.1.1 The narrow-band signal-to-noise ratio (NB-SNR) shall be determined by measuring the signal power (dBm) of a 5 MHz tone written at the required write power, (see annex L) with a 30 kHz resolution bandwidth and subtracting the estimated noise floor at 5 MHz.

N.1.2 The estimated noise floor shall be determined by interpolation of the noise floor in the range 4,5 MHz to 5,5 MHz.

N.1.3 It is permitted to use a spectrum analyzer with a bandwidth of 3 kHz to 100 kHz and to convert the measured value to that for a 30 kHz value.

N.2 Procedure

N.2.1 Write a test track in the user zone at 5,0 MHz ± 0,1 MHz at the required write power as determined in annex L.

N.2.2 Measure the 5,0 MHz signal content (S in dBm) of the test track under the read power requirements using a spectrum analyzer with a centre frequency of 5,0 MHz ± 0,1 MHz and a resolution bandwidth of 30 kHz.

N.2.3 Interpolate the noise floor (N in dBm) in the range 4,5 MHz to 5,5 MHz and estimate the noise at 5,0 MHz.

N.2.4 Calculate the narrow-band signal-to-noise ratio (S-N in decibels).

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Annex P

(normative)

Cross-talk test method

P.1 Introduction

The track-to-track cross-talk shall be determined by recording a set of three test tracks in an unformatted section of the disk at a pitch of 0,9 μm at the required write power.

P.2 Procedure

P.2.1 Record a series of alternating single frequency tracks at the required write power (as determined in annex N) in an unformatted section of the disk at 15 m/s. The alternating single frequencies are 2,5 MHz and 3,3 MHz. The track pitch is 0,9 μm. Each of the 3,3 MHz tracks is considered the "information" track and the two adjacent 2,5 MHz tracks are considered the "interference" tracks.

P.2.2 Since there can be track pitch variations as a function of angle, it is necessary to measure the 3,3 MHz carrier and the 2,5 MHz signal power using a spectrum analyzer with zero frequency span capability. With the analyzer set up for external triggering (the trigger source is once-per-rev index pulse), measure the worst case 2,5 MHz signal content and the corresponding 3,3 MHz signal content.

P.2.3 The ratio between the 3,3 MHz signal power in the centre track and the 2,5 MHz signal power from the adjacent tracks is the cross-talk level.

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Annex Q

(normative)

Radial runout test method

Q.1 Introduction

The radial runout, track-to-track pitch variability, and cumulative track pitch error shall be measured using this test method. This test method requires the implementation of a sensor which detects the position of the tracking actuator such as an interferometer or an optical, capacitive, or electromagnetic sensor. Such a system is shown in concept in figure Q.1.

Q.2 Calibration

Calibration of the sensor can be accomplished by writing two concentric tracks of known separation distance (e.g. 10 μm) in an unformatted area of the disk.

Translation of the fine tracking actuator from one track to the other can be correlated to the position sensor output.

Alternatively, if the sensitivity of the actuator deflection mechanism to input signal (e.g. in μm / mA at d.c.) is known, the position sensor can be indirectly calibrated (see example below).

Example:

Tracking actuator sensitivity	: 0,75 μm/mA
Deflection of the Actuator	: 10 mA
Position sensor output	: 75 mV

Therefore, the position sensor calibration factor
F = 75 mV/(10 mA x 0,75 μm/mA) = 10 mV/ μm.

Q.3 Test Procedure

Acquire closed-loop tracking operation at the mid-point of each band.

Measure the radial runout at the output of the calibrated position sensor as a function of angular position.

Repeat on the adjacent tracks.

The difference between the radial runout of two adjacent tracks is a measure of the track-to-track pitch variability.

Cumulative track pitch error measurement requires the implementation of a high precision radial access system with which to translate the head accurately a known distance. Comparison of actual track location and intended track location gives cumulative track pitch error information.

The measurement of the cumulative inter-band and intra-band track location error shall be made in this manner, using a random seek algorithm.

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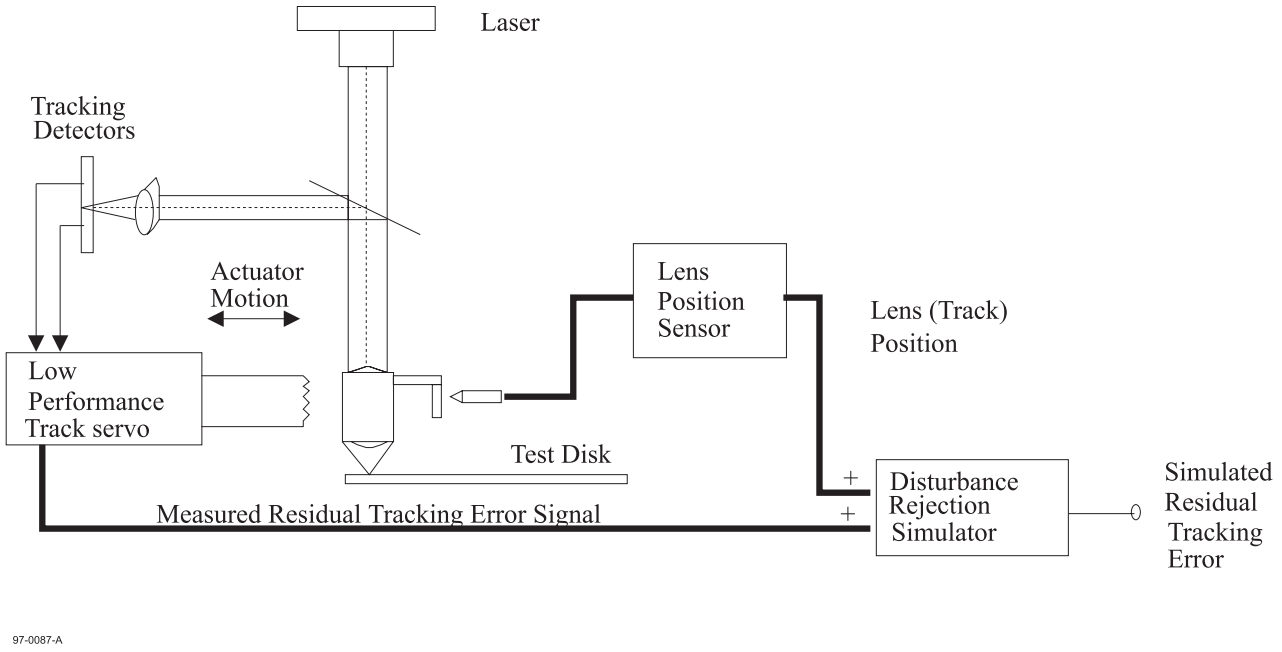


Figure Q.1 - Radial runout test method

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Annex R

(informative)

Recommendation for Transportation

R.1 The optical disk cartridge should be transported in a shipping package agreed upon by the user and the supplier.

R.2 The transportation period should not exceed 14 consecutive days.

R.3 The optical disk cartridge within its agreed upon shipping package should not be exposed outside the following environmental conditions during the transportation period.

temperature	: -20°C to 55°C
relative humidity	: 5% to 90%
wet bulb temperature	: 29°C max.
atmospheric pressure	: 75 kPa to 110 kPa
temperature gradient	: 20°C max.
relative humidity gradient	: 10%/h max.

R.4 No condensation on or in the optical disk cartridge should occur.

R.5 The optical disk cartridge exposed to these conditions should be in the operating environment at least 2 h before use.

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