

# ECMA

EUROPEAN COMPUTER MANUFACTURERS ASSOCIATION

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## STANDARD ECMA-147

DATA INTERCHANGE ON 90 mm FLEXIBLE DISK  
CARTRIDGES USING MFM RECORDING  
AT 31831 ftprad ON 80 TRACKS ON EACH SIDE

- ISO TYPE 303 -

December 1990

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## BRIEF HISTORY

Technical Committee TC19 of ECMA began work on the standardization of flexible disk cartridges in 1974. As a result ECMA has produced a set of standards for different types of flexible disk cartridges (FDC):

<b>200 mm FDCs</b>	<b>130 mm FDCs</b>	<b>90 mm FDCs</b>
ECMA-58	ECMA-66	ECMA-100
ECMA-59	ECMA-70	ECMA-125
ECMA-69	ECMA-78	
	ECMA-99	

Standards ECMA-70, ECMA-78 and ECMA-99 specify two different track formats. The first specifies FM recording in Cylinder 00 and is intended for use with the labelling system specified in Standard ECMA-91. The second track format, which is identical with that of Standard ECMA-100, specifies MFM recording on all cylinders and is intended for use with the volume and file structure of Standard ECMA-107. Standard ECMA-100 was developed with a view to achieving a capacity of 1 Mbyte. Standard ECMA-125 is a further development of the same medium providing a capacity of 2 Mbytes.

The present ECMA Standard is still a further development of FDCs of 90 mm, but with a magnetic layer of barium ferrite allowing for a higher recording density. This medium provides an unformatted capacity of 4 Mbytes.

Upon request of Committee ISO/IEC/JTC1/SC11, this ECMA Standard has been contributed to ISO/IEC for adoption under the fast-track procedure.

This Standard has been accepted by the General Assembly of ECMA on 13th December 1990.



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## SECTION I - GENERAL

### 1. SCOPE AND CONFORMANCE

#### 1.1 Scope

This ECMA Standard specifies the characteristics of 90 mm flexible disk cartridges recorded at 31831 ftprad using modified frequency modulation recording, on 80 tracks on each side. Such flexible disk cartridges are identified as ISO Type 303.

It specifies the mechanical, physical and magnetic characteristics of the cartridge, so as to provide physical interchangeability between data processing systems.

It also specifies the method of recording, the quality of the recorded signals, the track layout and the track format.

Together with Standard ECMA-107, this Standard provides for full data interchange between data processing systems.

#### 1.2 Conformance

A 90 mm flexible disk cartridge is in conformance with this Standard if it meets all mandatory requirements specified herein.

### 2. REFERENCES

- ECMA-107 : Volume and File Structure of Flexible Disk Cartridges for Information Interchange
- ISO 683/13 : Wrought Stainless Steels
- ISO 9983 : Information processing systems - Designation of unrecorded flexible disk cartridges.

### 3. DEFINITIONS

For the purpose of this Standard the following definitions apply.

#### 3.1 Average Signal Amplitude

The Average Signal Amplitude for a track is the arithmetically averaged value of the output voltages measured peak-to-peak over the whole track.

#### 3.2 Case

A protective enclosure including a shutter mechanism, an identification hole and a write-inhibit hole.

#### 3.3 Direction of Rotation

The direction of rotation shall be counter-clockwise when looking at Side 0.

#### 3.4 Eraseability

The eraseability is the ratio (percentage) of the residual Average Signal Amplitude, after erasing the original signal, to the original Average Signal Amplitude on the specified track and at the specified flux transition density.

#### 3.5 Formatting

Writing the proper control information establishing the physical cylinders and the addresses of physical records on the surfaces of the flexible disk.

**3.6 Hub**

A centring and referencing device attached to the disk which allows torque to be transmitted to the disk. The hub is attached to the centre of the disk. It ensures centring of the disk on the drive shaft in a unique angular position.

**3.7 In-Contact**

An operating condition in which the magnetic surface of the disk is in physical contact with the magnetic heads.

**3.8 Index**

The signal generated in the index transducer of the drive by the drive spindle once per revolution.

**3.9 Initialization**

Writing any information initially required to be on the flexible disk cartridge, e.g. the Volume Label, prior to the commencement of general processing use.

**3.10 Line of Access**

The straight line described by the centre of the gap of the read/write head as it is positioned from Track 00 to Track 79.

**3.11 Liner**

Suitable material positioned between the case and the disk to provide cleaning action and protection from abrasion.

**3.12 Master Standard Reference Flexible Disk Cartridge**

A reference flexible disk cartridge selected as the standard for reference fields, signal amplitudes, resolution, peak shift, and reference erase field. Track 00 and Track 79 on both sides are declared as reference tracks.

The reference tracks are calibrated at 300 rpm.

*NOTE 1*

*This Master Standard will be established by the Physikalisch-Technische Bundesanstalt (PTB), Bundesallee 100, D-3300 Braunschweig, Germany.*

*The Master Standard established by Toshiba Corporation shall be used until the PTB Master Standard is established.*

**3.13 Recording Disk**

A flexible disk which accepts and retains, on the specified side or sides, magnetic signals intended for input/output and storage purposes.

**3.14 Reference Erase Field**

The Reference Erase Field is the DC field which causes an eraseability of 5 % when measured for the Master Standard Reference Flexible Disk Cartridge.

There are two Reference Erase Fields, one for each side.

**3.15 Reference Field**

The Reference Field is the Typical Field of the Master Standard Reference Flexible Disk Cartridge. There are two Reference Fields, one for each side.

**3.16 Secondary Standard Reference Flexible Disk Cartridge**

A flexible disk cartridge the performance of which is known and stated in relation to that of the Master Standard Reference Flexible Disk Cartridge.

*NOTE 2*

*Secondary Standard Reference Flexible Disk Cartridges can be ordered from PTB, Lab. 1.41, under Part Number RM 10994 until the year 2001.*

*It is intended that these be used for calibrating tertiary cartridges for use in routine calibration.*

*Until they become available from PTB, Secondary Standard Reference FDCs can be ordered under part number TRD 301 from Toshiba Corporation, 1-1 Shibaura, 1-chome, Minato-Ku, Tokyo 105.*

**3.17 Shutter**

A device which uncovers the head windows upon insertion, and automatically covers them upon removal from the drive.

**3.18 Side**

Side 0 is the side engaged by the spindle. Side 1 is the opposite side.

**3.19 Standard Reference Amplitude**

The Standard Reference Amplitudes (SRAs) are the Average Signal Amplitudes derived from the reference tracks of the Master Standard Reference Flexible Disk Cartridge using the Test Recording Current.

There are four SRAs, two for each side:

SRA-1f is the Average Signal Amplitude from a recording written using 1f at Track 00.

SRA-2f is the Average Signal Amplitude from a recording written using 2f at Track 79.

**3.20 Test Erase Current**

The erase current between 148 % and 152 % of the erase current which produces the Reference Erase Field at test Frequency 1f on track 00.

**3.21 Test Recording Current**

The Test Recording Current is the current between 198% and 202% of the current which produces the Reference Field at 2f on Track 79. There are two Test Recording Currents, one for each side.

**3.22 Typical Field**

The minimum recording field which, when applied to a flexible disk cartridge, causes an average signal amplitude equal to 95% of the maximum Average Signal Amplitude when taken as a function of the recording field at the specified track and flux transition density.

**4. GENERAL DESCRIPTION**

**4.1 Drawings**

In the enclosed drawings an example of implementation of the flexible disk cartridge is shown schematically.

**4.2 Main Elements**

The main elements of the flexible disk cartridge are:

- the recording disk,

- the liner,
- the case.

#### 4.3 Description

The cartridge is of a substantially square form. It includes a central hole on one side, a head window on both sides, an identification hole and a write-inhibit hole.

The liner is provided between the case and the disk. It comprises two layers of material between which the disk lies.

The disk has a central hole with a metal hub attached.

## SECTION II - ENVIRONMENTS, MECHANICAL AND PHYSICAL CHARACTERISTICS

### 5. GENERAL REQUIREMENTS

#### 5.1 Environment and Transportation

##### 5.1.1 Testing environment

Tests and measurements made on the cartridge to check the requirements of this Standard shall be carried out under the following conditions:

Temperature : 23 °C ± 2 °C

RH : 40% to 60%

Conditioning before testing : 24 hours minimum

For the tests specified in 8.3 the temperature and the RH shall be measured in the air immediately surrounding the cartridge drive. For all other tests the temperature and the RH shall be measured in the air immediately surrounding the cartridge.

The stray magnetic field at any point on the disk surface, including that resulting from the concentrating effect of the recording head, shall not exceed 4000 A/m.

##### 5.1.2 Operating environment

Cartridges used for data interchange shall be operated under the following conditions:

Temperature : 10 °C to 51,5 °C

RH : 20% to 80%

Wet bulb temperature : less than 29 °C

The temperature and the RH shall be measured in the air immediately surrounding the cartridge. It is recommended that the rate of change of the temperature should not exceed 20 °C per hour. It is also recommended that the temperature and the RH conditions when reading a cartridge are not at the opposite extremes to the conditions when it was recorded.

There shall be no deposit of moisture on or in the cartridge.

The stray magnetic field at any point on the disk surface, including that resulting from the concentrating effect of the recording head, shall not exceed 4000 A/m.

##### 5.1.3 Storage environment

During storage the cartridges shall be kept within the following conditions:

Temperature : 4 °C to 53 °C

RH : 8% to 90%

The ambient stray magnetic field shall not exceed 4000 A/m. There shall be no deposit of moisture on or in the cartridge.

*NOTE 3*

*Cartridges which have been stored at temperatures and humidities exceeding the operating conditions may exhibit degraded performance characteristics. Such cartridges should be subjected to a conditioning period of not less than 24 hours within the operating environment prior to use.*

**5.1.4 Transportation**

Responsibility for ensuring that adequate precautions are taken during the transportation shall be with the sender. The cartridge shall be in a protective package free from dust or extraneous matter. It is recommended that a sufficient space exists between cartridge and outer surface of the final container, so that risk of erasure due to stray magnetic fields will be negligible.

It is recommended that the following conditions are not exceeded:

Temperature : -40 °C to 60 °C

Maximum rate of  
temperature change : 20 °C per hour

RH : 8% to 90%

There should be no deposit of moisture on or in the cartridge.

**5.2 Materials**

**5.2.1 Case**

The case may be constructed from any suitable material such that it meets the requirements of 6.7.

**5.2.2 Liner**

The material of the liner shall be able to retain dust or debris without damage to the disk.

**5.2.3 Disk**

The disk may be constructed from any suitable material (e.g. bi-axially oriented polyethylene terephthalate) coated on both sides with a flexible layer of magnetic material, (e.g. barium ferrite).

**5.2.4 Hub**

The hub shall be made of any suitable material (e.g. stainless steel alloy according to ISO 683/13, type 8).

**6. DIMENSIONAL CHARACTERISTICS**

The dimensions of the cartridge are referred to two Reference Axes X and Y. They are two lines in space intersecting at right angles. The plane they define is the Reference Plane XY of the cartridge.

**6.1 Case**

**6.1.1 Shape (Fig. 7)**

The case has a rectangular form, its sides shall be

$$L_1 = 94,0 \text{ mm} \pm 0,3 \text{ mm}$$

$$L_2 = 90,0 \text{ mm} \quad \left\{ \begin{array}{l} + 0,4 \text{ mm} \\ - 0,1 \text{ mm} \end{array} \right.$$

The radius of three of its corners shall be

$$R_1 = 2,0 \text{ mm} \pm 1,0 \text{ mm}$$

The angle of its fourth corner shall be

$$\omega = 45^\circ \pm 2^\circ$$

#### 6.1.2 Thickness

In the area extending 8,5 mm from each of the two edges as shown in Fig. 8, the thickness of the case shall be

$$E_1 = 3,3 \text{ mm} \pm 0,2 \text{ mm}$$

When the cartridge is inserted in the test gauge specified in Appendix G, a force of 0,2 N maximum, applied to the centre of the back edge shall cause the cartridge to pass through the gauge.

The edge radius shall be

$$R_2 = 0,40 \text{ mm} \pm 0,25 \text{ mm}$$

#### 6.1.3 Hub access hole (Fig. 7)

On Side 0 there shall be a hub access hole the diameter of which shall be

$$D_1 = 26,50 \text{ mm min.}$$

The position of the centre of this hole shall be defined by

$$L_3 = 40,00 \text{ mm} \pm 0,15 \text{ mm}$$

$$L_4 = 31,00 \text{ mm} \pm 0,15 \text{ mm}$$

#### 6.1.4 Locating holes (Fig. 7 and 9)

##### 6.1.4.1 Primary locating hole

The centre of the primary locating hole shall be at the intersection of Reference Axes X and Y.

Its diameter shall be

$$D_2 = 3,6 \text{ mm} \pm 0,1 \text{ mm}$$

The dimensions of its section (see cross-section A-A in Fig. 7) shall be

$$D_3 = 1,5 \text{ mm min.}$$

$$L_8 = 0,2 \text{ mm} \pm 0,1 \text{ mm}$$

$$L_9 = 1,0 \text{ mm min.}$$

$$L_{10} = 2,5 \text{ mm min.}$$

##### 6.1.4.2 Secondary locating hole

The centre of the secondary locating hole shall be on Reference Axis X, its distance from Reference Axis Y shall be

$$L_5 = 80,0 \text{ mm} \pm 0,2 \text{ mm}$$



It shall have a substantially rectangular shape. Its short axis shall be (cross-section B-B in Fig. 7)

$$L_6 = 3,6 \text{ mm} \pm 0,1 \text{ mm}$$

Its long axis shall be

$$L_7 = 4,4 \text{ mm} \pm 0,2 \text{ mm}$$

The dimensions  $D_3$ ,  $L_8$ ,  $L_9$  and  $L_{10}$  of the cross-section of the secondary locating hole are as specified in 6.1.4.1.

#### **6.1.5 Label area**

##### **6.1.5.1 Side 0 (Fig. 7)**

The locations and dimensions of the label area of Side 0 shall be defined by

$$L_{11} = 3,5 \text{ mm min.}$$

$$L_{12} = 76,5 \text{ mm max.}$$

$$L_{14} = 60,0 \text{ mm min.}$$

##### **6.1.5.2 Side 1**

The locations and dimensions of the label area of Side 1 shall be defined by

$$L_{11} = 3,5 \text{ mm min.}$$

$$L_{12} = 76,5 \text{ mm max.}$$

$$L_{13} = 20,0 \text{ mm min.}$$

#### **6.1.6 Head windows (Fig. 9)**

The locations and the dimensions of the two head windows are specified by the same set of dimensions.

##### **6.1.6.1 Location**

The location of the head windows shall be defined by

$$L_{15} = 12,3 \text{ mm min.}$$

$$L_{16} = 11,5 \text{ mm min.}$$

$$L_{17} = 35,5 \text{ mm} \pm 0,2 \text{ mm}$$

##### **6.1.6.2 Dimensions**

The width of the head windows shall be

$$L_{18} = 9,00 \text{ mm} \pm 0,20 \text{ mm}$$

The radius of their corners shall be

$$R_3 = 0,5 \text{ mm} \pm 0,1 \text{ mm}$$

The radius of their upper edge shall be

$$R_4 = 8,85 \text{ mm min.}$$

#### **6.1.7 Write-inhibit hole (Fig. 8)**

##### **6.1.7.1 Location**

The centre of the write-inhibit hole shall be on Reference Axis Y. Its distance from Reference Axis X shall be

$$L_{19} = 67,75 \text{ mm} \pm 0,25 \text{ mm}$$

#### 6.1.7.2 Dimensions

The dimensions of the write-inhibit hole shall be

$$L_{20} = 3,5 \text{ mm min.}$$

$$L_{21} = 4,0 \text{ mm min.}$$

The write-inhibit hole is intended for use either with a mechanical switch or with an optical detector so that only when the hole is covered is writing on the disk possible. When covered, the closure device shall not extend outside the Reference Plane nor shall it deflect by more than 0,3 mm from the Reference Plane inside the case under the action of a force of 3 N.

Also when covered, the light transmittance of the write-inhibit hole area shall not exceed 1%, when measured with an optical system as described in Appendix B.

#### 6.1.8 Identification hole (Fig. 7 and 8)

The identification hole is provided to distinguish between the flexible disk cartridge specified by this Standard from those specified by Standards ECMA-100 and ECMA-125.

##### NOTE 4

*As no specification is given in Standards ECMA-100 and ECMA-125 for the opacity of the case, it is recommended that detection of the identification hole is by mechanical means.*

#### 6.1.8.1 Location

The position of the centre of the identification hole shall be specified by  $L_5$  and

$$L_{51} = 62,25 \text{ mm} \pm 0,25 \text{ mm}$$

#### 6.1.8.2 Dimensions

The dimensions of the identification hole shall be

$$L_{49} = 3,5 \text{ mm min.}$$

$$L_{50} = 4,0 \text{ mm min.}$$

#### 6.1.9 Profile of the shutter edge of the case (Fig. 7 and 9)

The edge on which the shutter is mounted shall have a profile defined by the following dimensions:

$$L_{22} = 80,0 \text{ mm} \pm 0,2 \text{ mm}$$

$$L_{23} = 76,0 \text{ mm} \pm 0,3 \text{ mm}$$

$$L_{24} = 68,0 \text{ mm} \pm 0,3 \text{ mm}$$

$$L_{25} = 64,50 \text{ mm} \pm 0,35 \text{ mm}$$

$$L_{26} = 57,00 \text{ mm} \pm 0,35 \text{ mm}$$

$$L_{27} = 55,5 \text{ mm} \pm 0,6 \text{ mm}$$

$$L_{28} = 3,5 \text{ mm min.}$$

$$L_{29} = 17,5 \text{ mm} \pm 0,2 \text{ mm}$$

$$L_{30} = 17,00 \text{ mm} \pm 0,15 \text{ mm}$$

$$L_{31} = 15,50 \text{ mm} \pm 0,25 \text{ mm}$$

$$L_{45} = 12,50 \text{ mm} \pm 0,25 \text{ mm}$$

$$\alpha = 45^\circ \pm 2^\circ$$

$$\beta = 135^\circ \pm 2^\circ$$

$$\omega = 45^\circ \pm 2^\circ$$

#### 6.1.10 Shutter (Fig. 8 and 9)

The shutter shall slide upon insertion of the cartridge into the drive so as to uncover the head windows, and close automatically upon removal. The maximum resistance force at the fully open position shall be 1 N, and the minimum resistance force at the fully closed position shall be 0,2 N.

The path along which the shutter can slide is defined by L<sub>25</sub> and L<sub>28</sub>.

In the open position of the shutter, the distance from its leading edge to the Reference Axis Y shall be

$$L_{32} = 53,75 \text{ mm} \pm 1,25 \text{ mm}$$

The width of the windows of the shutter shall be

$$L_{33} = 12,0 \text{ mm} \pm 0,2 \text{ mm}$$

#### NOTE 5

*It is a requirement that the drive shall provide a mechanism whereby correct insertion of the cartridge into the drive causes the shutter to slide so as to uncover the head windows.*

#### 6.2 Liner

No part of the liner shall protrude by more than 0,2 mm into the head access windows.

#### 6.3 Disk (Fig. 10)

##### 6.3.1 Diameter

The diameter of the disk shall be

$$D_4 = 85,8 \text{ mm} \pm 0,2 \text{ mm}$$

##### 6.3.2 Thickness

The thickness of the disk shall be

$$E_2 = 0,080 \text{ mm} \pm 0,008 \text{ mm}$$

#### 6.4 Hub (Fig. 10)

The hub shall have a central part and a flange.

##### 6.4.1 Dimensions

The diameter of the central part shall be

$$D_5 = 25,00 \text{ mm} \left\{ \begin{array}{l} + 0,00 \text{ mm} \\ - 0,15 \text{ mm} \end{array} \right.$$

The diameter of the flange shall be

$$D_6 = 31,15 \text{ mm max.}$$

The distance from the surface of the central part of the hub to the surface of Side 0 of the disk shall be

$$L_{34} = 1,36 \text{ mm} \pm 0,10 \text{ mm}$$

when measured at a radius R<sub>7</sub>

$$R_7 = 14 \text{ mm nominal}$$

#### 6.4.2 Hub orientation holes (Fig. 10)

The hub shall have two orientation holes. The first one at its centre, the second off centre.

##### 6.4.2.1 First orientation hole

The first orientation hole shall have a square form defined by

$$L_{35} = 4,00 \text{ mm min.}$$

The position of the centre of rotation of the disk is defined by

$$L_{36} = 1,9955 \text{ mm}$$

measured from two sides of the hole. This centre of rotation shall be within 0,5 mm of the geometric centre of the disk.

The radius of the four corners of this hole shall be

$$R_5 = 1,0 \text{ mm} \pm 0,3 \text{ mm}$$

##### 6.4.2.2 Second orientation hole

The position and dimensions of the sides of the rectangular second orientation hole are referred to two radial Reference Lines A and B that are perpendicular to each other. Their positions shall be specified by

$$\gamma = 15^\circ \pm 3^\circ$$

The length of the sides of this hole shall be

$$L_{37} = 8,0 \text{ mm} \pm 0,3 \text{ mm}$$

$$L_{38} = 4,5 \text{ mm min.}$$

These sides shall be parallel to lines A and B, respectively, at a distance:

$$L_{39} = 2,0 \text{ mm} \pm 0,2 \text{ mm}$$

$$L_{40} = 10,00 \text{ mm} \pm 0,15 \text{ mm}$$

The radius of one corner of this hole shall be

$$R_6 = 2,0 \text{ mm} \pm 0,1 \text{ mm}$$

The radius of the three other corners shall be

$$R_5 = 1,0 \text{ mm} \pm 0,3 \text{ mm}$$

#### 6.5 Optional Handling Notches (Fig. 7 and 8)

Two handling notches are permitted. If present they shall satisfy the following requirements.

Their centres shall be on a line parallel to, and lying above, Reference Axis X at a distance

$$L_{41} = 7,50 \text{ mm} \pm 0,15 \text{ mm}$$

Their dimensions shall be

$$L_{42} = 3,0 \text{ mm min.}$$

$$L_{43} = 4,2 \text{ mm} \pm 0,2 \text{ mm}$$

Their depth below the Reference Plane shall be

$$L_{44} = 2,0 \text{ mm min.}$$

## 6.6 Interface between Cartridge and Drive

When the cartridge is inserted into the drive, the drive spindle engages the cartridge as shown in Fig. 5. The hub is held against the drive spindle by means of a magnetic attraction force. When in this position the distance between the hub surface on Side 0 and plane XY shall be

$$L_{46} = 0,3 \text{ mm nominal}$$

The inside dimensions of the case on Side 1 shall be

$$D_7 = 7,0 \text{ mm min.}$$

$$E_3 = 1,3 \text{ mm} \pm 0,1 \text{ mm}$$

with the exception of the annular zone defined by  $L_{47}$  and  $L_{48}$  where the thickness shall be

$$E_4 = 2,5 \text{ mm max.}$$

$L_{47}$  shall be sufficiently large to ensure that the circumference of the disk shall not touch the inside edges of the case. The value of  $L_{47}$  specified below is a recommended value therefore it is stated without tolerance.

$$L_{47} = 22,6 \text{ mm}$$

$$L_{48} = 21,7 \text{ mm} \pm 0,2 \text{ mm}$$

## 6.7 Compliance

When the cartridge is constrained in the manner described in Appendix A, the cartridge shall be in contact with posts P1 to P4.

## 7. PHYSICAL CHARACTERISTICS

### 7.1 Flammability

The disk, case and liner components shall be made from materials that, if ignited from a match flame, do not continue to burn in a still carbon dioxide atmosphere.

### 7.2 Coefficient of Linear Thermal Expansion of the Disk

The coefficient of thermal expansion of the disk shall be

$$(17 \pm 8) \cdot 10^{-6} \text{ per } ^\circ\text{C}$$

### 7.3 Coefficient of Linear Hygroscopic Expansion of the Disk

The coefficient of hygroscopic expansion of the disk shall be

$$(0 \text{ to } 15) \cdot 10^{-6} \text{ per percent of relative humidity}$$

### 7.4 Torque

#### 7.4.1 Starting torque

The starting torque, without the heads loaded, shall not exceed 0,006 Nm.

#### 7.4.2 Running torque without heads loaded

The torque necessary to turn the disk shall be in the range 0,0005 N.m to 0,0025 N.m when the cartridge is in operation at a speed of 300 rpm  $\pm$  3 rpm.

## SECTION III - UNRECORDED FLEXIBLE DISK CARTRIDGE

### 8. MAGNETIC CHARACTERISTICS

#### 8.1 Recording Area

On each side the magnetic properties specified shall be uniform in the recording area, which shall be the area limited by two radii:

20,6 mm max.  
42,0 mm min.

#### 8.2 Track Geometry

##### 8.2.1 Number of tracks

In the recording area there shall be 80 discrete concentric tracks on each side of the disk. The distance between centrelines of adjacent tracks shall be 0,1875 mm.

##### 8.2.2 Width of tracks

The width of a recorded track shall be

0,115 mm  $\pm$  0,008 mm

The method of measuring effective track width is given in Appendix C.

##### 8.2.3 Track location

###### 8.2.3.1 Nominal locations

The nominal radius ( $R_n$ ) of the centrelines of all tracks shall be calculated by using the formula:

$$R_n = x - 0,1875 n$$

where  $n$  is the track number,  $n = 00$  to 79.

$x = 39,5000$  mm for Side 0

$x = 38,0000$  mm for Side 1

###### 8.2.3.2 Track location tolerance

For testing purposes the centrelines of the recorded tracks shall be within  $\pm 0,020$  mm of the nominal positions, when measured in the testing environment (5.1.1).

###### 8.2.3.3 Line of access of the read/write heads

The line of access of the read/write heads is a line parallel to a radial line and spaced 0,35 mm from it (see 9.3).

#### 8.2.4 Track number

The track number shall be a two-digit decimal number (from 00 to 79) for each side. It identifies the tracks consecutively, starting at the outermost track (00).

### 8.3 Functional Testing

For the purpose of the following tests the same drive unit (see Appendix J) shall be used for writing and reading operations, both for the disk under test and for the Secondary Standard Reference Flexible Disk Cartridge. The in-contact condition shall be used.

The drive shall have a combined head consisting of an erase head and a read/write head. The erase head shall be located ahead of the read/write head, so that it erases previously written data before the new data is written by the read/write head. The gap width of the erase head shall be

larger than that of the read/write head, to prevent previously written data from being left on either side of the newly written data.

The Test Recording Current and the Test Erase Current shall be determined according to the method specified in Appendix K.

Unless otherwise specified, when writing the new data, the previously written data shall be simultaneously erased by the erase head.

**8.3.1 Surface tests**

The magnetic properties of both surfaces are defined by the testing requirements given below.

**8.3.1.1 Test conditions**

The disk shall be tested at 300 rpm  $\pm$  3 rpm (see 4.6). The test frequencies, expressed in flux transitions per second (ftps), shall be:

$$1f = 500\,000 \text{ ftps} \pm 500 \text{ ftps}$$

$$2f = 1\,000\,000 \text{ ftps} \pm 1\,000 \text{ ftps}$$

The frequency(ies) to be used is specified for each test.

**8.3.1.2 Typical field**

The Typical Field of the disk under test shall be within  $\pm$  20% of the Reference Field. It shall be measured using 2f on Track 79 on both sides.

**8.3.1.3 Average Signal Amplitude**

When the disk under test has been recorded with the Test Recording Current, then read back and compared with the Secondary Standard Reference Flexible Disk Cartridge recorded under the same conditions, the Average Signal Amplitude shall be:

Track 00, using 1f: less than 130% of SRA-1f,

Track 79, using 2f: more than 80% of SRA-2f.

This test shall be performed on both sides.

**8.3.1.4 Resolution**

After recording on Track 79, using the Test Recording Current, the ratio:

$$\frac{\text{Average Signal Amplitude using } 2f}{\text{Average Signal Amplitude using } 1f} \times 100\%$$

shall be greater than 80% of the same ratio for the Master Standard Reference Flexible Disk Cartridge.

This test shall be performed on both sides.

**8.3.1.5 Peak shift**

The average peak shift measured on the disk cartridge under test, using the method specified in Appendix H, shall be within the range 63% to 137% of that of the Master Standard Reference Flexible Disk Cartridge when measured on RM 10994 under the same conditions. This test shall be performed on Track 79 on both sides.

**8.3.1.6 Eraseability**

AC bulk erase the disk under test. On Track 00 record at 1f using the Test Recording Current for one revolution. Erase for one revolution using the Test Erase Current with the read/write head turned off.

The ratio :

$$\frac{\text{Residual Average Signal Amplitude after erasing}}{\text{Average Signal Amplitude after first recording using 1f}} \times 100\%$$

shall be less than 3%. This test shall be performed on both sides, and a frequency-selective voltmeter with a bandwidth of 3 kHz to 5 kHz shall be used.

**8.3.1.7 Modulation**

Modulation shall be

$$\frac{\text{Maximum mean} - \text{Minimum mean}}{\text{Maximum mean} + \text{Minimum mean}} \times 100\%$$

The maximum mean shall be the average value of the amplitude modulated output voltage in that part of the track with the maximum amplitudes, and the minimum mean shall be that in the respective part with the minimum amplitudes. Output voltage shall be measured peak-to-peak; averaging shall be done over about 2000 consecutive flux transitions.

On Track 00 using 1f and on Track 79 using 2f, modulation shall be less than 10%.

This test shall be performed on both sides.

**8.3.2 Track quality tests**

These tests shall apply to all 80 tracks at the defined positions on each side. The appropriate Test Recording Current shall be used.

**8.3.2.1 Missing pulse**

Write a track with 2f and measure the Average Signal Amplitude. Any playback signal which, when measured base-to-peak, is less than 45% of half the Average Signal Amplitude of the track, shall be a missing pulse.

**8.3.2.2 Extra pulse**

Write a track with 2f and measure the Average Signal Amplitude. Then erase the track for one revolution with a direct current equal to the quiescent value of the Test Recording Current applied to the read/write head and the Test Erase Current applied to the erase head. The polarity of the magnetic field produced by the read/write head shall be the same as that produced by the erase head. Any playback signal which, when measured base-to-peak, exceeds 20% of half the Average Signal Amplitude shall be an extra pulse.

**8.3.3 Rejection criterion**

**8.3.3.1 Defective track**

A track on which one or more missing and/or extra pulses are detected in the same position(s) on consecutive passes shall be a defective track. The applicable number of consecutive passes shall be a matter for agreement between purchaser and supplier.

**8.3.3.2 Requirement for tracks**

As initially received from the medium supplier, the cartridge shall have no defective tracks.

**8.3.3.3 Rejected cartridge**

A cartridge which does not meet the requirements of 8.3.3.2 shall be rejected.



## SECTION IV - RECORDING METHOD AND TRACK FORMAT

### 9. GENERAL REQUIREMENTS

#### 9.1 Mode of Recording

The mode of recording shall be Modified Frequency Modulation (MFM) for which the conditions are:

- a flux transition shall be written at the centre of each bit cell containing a ONE,
- a flux transition shall be written at each cell boundary between consecutive bit cells containing ZEROs.

Exceptions to this are defined in 9.12.

#### 9.2 Track Location Tolerance of the Recorded Flexible Disk Cartridge

For the purpose of this Section, the nominal track locations specified in 8.2.3.1 require compensation for the actual temperature using the nominal value of the coefficient of thermal expansion specified in 7.2. Over the range of operating environment specified in 5.1.2, the centrelines of the recorded tracks shall be within 0,028 mm of these compensated nominal track locations.

#### 9.3 Recording Offset Angle

At the instant of writing or reading a magnetic transition, the transition shall have an angle of:

$$\theta = \arcsin \left( \frac{d}{R_n} \right) \pm 0^\circ 9'$$

where  $R_n$  is the radius through that transition (see 8.2.3.1).

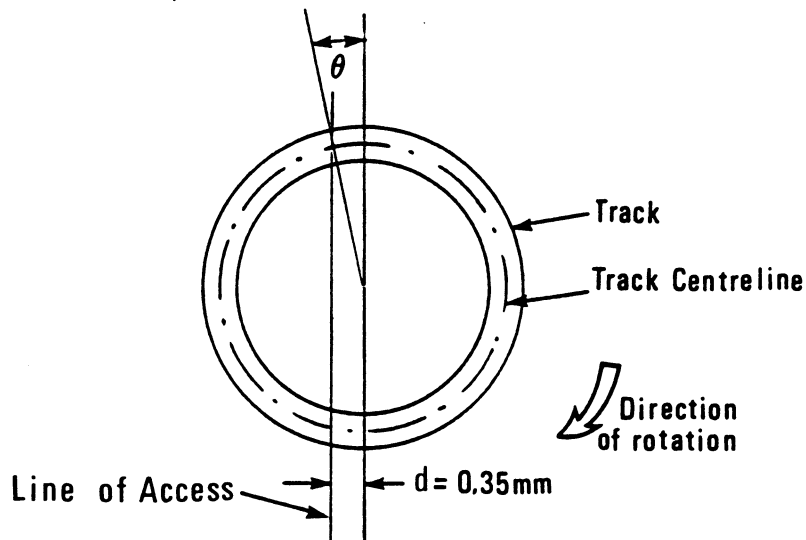


Fig. 1 - Line of access

#### 9.4 Density of Recording

- 9.4.1 The nominal density of recording shall be 31831 ftrpad. The resulting nominal bit cell length is 31,4  $\mu$ rad.
- 9.4.2 The long-term average bit cell length shall be the average bit cell length measured over a sector. It shall be within  $\pm 3,0\%$  of the nominal bit cell length.
- 9.4.3 The short-term average bit cell length, referred to a particular bit cell, shall be the average of the lengths of the preceding eight bit cells. It shall be within  $\pm 8\%$  of the long-term average bit cell length.

#### 9.5 Flux Transition Spacing

The instantaneous spacing between flux transitions is influenced by the reading and writing process, the bit sequence (pulse crowding effects) and other factors. The locations of the transitions are defined as the locations of the peaks in the signal when reading. Tests shall be carried out according to Appendix D.

- 9.5.1 The spacing between the flux transitions of a sequence of ONES shall be between 80% and 120% of the short-term average bit cell length.
- 9.5.2 The spacing between the flux transition for a ONE and that between two ZEROs preceding or following it shall be between 130% and 165% of the short-term average bit cell length.
- 9.5.3 The spacing between the flux transitions of two ONES surrounding a ZERO shall lie between 185% and 225% of the short-term average bit cell length.

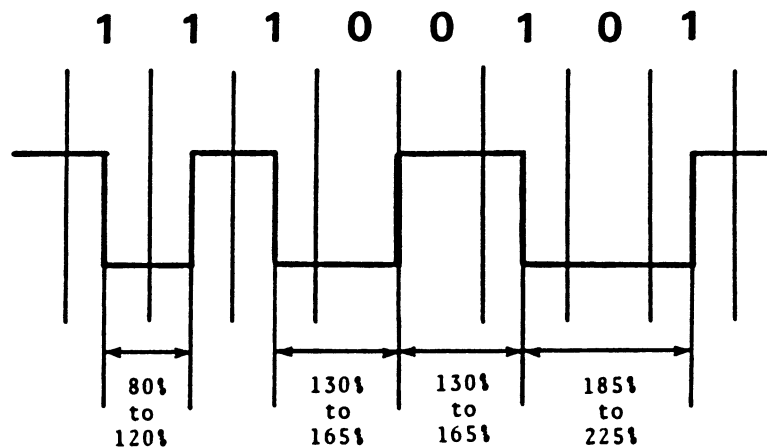


Fig. 2 - Flux transition spacings

#### 9.6 Average Signal Amplitude

For each side the Average Signal Amplitude on any track of the interchanged flexible disk cartridge shall be less than 160% of  $SRA_{1f}$  and more than 40% of  $SRA_{2f}$ .

#### 9.7 Byte

A byte is a group of eight bit-positions, identified  $B_1$  to  $B_8$ .

The bit in each position is a ZERO or a ONE.

**9.8 Sector**

All tracks shall be divided into 36 sectors of 512 bytes.

**9.9 Cylinder**

A pair of tracks, one on each side, having the same track number.

**9.10 Cylinder Number**

The cylinder number shall be a two-digit number identical with the track number of the tracks of the cylinder.

**9.11 Data Capacity of a Track**

The data capacity of a track shall be 18432 bytes.

**9.12 Hexadecimal Notation**

Hexadecimal notation shall be used hereafter to denote the following bytes:

- (00) for (B<sub>8</sub> to B<sub>1</sub>) = 00000000
- (01) for (B<sub>8</sub> to B<sub>1</sub>) = 00000001
- (02) for (B<sub>8</sub> to B<sub>1</sub>) = 00000010
- (4E) for (B<sub>8</sub> to B<sub>1</sub>) = 01001110
- (FE) for (B<sub>8</sub> to B<sub>1</sub>) = 11111110
- (FB) for (B<sub>8</sub> to B<sub>1</sub>) = 11111011
- (A1)\* for (B<sub>8</sub> to B<sub>1</sub>) = 10100001

In byte (A1)\* the boundary transition between B<sub>3</sub> and B<sub>4</sub> is missing.

**9.13 Error Detection Characters (EDC)**

The two EDC bytes are hardware-generated by shifting serially the relevant bits, specified later for each part of the track, through a 16-bit shift register described by the generator polynomial:

$$X^{16} + X^{12} + X^5 + 1$$

(See also Appendix F).

**10. TRACK LAYOUT**

Formatting of a track shall commence with the occurrence of Index. Index shall occur within 440 μs from the instant at which the Reference Line B (see 6.4.2.2) is parallel to the line of access. During formatting the rotational speed of the disk shall be :

- averaged Index-to-Index : 300 rpm ± 1,5%
- averaged over a sector : 300 rpm ± 3,0%

After formatting, there shall be 36 sectors on each track. The layout of each track shall be as follows:

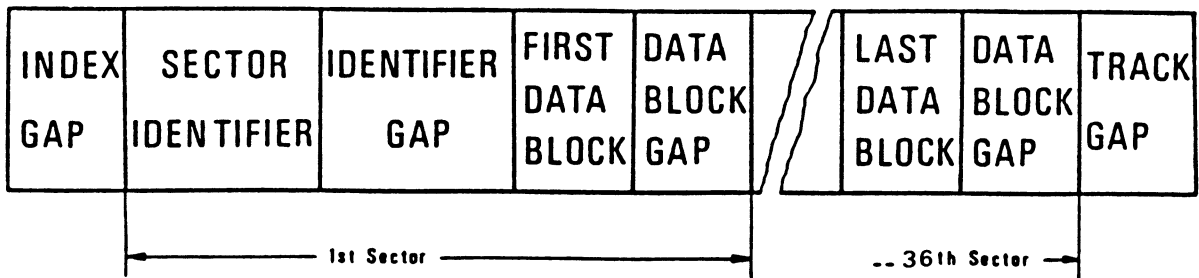


Fig. 3 - Track layout

**10.1 Index Gap**

At nominal density, this field shall comprise 146 bytes of unspecified content (except that there shall be no (A1)\*-bytes). Some of the first bytes may have become ill-defined due to overwriting.

**10.2 Sector Identifier**

The layout of this field shall be as follows:

SECTOR IDENTIFIER							
IDENTIFIER MARK			ADDRESS IDENTIFIER				
12 Bytes (00)	3 Bytes (A1)*	1 Byte (FE)	TRACK ADDRESS		S	1 Byte (02)	EDC
			C 1 Byte	Side 1 Byte (00) or (01)	1 Byte		2 Bytes

Fig. 4 - Sector Identifier

**10.2.1 Identifier Mark**

This field shall comprise 16 bytes:

- 12 (00)-bytes
- 3 (A1)\*-bytes
- 1 (FE)-byte

**10.2.2 Address Identifier**

This field shall comprise 6 bytes.

**10.2.2.1 Track Address**

This field shall comprise 2 bytes.

- i) Cylinder Number (C)

This field shall specify in binary notation the cylinder number from 00 for the outermost cylinder to 79 for the innermost cylinder.

- ii) Side Number (Side)

This field shall specify the side of the disk. On Side 0, it shall be (00) on all tracks. On Side 1 it shall be (01) on all tracks.

**10.2.2.2 Sector Number (S)**

The 3rd byte shall specify in binary notation the sector number from 01 for the 1st sector to 36 for the last sector.

The sectors may be recorded in any order of their sector numbers.

**10.2.2.3 4th Byte**

The 4th byte shall always be a (02)-byte.

**10.2.2.4 EDC**

These two bytes shall be generated as defined in 9.13 using the bytes of the Sector Identifier starting with the first (A1)\*-byte (see 10.2.1) of the Identifier Mark and ending with the 4th byte (see 10.2.2.3) of the Address Identifier.

If the EDC is incorrect the sector is defective. The relevant standard for file structure and labelling specifies the handling of defective sectors.

**10.3 Identifier Gap**

This field shall comprise 41 initially recorded (4E)-bytes. These bytes may have become ill-defined due to overwriting.

**10.4 Data Block**

The layout of this field shall be as follows:

DATA BLOCK				
DATA MARK			DATA FIELD	EDC
12 Bytes (00)	3 Bytes (A1)*	1 Byte (FB)	512 Bytes	2 Bytes

Fig. 5 - Data Block

**10.4.1 Data Mark**

This field shall comprise 16 bytes:

- 12 (00)-bytes
- 3 (A1)\*-bytes
- 1 (FB)-byte.

**10.4.2 Data Field**

This field shall comprise 512 bytes.

If it comprises less than the requisite number of data bytes, the remaining positions shall be filled with (00)-bytes.

**10.4.3 EDC**

These two bytes shall be generated as defined in 9.13 using the bytes of the Data Block starting with the first (A1)\*-byte of the Data Mark and ending with the last byte of the Data Field.

If the EDC is incorrect the sector is defective. The relevant standard for file structure and labelling specifies the handling of defective sectors.

**10.5 Data Block Gap**

This field shall comprise 83 initially recorded (4E)-bytes. These bytes may have become ill-defined due to overwriting. The Data Block Gap is recorded after each Data Block and it precedes the following Sector Identifier. After the last Data Block, it precedes the Track Gap.

**10.6 Track Gap**

This field shall follow the Data Block Gap of the last sector. (4E)-bytes are written until Index occurs, unless it has occurred during writing of the last Data Block Gap, in which case there shall be no Track Gap.

**11. CODED REPRESENTATION OF DATA**

**11.1 Byte coding**

When the coding method requires it, the data field shall be regarded as an ordered sequence of 8-bit bytes.

Within each byte the bit positions shall be identified by B<sub>8</sub> to B<sub>1</sub>. The high-order bit shall be recorded in position B<sub>8</sub> and the low-order bit in position B<sub>1</sub>. The sequence of recording shall be high-order bit first.

When the data is encoded according to an 8-bit code, the binary weights of the bit positions shall be:

Bit Position	B <sub>8</sub>	B <sub>7</sub>	B <sub>6</sub>	B <sub>5</sub>	B <sub>4</sub>	B <sub>3</sub>	B <sub>2</sub>	B <sub>1</sub>
Binary Weight	128	64	32	16	8	4	2	1

**Fig. 6 - Binary weights**

When the data is encoded according to a 7-bit code, bit position B<sub>8</sub> shall contain bit ZERO, and the data shall be encoded in bit positions B<sub>7</sub> to B<sub>1</sub>, using the same binary weights as shown above.

**11.2 Bit Coding**

When the coding method requires it, the data field shall be regarded as an ordered sequence of bit positions, each containing a bit.

**SECTION V**

**DRAWINGS**





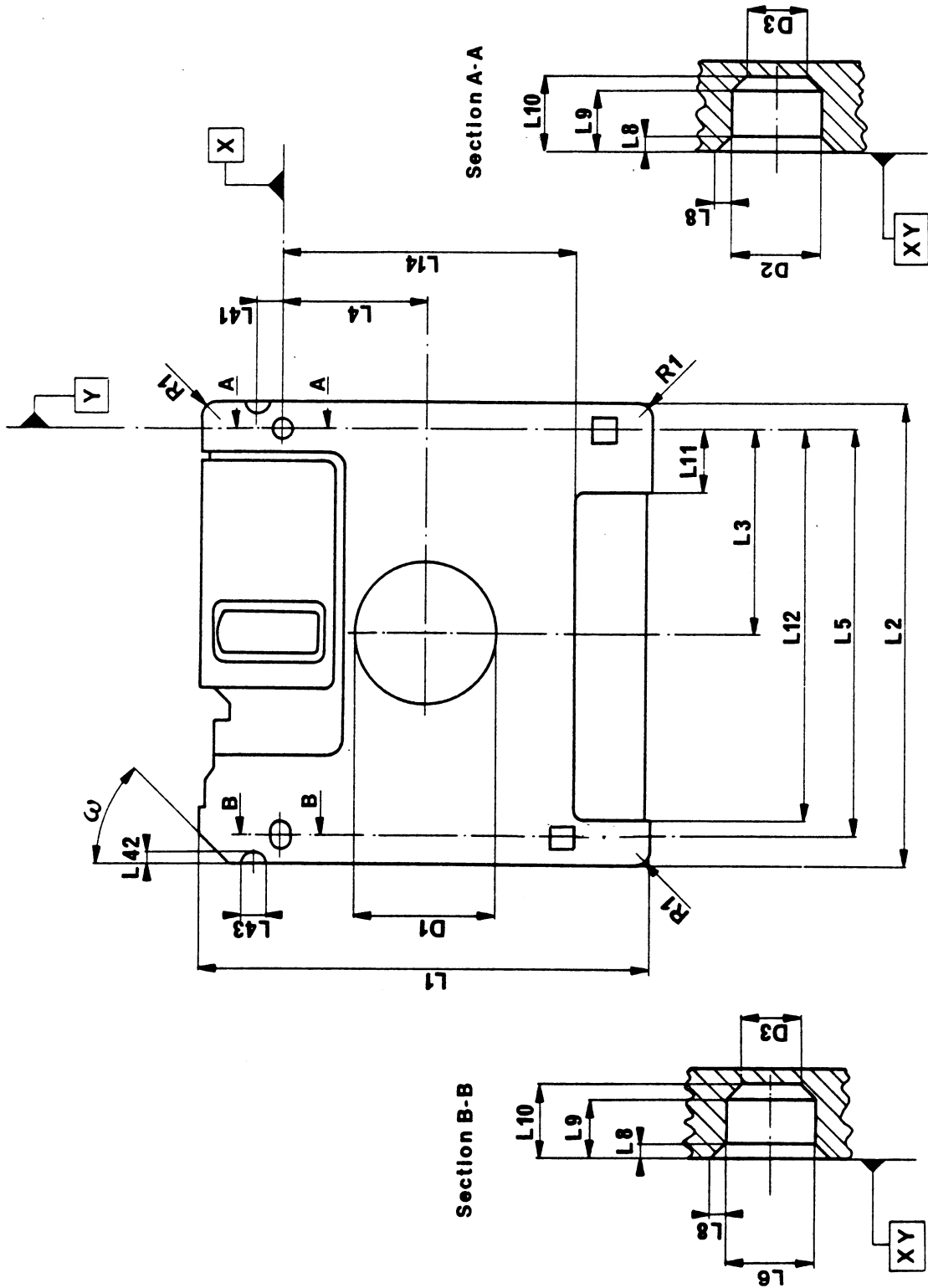


Fig. 7 - Side 0

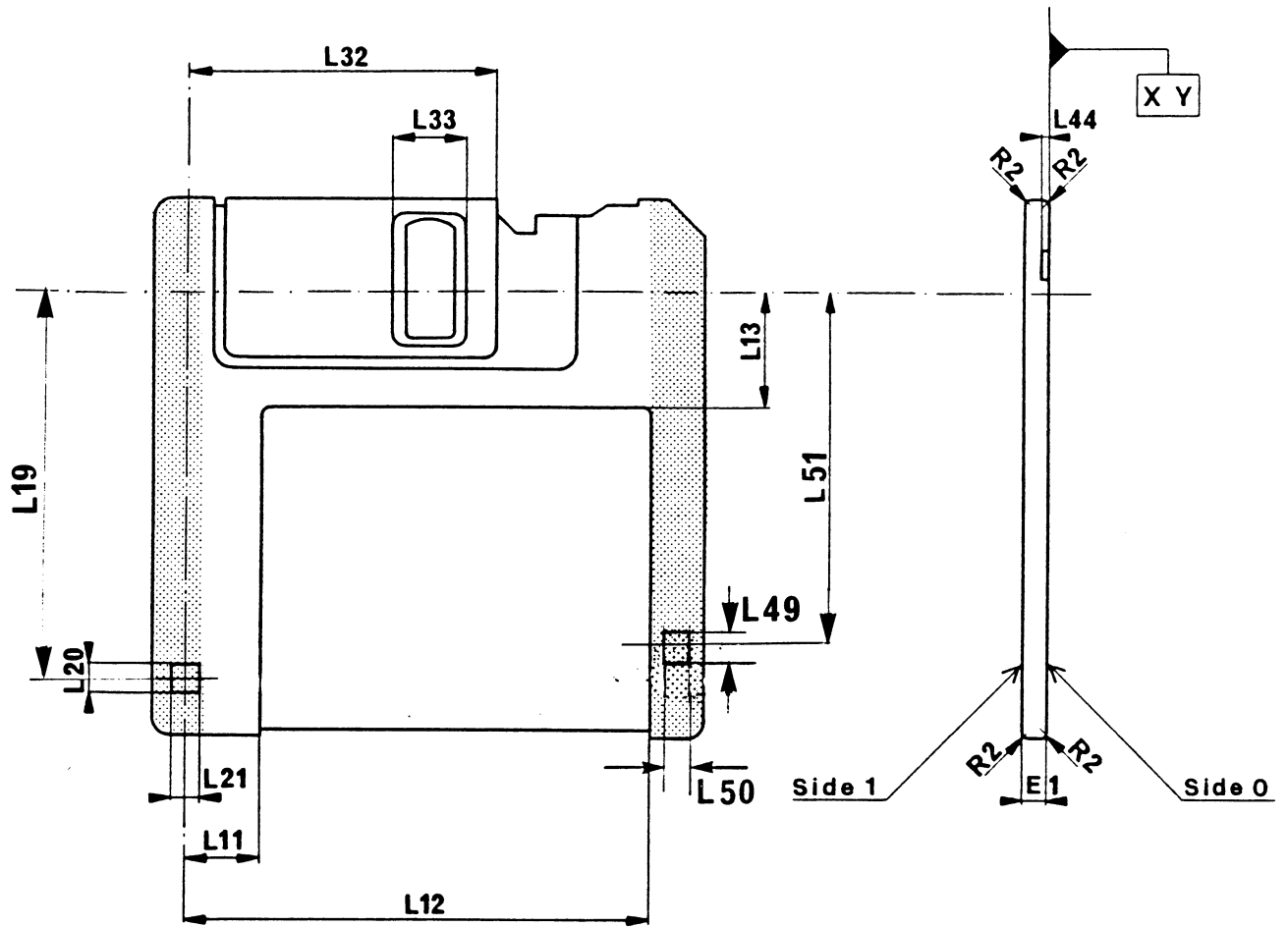


Fig. 8 - Side 1

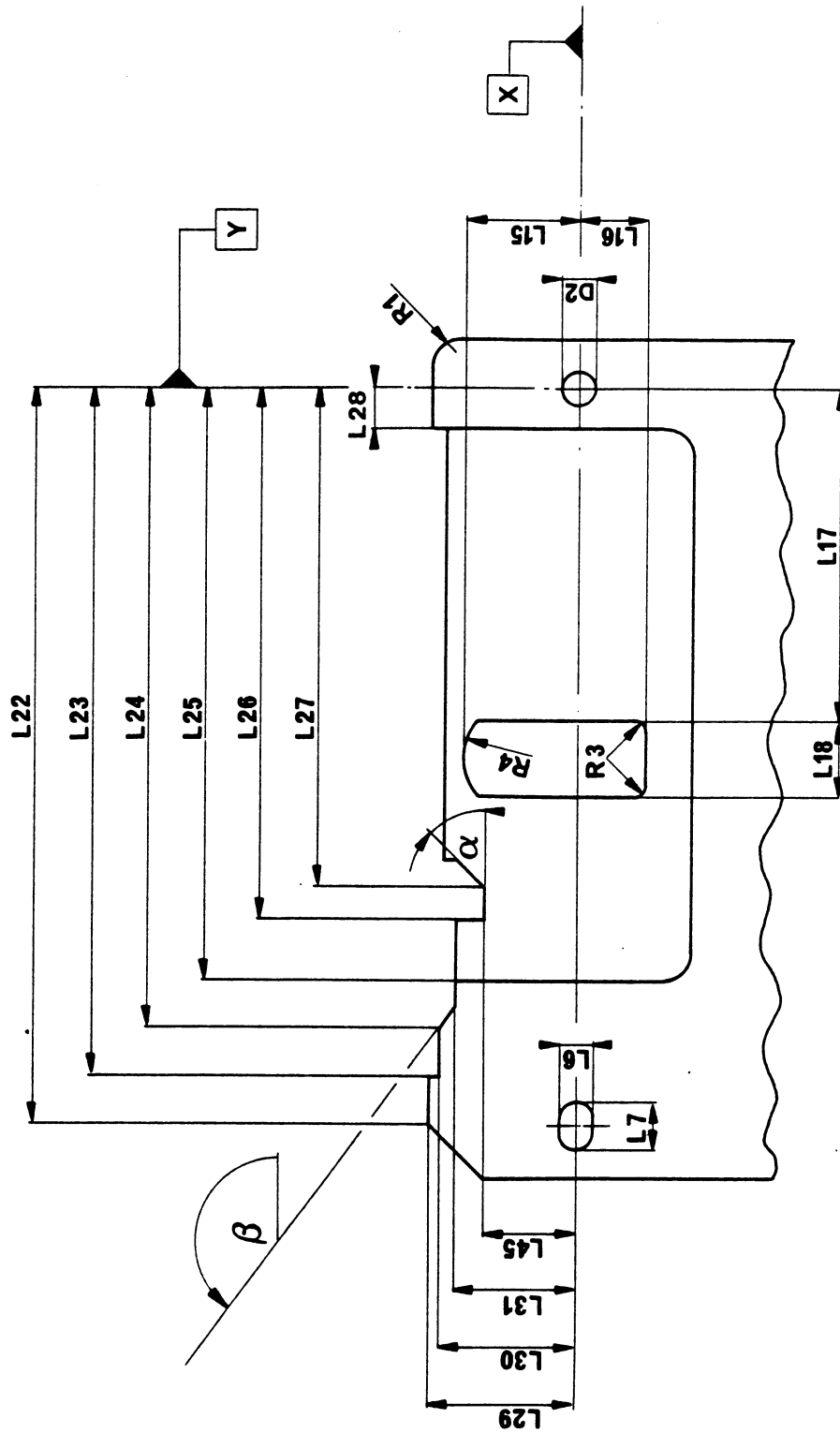


Fig. 9 - Side 0, top part

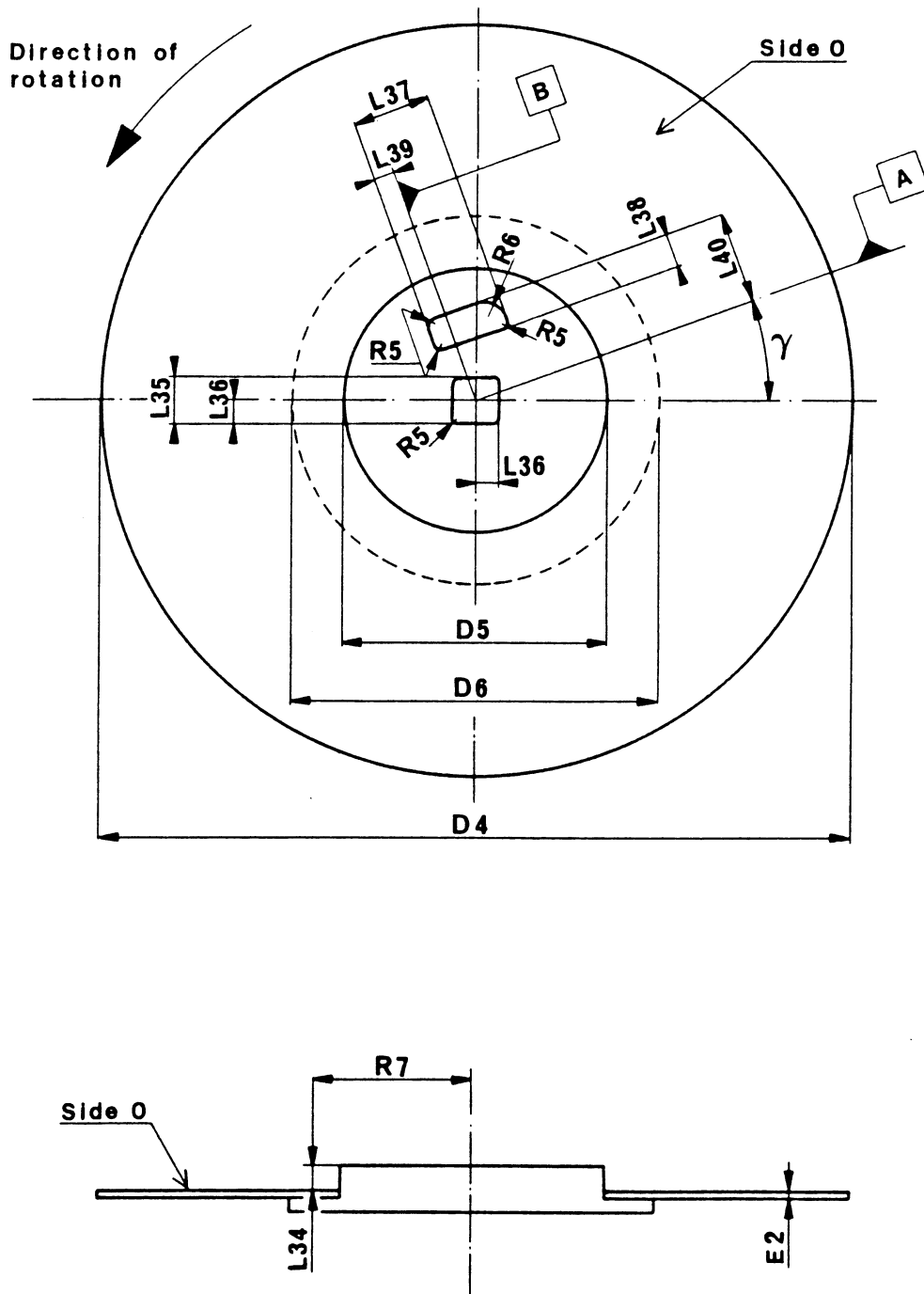


Fig. 10 - Disk with its hub

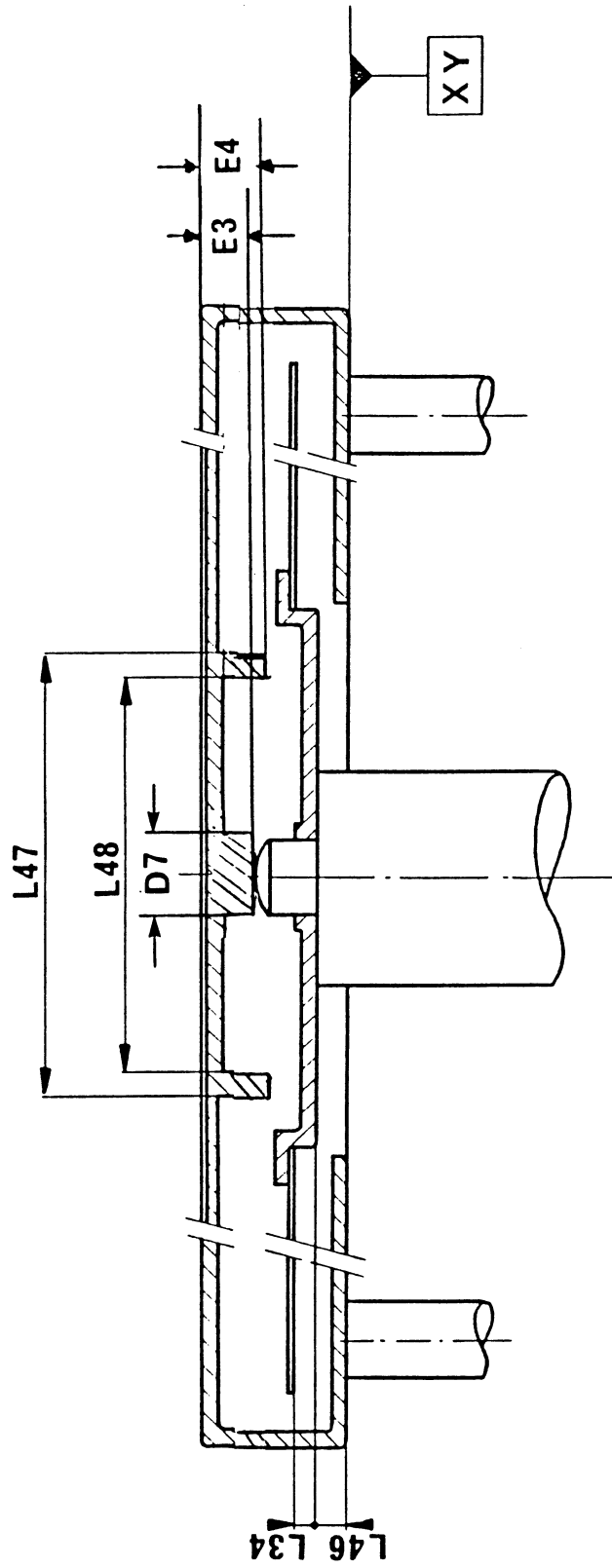


Fig. 11 - Cartridge / Drive interface



**APPENDICES**

**APPENDIX A : TEST FOR COMPLIANCE**

**APPENDIX B : MEASUREMENT OF LIGHT TRANSMITTANCE**

**APPENDIX C : METHOD FOR MEASURING THE EFFECTIVE TRACK WIDTH**

**APPENDIX D : PROCEDURE AND EQUIPMENT FOR MEASURING FLUX  
TRANSITION SPACING**

**APPENDIX E : DATA SEPARATORS FOR DECODING MFM RECORDING**

**APPENDIX F : EDC IMPLEMENTATION**

**APPENDIX G : CARTRIDGE DISTORTION TEST GAUGE**

**APPENDIX H : METHOD FOR MEASURING PEAK SHIFT**

**APPENDIX J : HEAD AND READ AMPLIFIER FOR FUNCTIONAL TESTING**

**APPENDIX K : PROCEDURE FOR DETERMINING TEST RECORDING CURRENT  
AND TEST ERASE CURRENT**





## APPENDIX A

(This Appendix is part of the Standard)

### TEST FOR COMPLIANCE

**A.1** The purpose of this test is to determine whether the cartridge will maintain the proper plane of operation within the drive. This is achieved by supporting the cartridge at defined reference zones and applying forces opposite to the supports.

**A.2** The location of the four zones a, b, c, d (Fig. A.1) is defined by

$$L_5 = 80,0 \text{ mm} \pm 0,2 \text{ mm}$$

$$L_x = 56,8 \text{ mm} \pm 0,2 \text{ mm}$$

Two of these zones, a and b, coincide with the primary and the secondary location holes, respectively.

**A.3** The test device (Fig. A.2) consists of a base plate on which four posts are fixed so as to correspond to the four zones a, b, c, d. Posts P1, P2 correspond to the zones a and b, respectively. Posts P3, P4 correspond to zones c and d, respectively. A fifth post (P5) is mounted in the middle of the plate and corresponds to the drive spindle.

The dimensions of these posts are as follows (Fig. A.3):

#### Posts P1, P2

$$d_1 = 6,00 \text{ mm} \pm 0,01 \text{ mm}$$

$$d_2 = 3,00 \text{ mm} \pm 0,01 \text{ mm}$$

$$h_1 = 1,00 \text{ mm max.}$$

$$h_2 = 2,00 \text{ mm max.}$$

#### Post P5

$$d_3 = 12,70 \text{ mm} \pm 0,01 \text{ mm}$$

$$d_4 = 3,98 \text{ mm} \pm 0,01 \text{ mm}$$

$$h_3 = 2,20 \text{ mm} \left\{ \begin{array}{l} + 0,03 \text{ mm} \\ - 0,00 \text{ mm} \end{array} \right.$$

$$r = 0,25 \text{ mm} \pm 0,3 \text{ mm}$$

#### Posts P3, P4

$$d_5 = 6,00 \text{ mm} \pm 0,01 \text{ mm}$$

After assembly, the upper annular surfaces of posts P1 to P4 shall lie between two horizontal planes spaced 0,02 mm apart.

**A.4** The cartridge is laid on these four posts and a vertical, downward force of 0,65 N is exerted on each of the four zones.

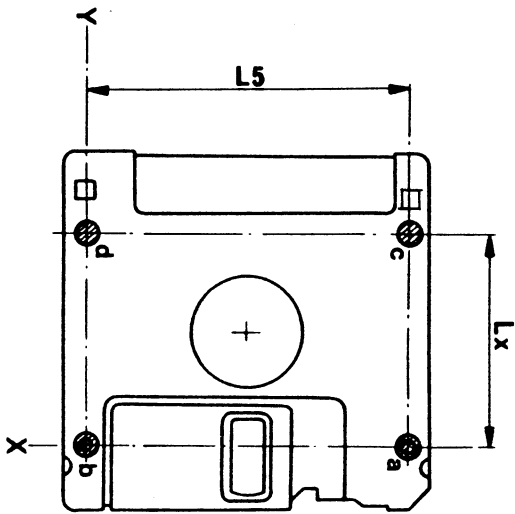


Fig. A.1 - Location of the reference zones

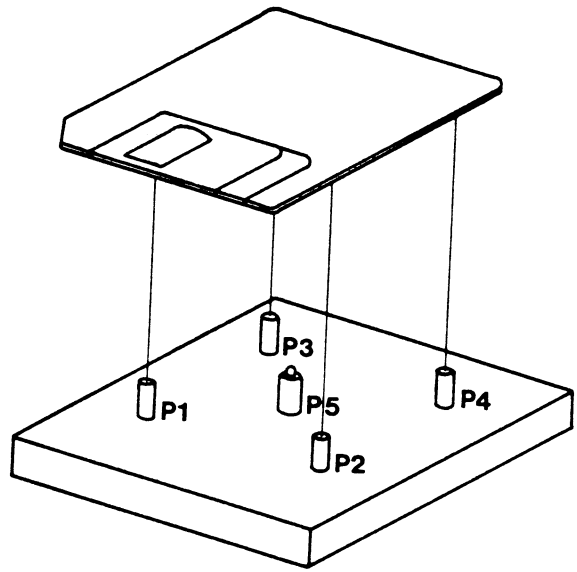


Fig. A.2 - Test device

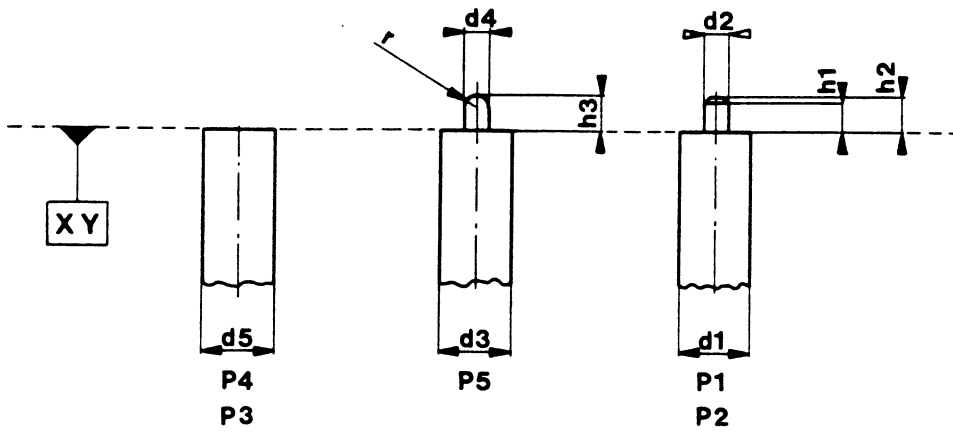


Fig. A.3 - Dimensions of the posts

## APPENDIX B

(This Appendix is part of the Standard)

### MEASUREMENT OF LIGHT TRANSMITTANCE

#### B.1 INTRODUCTION

The following description outlines the general principle of the measuring equipment and the measuring method to be applied when measuring the radiation (light) transmittance of the write-inhibit hole and the opacity of its cover.

For the purpose of this document "light transmittance" is defined by convention as the relationship between the reading obtained from the test device with the sample inserted and the reading obtained when no sample is present. The transmittance value is expressed as the percentage ratio of the two readings. The essential elements of the measuring equipment are:

- the radiation source
- the photo diode
- the optical path
- the measuring circuitry.

#### B.2 DESCRIPTION OF THE MEASURING EQUIPMENT

##### B.2.1 Radiation Source

An infra red light-emitting diode (LED) with the following parameters shall be used:

Wavelength at peak emission: 940 nm  $\pm$  10 nm

Half-power band width  $b = \pm 50$  nm

##### B.2.2 Radiation Receiver

A flat silicon photo diode shall be used as the radiation receiver. It shall be operated in the short circuit mode. The active area of the diode shall be equal to, or at the most 20% larger than, the open area of the aperture. This condition guarantees a linear dependency of the short circuit diode current on the light intensity.

##### B.2.3 Optical Path (Fig. B.1)

The optical axis of the set up shall be perpendicular to the case (Side 1).

The distance from the emitting surface of the LED to the case shall be:

$$l_1 = \frac{3,5}{2 \operatorname{tg} \alpha}$$

3,5 mm is the minimum value of dimension  $L_{20}$  (see 6.1.7.2).

$\alpha$  is the angle where the relative intensity of the LED is equal to, or greater than, 95% of the maximum intensity in the optical axis.

The aperture shall have a thickness of 1,2 mm to 1,4 mm and a diameter given by:

$$D = (2 l_2 \operatorname{tg} \alpha) \text{ mm}$$

$$l_2 = (l_1 + 1,5) \text{ mm}$$

Its surfaces shall be matt black. The whole device should be enclosed within a light-tight casing.

#### B.2.4 Measuring Circuitry

Fig. B.2 shows the recommended circuitry with the following components:

E	: regulated power supply with variable output voltage
R	: current-limiting resistor
LED	: light-emitting diode
D <sub>i</sub>	: Si photo diode
A	: operational amplifier
R <sub>f0</sub> , R <sub>f1</sub>	: feedback resistors
S	: gain switch
V	: voltmeter

The forward current of the LED and consequently its radiation power can be varied by means of the power supply E. D<sub>i</sub> is working in the short circuit mode. The output voltage of the operational amplifier is given by:

$$V_0 = I_k \cdot R_f$$

and is therefore a linear function of the light intensity. I<sub>k</sub> is the short circuit current of D<sub>i</sub>.

R<sub>f0</sub> and R<sub>f1</sub> shall be low-temperature drift resistors with an accuracy of 1%. The following ratio applies:

$$\frac{R_{f0}}{R_{f1}} = \frac{1}{50}$$

#### B.3 MEASURING METHOD

The measurements shall be taken with the case in a fixed position.

- S is set to position 0. With the write-inhibit hole open in front of the photo diode. The voltmeter is set to full-scale reading (100% transmittance) by varying the output voltage of E.
- The write-inhibit hole is then covered. S is set to position 1. Full deflection of the voltmeter now represents 2% transmittance.

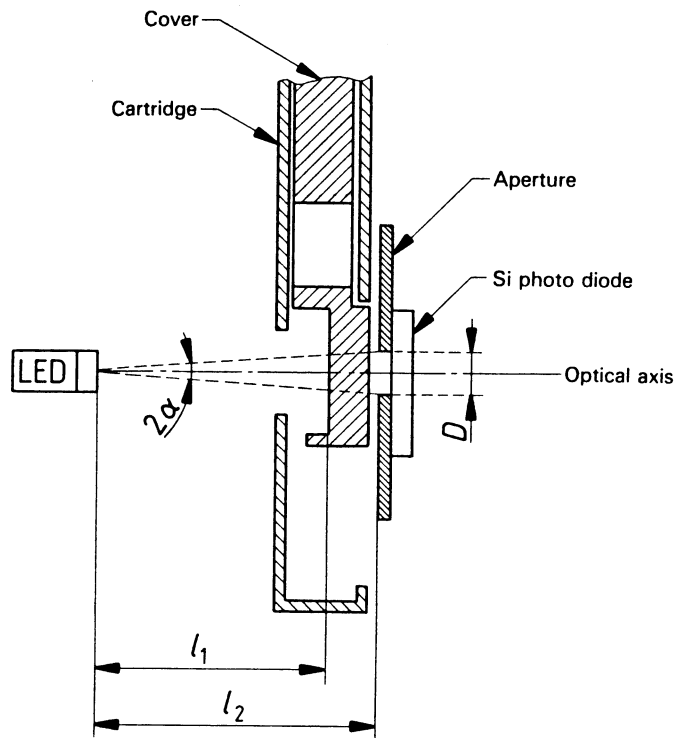


Fig. B.1 - Measuring Device

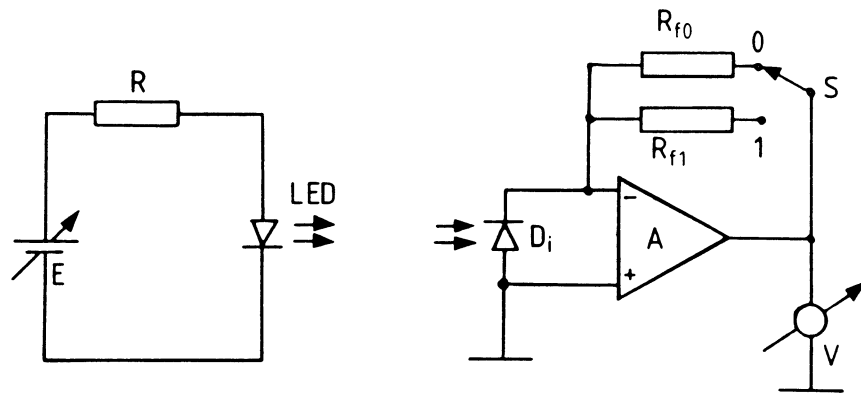


Fig. B.2 - Electronic Circuitry



### APPENDIX C

(This Appendix is part of the Standard)

#### METHOD FOR MEASURING THE EFFECTIVE TRACK WIDTH

Erase a 7-track wide band. Record a 500 000 ftps frequency pattern in a track centred in the middle of the erased band, with the erase head active.

For reading use a head the gap width of which is wider than the expected track width. Move this head radially over the disk in increments not greater than 0,01 mm across the track. Determine the read back signal amplitude for each incremental move and plot its amplitude versus displacement. See Fig.C.1 below for reading the half track widths A and B. The total effective track width is the sum of A and B.

Repeat the test to ensure that no thermal or hygroscopic effects have taken place during the measurement.

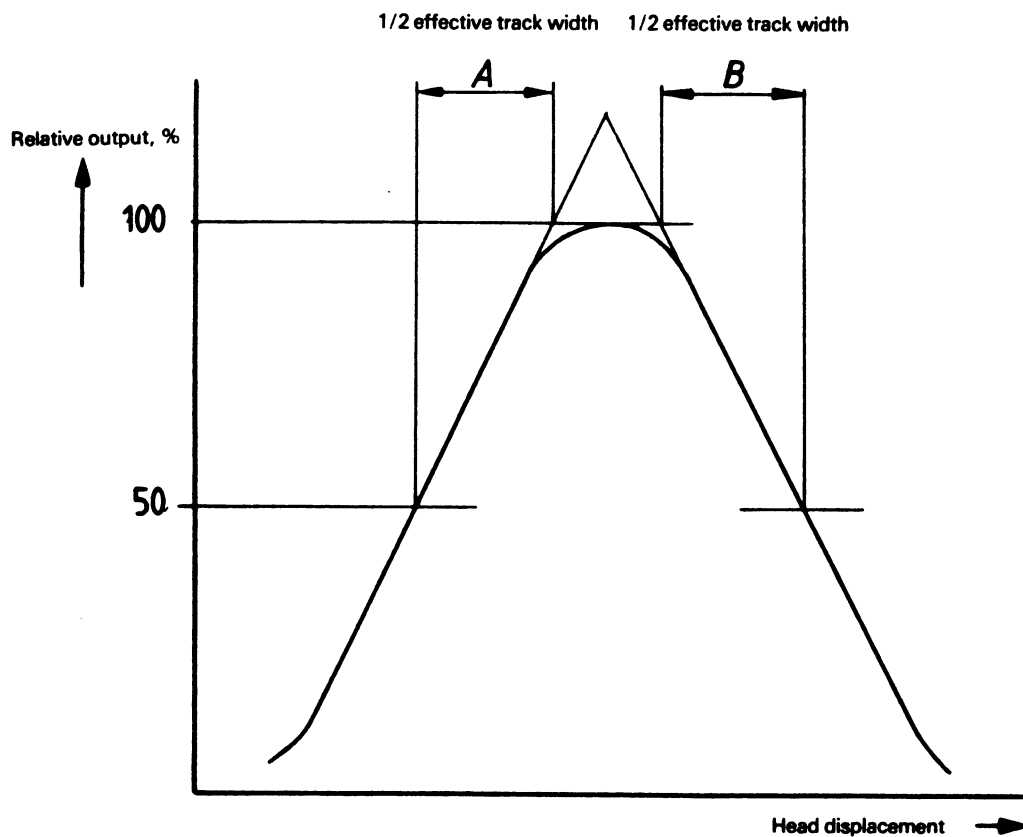


Fig. C.1 - Effective track width





## APPENDIX D

(This Appendix is part of the Standard)

### PROCEDURE AND EQUIPMENT FOR MEASURING FLUX TRANSITION SPACING

#### D.1 GENERAL

This Appendix specifies equipment and procedure for measuring flux transition spacing of data recorded for data interchange on a 90 mm flexible disk cartridge using MFM recording at 31831 flux transitions per radian on both sides.

#### D.2 TEST EQUIPMENT

##### D.2.1 Disk Drive

The disk drive shall have a rotational speed of 300 rpm  $\pm$  3 rpm averaged over one revolution. The average angular speed taken over 32  $\mu$ s shall not deviate by more than 0,5% from the speed averaged over one revolution.

##### D.2.2 Head

The head shall be as specified in Appendix J, with the exception that the tolerance for the offset angle (see J.2.1.3) shall be  $0^\circ \pm 3'$  (instead of  $0^\circ \pm 9'$ ).

##### D.2.3 Read Channel

The read channel shall be as specified in Appendix J. Peak sensing shall be carried out by a differentiating and limiting amplifier.

##### D.2.4 Time Interval Measuring Resolution

The time interval counter shall be able to measure time intervals from 0,5  $\mu$ s to 2,5  $\mu$ s with at least 5 ns resolution.

A triggering oscilloscope may be used for this purpose.

#### D.3 PROCEDURE FOR MEASUREMENT

##### D.3.1 Flux Transition Spacing Measurement

The flux transition spacings shall be measured by measuring the time intervals between successive peaks in the read signal for  $10^5$  intervals of random sampling on a track, and plotting logarithmically the distribution of the time intervals as shown below.

The measurements shall be made at the output of the read amplifier specified in D.2.3.

##### D.3.2 Flux Transition Spacing for all Tracks

Measurement of time intervals  $t_1$  to  $t_6$  shall be as shown below.

$t_2/t_0$  and  $t_1/t_0$  (x 100%) correspond to 9.5.1

$t_4/t_0$  and  $t_3/t_0$  (x 100%) correspond to 9.5.2

$t_6/t_0$  and  $t_5/t_0$  (x 100%) correspond to 9.5.3.

$t_0$  is the short-term average bit cell length = 1  $\mu$ s nominal.

Intervals which are out of specification due to data block splicings or index splicing may be neglected.

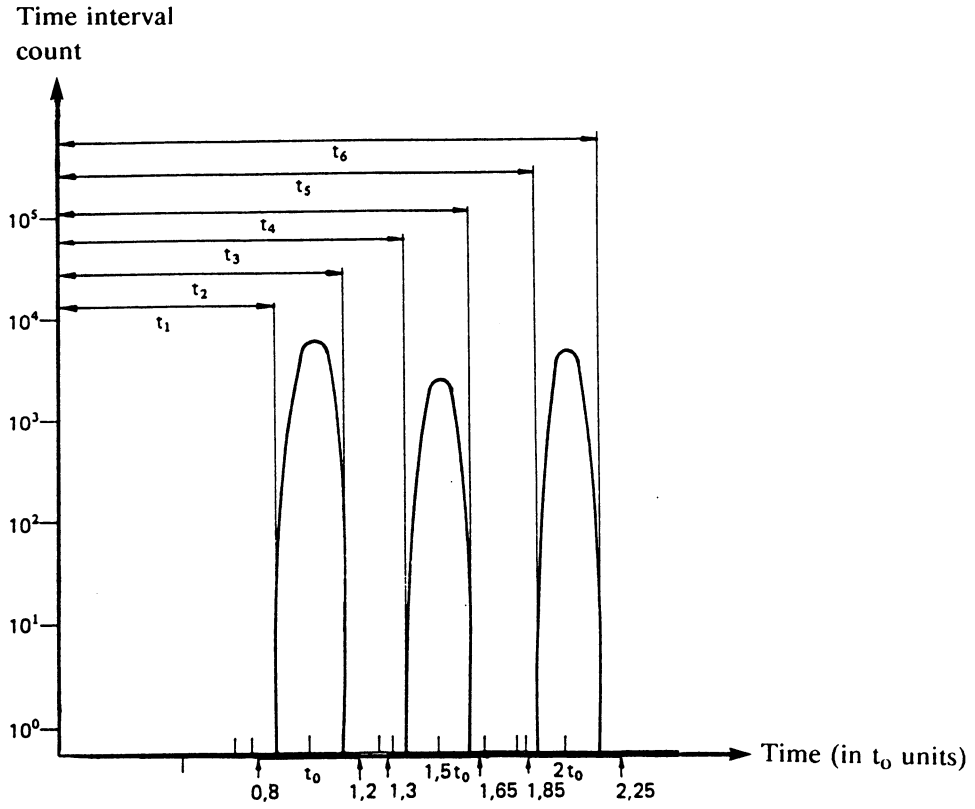


Fig.D.1 - Flux Transition spacing distribution

## APPENDIX E

(This Appendix is not part of the Standard)

### DATA SEPARATORS FOR DECODING MFM RECORDING

The MFM recording method gives nominal flux transition spacings of:

$t$  for the patterns 111 or 000

$3t/2$  for the patterns 100 or 001

$2t$  for the pattern 101

The data separator should be capable of resolving a difference of only  $1 \mu\text{s}$ . To achieve this with a low error rate, the data separator cannot operate on a fixed period but should follow changes in the bit cell length.

It is recognized that various techniques may be developed to achieve dynamic data separation; with present technology only an analogue data separator based on a phase-locked oscillator can provide the necessary reliability.



## APPENDIX F

(This Appendix is not part of the Standard)

### EDC IMPLEMENTATION

The figure below shows the feedback connections of a shift register which may be used to generate the EDC bytes.

Prior to the operation, all positions of the shift register are set to ONE. Input data are added (exclusive OR) to the contents of position  $C_{15}$  of the register to form a feedback. This feedback is in its turn added (exclusive OR) to the contents of position  $C_4$  and position  $C_{11}$ .

On shifting, the outputs of the exclusive OR gates are entered respectively into positions  $C_0$ ,  $C_5$  and  $C_{12}$ . After the last data bit has been added, the register is shifted once more as specified above.

The register then contains the EDC bytes.

If further shifting is to take place during the writing of the EDC bytes, the control signal inhibits exclusive OR operations.

To check for errors when reading, the data bits are added into the shift register in exactly the same manner as they were during writing. After the data the EDC bytes are also entered into the shift register as if they were data. After the final shift, the register contents will be all ZERO if the record does not contain errors.

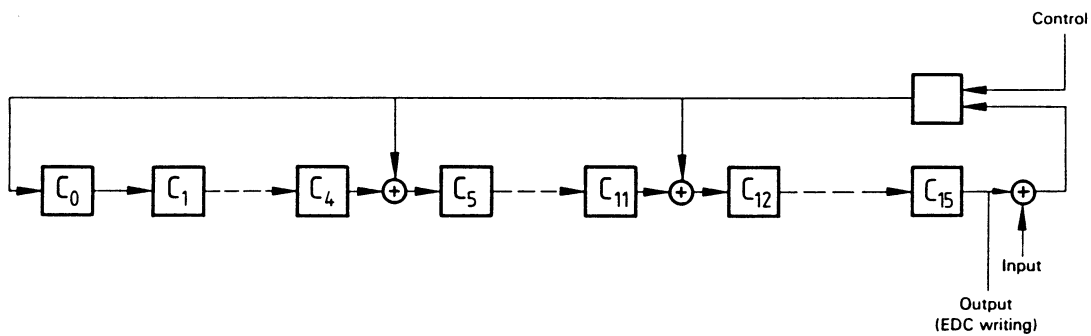


Fig. F1 - Shift register



## APPENDIX G

(This Appendix is part of the Standard)

### CARTRIDGE DISTORTION TEST GAUGE

- G.1** The gauge to be used is shown in Fig. G.1
- G.2** The gauge shall be made of a suitable material, e.g. of carbon steel and be chrome-plated. The inner surfaces shall be polished to a surface finish of 5  $\mu\text{m}$  peak-to-peak.
- G.3** Dimensions shall be as follows:
- A = 96,0 mm min.
  - B = 91,0 mm  $\pm$  0,1 mm
  - C = 8,50 mm  $\pm$  0,01 mm
  - D = 3,80 mm  $\pm$  0,01 mm
  - E = 4,20 mm  $\pm$  0,01 mm

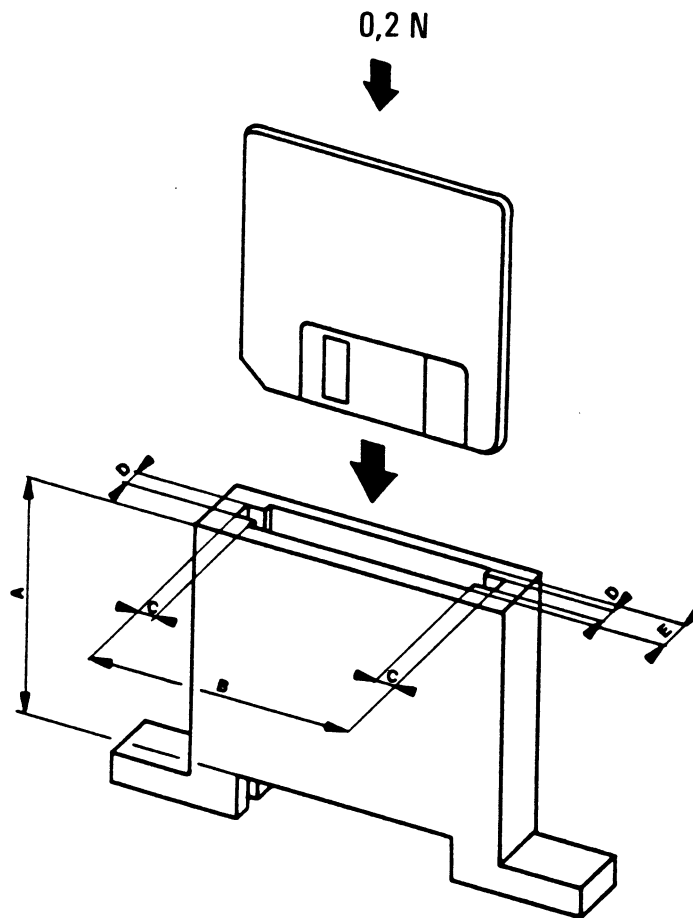


Fig.G.1 - Test Gauge





## APPENDIX H

(This Appendix is part of the Standard)

### METHOD FOR MEASURING PEAK SHIFT

#### H.1 INTRODUCTION

The resolution of a flexible disk system at the inner tracks, where the recording density is highest, must be sufficiently high to minimize the peak shift. However, it must not be too high otherwise at outer tracks, where the recording density is lowest, spurious read pulses may be generated.

This test controls the characteristics of the disk by measuring the peak shift at inner tracks and setting limits for the upper and lower values.

#### H.2 DESCRIPTION OF THE MEASURING EQUIPMENT

##### H.2.1 Peak Shift Test Drive

The test drive shall be any drive suitable for use at 31831 ftprad.

##### H.2.2 Peak Shift Measurement Circuit

The measurement circuit shall be as shown in Fig. H.1.

The operation of the circuit is illustrated in the timing diagram Fig. H.2 as follows:

- a) Index Pulse
- b) Index Pulse Timer  
A 1 ms timer triggered by the Index Pulse. Its output masks the discontinuities that occur in the recording when the write current is switched off.
- c) Read Signal  
The read signal resulting from the test pattern. The positive-going edge of the first bit of a pair triggers the LS 74 flip-flop. The negative-going edge of the first bit of a pair triggers the LS 221 timer.
- d) Bit Period Window  
This is the output waveform of the LS 221 timer. It allows the positive-going edge of the second bit of a pair to reset flip-flop LS 74.
- e) is the output of the LS 74; its duration is the time interval  $T'$  between the two bits of a pair.
- f) Sampling Period  
This period commences when the second LS 74 flip-flop is set by the trailing edge of (d) after the Index Pulse Timer has reset.  
It is terminated by the trailing edge of the first output pulse of the LS 221 timer to occur during the period of the next Index Pulse Timer.

g) Output

Waveform (e) is passed to the Time Interval Counter during the Sampling Period.

**H.2.3 Period of the LS 221 Timer**

The period of this timer shall be 1,5 µs.

**H.2.4 Time Interval Counter**

The counter shall have a resolution of 5 ns or better.

**H.3 TEST METHOD**

**H.3.1 AC bulk-erase the disk cartridge.**

**H.3.2** Using the Test Recording Current, write the test pattern DB6 (110110110110...) continuously on Track 79 on each side commencing with the Index Pulse and switching off the write current when the Index Pulse is detected at the end of one revolution.

**H.3.3** Read back on the same test drive and measure intervals T' on the time Interval Counter.

*NOTE H.1*

*To minimize errors due to changes in the rotational speed of the drive, it is essential that reading shall occur immediately after writing.*

**H.3.4 Sampling Method**

**H.3.4.1** The Data Recording Area extends from the leading edge of the Index Pulse to the leading edge of the next Index Pulse.

**H.3.4.2** The Sampling Area extends from the resetting of the Index Pulse Timer to the leading edge of the next Index Pulse (resulting from H.2.2 b).

**H.3.4.3** The preferred sampling method is to measure every T' interval in the Sampling Area, if permitted by the sampling rate of the Time Interval Counter. If the sampling rate of the counter prohibits the measurement of every T', then a lesser number of T' measurements shall be permitted, providing that the sampling is random.

**H.3.4.4** The minimum number of random samples shall be 1000.

**H.3.5 Asymmetry of the Write Waveform**

To eliminate errors due to asymmetry of the write current waveform, repeat operations H.3.1 to H.3.4 using the test pattern B6D (101101101101...).

**H.3.6** The operations specified in H.3.1 to H.3.5 shall be repeated for the Secondary Standard Reference FDC.

**H.4 DEFINITIONS**

$$\text{Peak Shift} = \frac{T' - T}{2}$$

where:

T' is the mean period between pairs of bits in the read waveform,

T equals 1 µs, i.e. the period of the 2f pattern.

The peak shift value of the disk under test expressed in % shall be:

$$\frac{P_t}{P_s} \cdot K_o$$

where:

$P_t$  is the peak shift value obtained for the disk under test.

$P_s$  is the peak shift value obtained for Secondary Standard Reference FDC

$K_o$  is the calibration factor in % of the Secondary Standard Reference FDC.

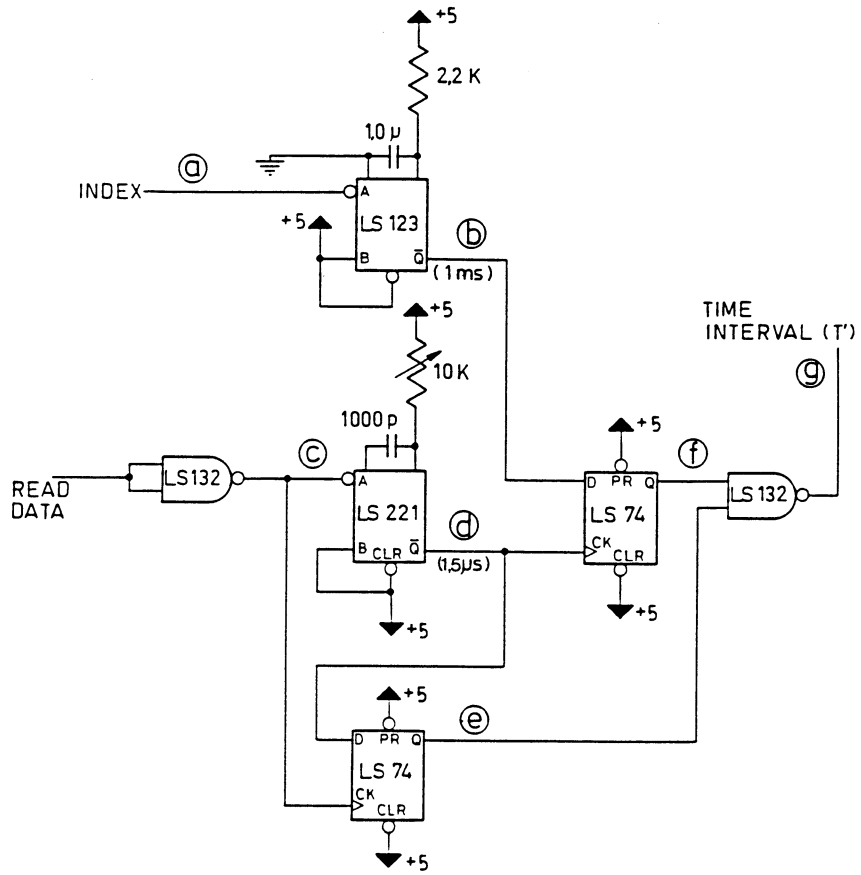


Fig. H.1 - Measurement Circuit

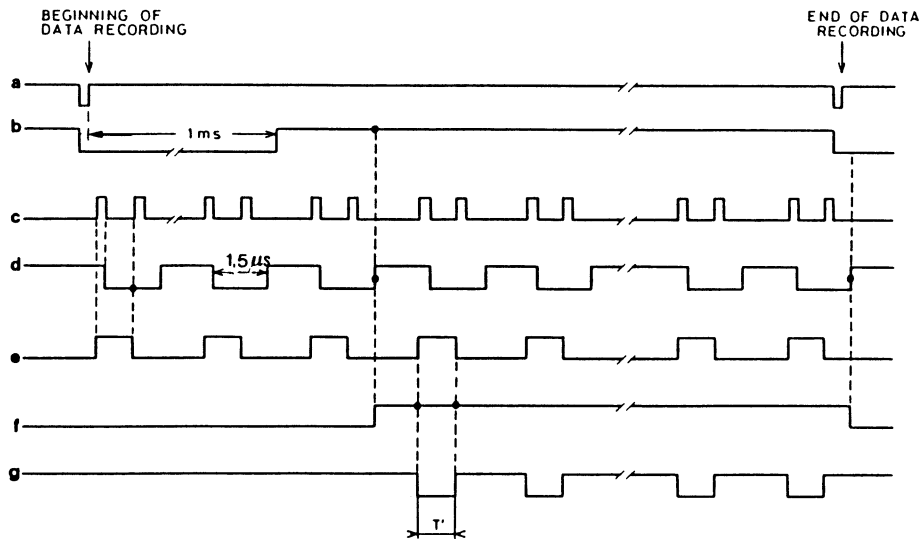


Fig. H.2 - Timing Diagram

## APPENDIX J

(This Appendix is part of the Standard)

### HEAD AND READ AMPLIFIER FOR FUNCTIONAL TESTING

#### J.1 GENERAL

This Appendix specifies the head and the read amplifier for functional testing of 90 mm flexible disk cartridges using MFM recording at 31 831 flux transitions per radian on both sides, and for measurement of flux transition spacing.

#### J.2 TEST EQUIPMENT

##### J.2.1 Head

##### J.2.1.1 Read/write head

The read/write head of a combined head consisting of an erase head and a read/write head shall have an absolute resolution of 75% to 85% at Track 79 on each side, using the Secondary Standard Flexible Disk Cartridge, Reference Material RM 10994, applying the calibration factor of the Reference Material appropriate to the side, and recording with the appropriate Test Recording Current.

The resonant frequency of the read/write head shall be greater than 1'000'000 Hz.

The resolution shall not be adjusted by varying the load impedance of the read/write head.

The resolution shall be measured at the output of the amplifier defined in J.2.2.

##### J.2.1.2 Erase head

The erase head of a combined head consisting of an erase head and a read/write head shall have an absolute eraseability of less than 2% at Track 00 using If on each side, using Reference Material RM 10994, and using the Test Recording Current and the Test Erase Current.

##### NOTE J.1

*The eraseability of RM 10994 to less than 2%, using the Test Recording Current and the Test Erase Current, is a property of the RM certified by PTB.*

##### J.2.1.3 Offset angle

The offset angle of the read/write head shall be:

$$\theta = \arcsin \frac{0,35}{R_n} \pm 0^{\circ} 9'.$$

##### J.2.1.4 Contact

Care shall be taken that the heads are in good contact with the disk during tests.

**J.2.2 Read Amplifier**

The read amplifier shall have a flat response from 1'000 Hz to 750'000 Hz within a 2 dB wide band, and amplitude saturation shall not occur.

The -3 dB roll off point shall be less than 1'500'000 Hz (approx. 6f).

The attenuation above the -3 dB roll off point frequency shall not be less than that given by a line drawn through 0 dB at the -3 dB roll off point frequency with a slope of -12 dB/octave.

The phase shift shall be linear within a 10° wide band between 1'000 Hz and 750'000 Hz.

## APPENDIX K

(This Appendix is part of the Standard)

### PROCEDURE FOR DETERMINING TEST RECORDING CURRENT AND TEST ERASE CURRENT

#### K.1 INTRODUCTION

This Appendix specifies the procedure for determining the Test Recording Current and the Test Erase Current in a drive for the functional testing specified in 8.3, using a Secondary Reference Flexible Disk Cartridge.

The Test Recording Current  $I_{tr}$  obtained by measuring the Average Signal Amplitude as a function of the recording current, may be influenced by the erase current used in this measurement. On the other hand, the Test Erase Current  $I_{te}$  obtained by measuring eraseability as a function of the erase current, may be influenced by the recording current. If  $I_{tr}$  and  $I_{te}$  are determined independently, in general a deviation from the true values occurs.

In order to avoid the above problem, the method described below shall be used. It allows to determine  $I_{tr}$  and  $I_{te}$  consistently.

#### K.2 PROCEDURE

In the following description  $I_{rf}$  is the recording current which causes the Reference Field, and  $I_{re}$  is the erase current which causes the Reference Erase Field. The notation (n) indicates the n-th approximation.

- 1) Set  $I_{te}(0)$  to an appropriate erase current, e.g. the erase current of the drive as it is. Measure the Average Signal Amplitude as a function of the recording current, and determine  $I_{rf}(1)$ .  $I_{tr}(1)$  is given by  $2 \times I_{rf}(1)$  (see K.3).
- 2) Set a recording current of the drive to  $I_{tr}(1)$ . Measure eraseability as a function of the erase current. The erase current when 1f is recorded in this measurement shall be set to  $I_{te}(0)$ . Determine  $I_{ref}(1)$ , then  $I_{te}(1)$  is given by  $1,5 \times I_{ref}(1)$  (see K.4).
- 3) Determine  $I_{rf}(2)$  by using  $I_{te}(1)$ , then determine  $I_{tr}(2)$  by the same method as in 1).
- 4) Determine  $I_{ref}(2)$  by using  $I_{tr}(1)$  and  $I_{te}(1)$ , then determine  $I_{te}(2)$  by the same method as in 2).
- 5) Continue the above procedure until the following conditions are satisfied:

$$\begin{aligned} I_{te}(n) &= I_{te}(n-1) \\ I_{tr}(n) &= I_{tr}(n-1) \end{aligned}$$

*NOTE K.1*

*Usually, the above conditions are satisfied before n equals 3.*

The values of  $I_{tr}$  and  $I_{te}$  satisfying the two equations in 5) above will be the values of the Test Recording Current and of the Test Erase Current to be used for functional testing.

**K.3 CALIBRATION FACTOR FOR DETERMINING THE REFERENCE FIELD**

The Typical Field of RM 10994 is related to the Reference Field, that is the Typical Field of the Master Standard Reference Flexible Cartridge, by means of a calibration factor  $K_r$  :

$$K_r = \frac{\text{Typical Field for the Reference Material}}{\text{Reference Field}} \times 100\%$$

This calibration factor  $K_r$  shall be used for determining  $I_{rf}$ , the recording current which causes the Reference Field:

$$I_{rf} = \frac{\text{Current which causes the Typical Field of RM 10994}}{0,01 K_r}$$

See Fig. K.1.

**K.4 CALIBRATION FACTOR FOR DETERMINING THE REFERENCE ERASE FIELD**

$K_e$  is the calibration factor for determining the Reference Erase Field, it is given in the certificate attached to each RM 10994.

$$K_e = \frac{\text{Eraseability of the Reference Material at } I_{ref}}{\text{Eraseability of the Master Standard Reference Disk Cartridge at } I_{ref}} \times 100\%$$

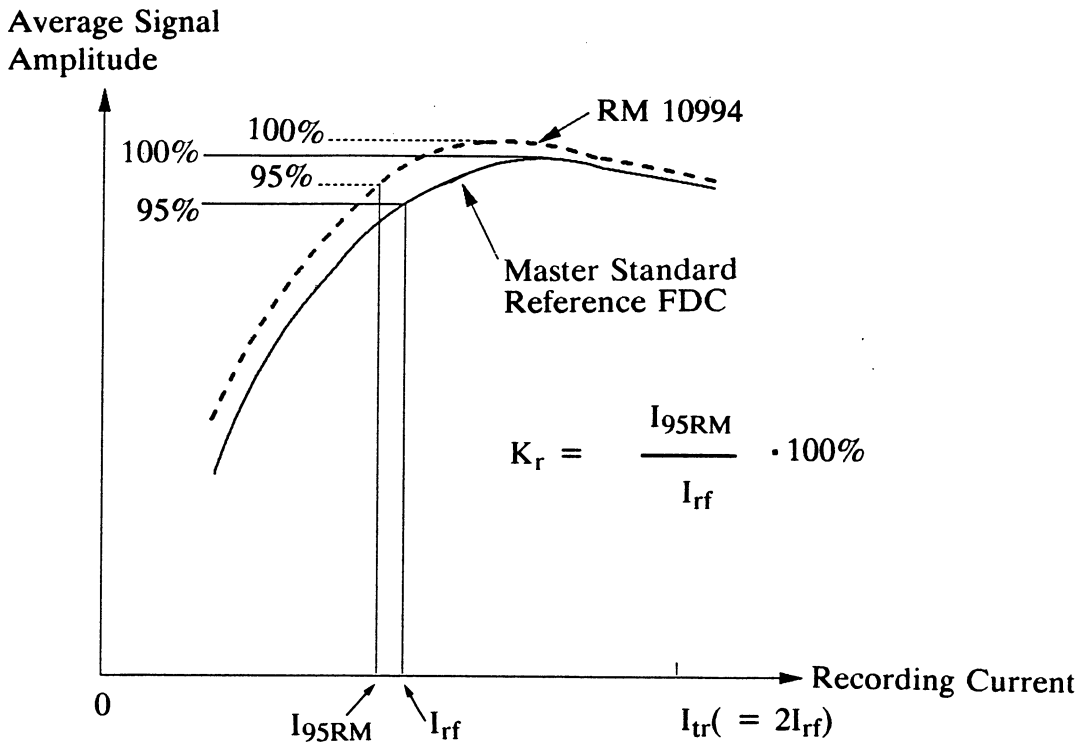
$I_{ref}$  is defined as the erase current which causes an eraseability of 5% for the Master Standard Reference Flexible Disk Cartridge.

$I_{ref}$  can be obtained as the current which causes an eraseability for RM 10994 of

$$5 \frac{K_e}{100}$$

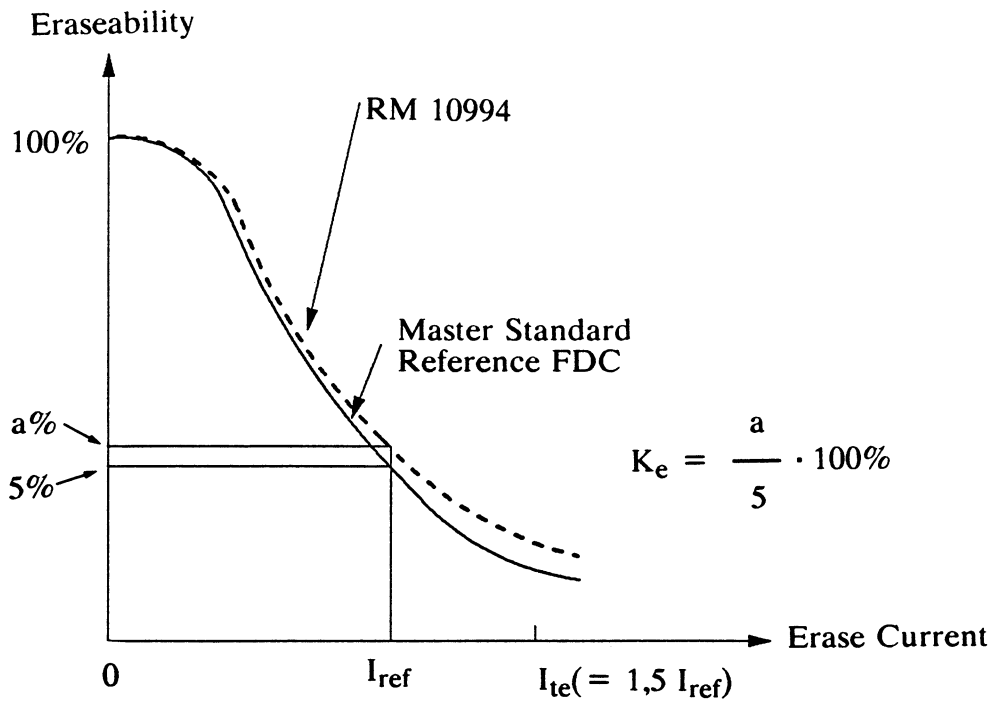
See Fig. K.2.





$I_{95RM}$  is the current which causes the Typical Field of RM 10994

**Fig. K.1 - Reference Field and Test Recording Current**



a is the erasability at  $I_{ref}$  for the RM 10994

**Fig. K.2 - Reference Erase Field and Test Erase Current**





