# ECMA

EUROPEAN COMPUTER MANUFACTURERS ASSOCIATION

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# STANDARD ECMA-32

FOR

# MECHANICAL, PHYSICAL AND MAGNETIC CHARACTERISTICS OF INTERCHANGEABLE 6-DISK PACKS

September 1971

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## BRIEF HISTORY

On April 30, 1965, ECMA adopted their Standard ECMA-6 for a 7-Bit Coded Character Set. In the form adopted, it included no proposals for implementation in media which were deliberately left as the subject for specific standards.

This Standard ECMA-32, prepared by ECMA TC16, is directed to the Mechanical, Physical and Magnetic Characteristics for Interchangeable 6 Disk Packs.

Another Standard, ECMA-33, is directed to Track Format Characteristics for the same Disk Packs.

Adopted by the General Assembly as Standard ECMA-32 on June 2 - 3, 1971.

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# SECTION I

## MECHANICAL AND PHYSICAL CHARACTERISTICS

# 1. GENERAL REQUIREMENTS

## 1.1 Operation and Storage Environment

### 1.1.1 Operation

The operation temperature shall range from 15°C to 50°C at a relative humidity of 8% to 80%. The wet bulb reading shall not exceed 30°C. Before a disk pack is placed into operation, it shall be conditioned within the covers for a minimum of two hours in the same environment in which the disk drive is operating. The above specified range does not necessarily apply for the disk drive.

### 1.1.2 Storage

1.1.2.1 Unrecorded: The storage temperature shall lie within the range -40°C to 65°C, the wet bulb reading not exceeding 30°C. For wet bulb temperatures between 0,5°C and 30°C the disk pack shall be able to withstand a relative humidity of 8% to 80%.

1.1.2.2 Recorded: The storage temperature shall lie within the range -40°C to 65°C, the wet bulb reading not exceeding 30°C.

For wet bulb temperatures between 0,5°C and 30°C the disk pack shall be able to withstand a relative humidity of 8% to 80%. The stray magnetic field intensity shall not exceed 4000 A/m.

### 1.1.3 Test Conditions

Unless otherwise stated, measurements shall be carried out at 23 ± 3°C, 50% ± 10% RH after 24 hours of acclimatization. Tests shall be carried out with the disk pack in the upright position, unless otherwise stated.

## 1.2 Shock and Vibration

The disk pack shall withstand exposure to shock and/or vibration and still meet all dimensional and functional specifications of this Standard.

A typical test procedure is described in Appendix A. Any damage to the cover shall not be a failure criterion.

## 1.3 Materials

Unless otherwise stated, the disk pack may be constructed from any suitable materials so long as the dimensional,

inertial and other functional requirements of this Standard are maintained. The material and surface finish of the sector disk shall permit reading the notches by eddy current and optical transducers.

The coefficient of thermal expansion of the disk material shall preferably be:

$$\frac{\Delta l}{l \cdot \Delta t} = \frac{1}{l} \cdot \frac{l_{50} - l_{15}}{35} \text{ per } ^{o}C = (24 \pm 2) \cdot 10^{-6} \text{ per } ^{o}C$$

The sample length is equal to $\frac{l_{50} + l_{15}}{2}$

## 2. PHYSICAL REQUIREMENTS

### 2.1 Dimensions

Reference Line: The Reference Line is the line on which rests a reference ball having a diameter of 38,894 mm (see figures 3 and 6).

#### 2.1.1 Overall Height (see Fig. 1)

The overall height $h_1$ of the disk pack with top and bottom cover is

$h_1$ = 120 mm maximum.

#### 2.1.2 Top cover (see Fig. 1)

##### 2.1.2.1 Outside diameter

The outside diameter $d_1$ of the top cover shall be

$d_1$ = 370 mm maximum.

##### 2.1.2.2 Concentricity

The top cover is to be concentric with the cover centerline within 1,0 mm total indicated runout.

##### 2.1.2.3 Vertical clearance

The vertical clearance $h_2$ between the lower edge of the top cover and the reference line is

$h_2$ = 10 mm minimum.

#### 2.1.3 Hub (see Fig. 3)

##### 2.1.3.1 Height of the hub

The height $h_3$ of the hub is

$$h_3 = 35,3 \pm 0,4 \text{ mm}$$

2.1.3.2 Bore relieve

In a zone having a height

$$h_4 = 20,6 \pm 1,5 \text{ mm}$$

extending above height

$$h_5 = 6,3 \pm 0,8 \text{ mm}$$

the bore can be relieved.

2.1.3.3 Height of the hub over the reference line

The height $h_6$ of the hub over the reference line is

$$h_6 = 21 \pm 0,5 \text{ mm}$$

2.1.3.4 Taper

The taper of the hub bore is

$$(1 \pm 0,0002) : 2$$

2.1.3.5 Finish of the bore

The finish shall be of class N7 (1,6 to 0,8 micrometer arithmetical mean deviation).

2.1.4 Spindle Lock (see Figs. 3 and 4)

2.1.4.1 Thread of the spindle lock

The thread of the spindle lock is a two start thread of type 8NS-2A or 16 UNC-2A. The nominal diameter is

$$d_2 = 9,52 \text{ mm } (3/8")$$

2.1.4.2 Minimum full thread length

The full thread length is

$$h_7 = 7,4 \text{ mm minimum.}$$

2.1.4.3 Chamfer

The lower end of the spindle lock presents a chamfer having an inner diameter of

$$d_3 = 7,4 \pm 0,2 \text{ mm}$$

and an angle

$$\gamma = 30^{o} \pm 2^{o}$$

2.1.4.4 Location of the flange of the spindle lock

The flange of the spindle lock is located with regard to the reference line at a distance of

$$h_8 = 59,048 \begin{smallmatrix} +0,175 \\ -0,255 \end{smallmatrix} \text{ mm}$$

2.1.4.5 Length of the lower part of the spindle lock

The length of the lower part of the spindle lock is

$$h_9 = 19,65 \pm 0,15 \text{ mm}$$

2.1.4.6 Maximum diameter of the lower part of the spindle lock

The maximum diameter of the lower part of the spindle lock with the safety balls expanded is

$$d_4 = 10,97 \text{ mm maximum}$$

The safety balls must not extend before the lock-shaft pin is at least at a distance

$$h_{22} = 18,5 \text{ mm}$$

from the flange of the spindle lock. The safety balls must cease to expand when the lockshaft is at most at a distance

$$h_{23} = 14,3 \text{ mm}$$

from the flange of the spindle lock.

The maximum diameter with relaxed balls is

$$d_5 = 9,65 \text{ mm maximum}$$

2.1.4.7 Location of the safety balls

The centers of the safety balls are located with regard to the spindle lock flange at a distance

$$h_{10} = 8,66 \pm 0,24 \text{ mm}$$

2.1.4.8 Hole for the penetration of the lockshaft pin

The minimum diameter of the hole for the penetration of the drive spindle lockshaft pin into the spindle lock is

$$d_6 = 3,0 \text{ mm minimum}$$

2.1.4.9 Depth of penetration of the lockshaft pin

The clearance for the penetration of the drive spindle lockshaft pin into the spindle lock must stretch to a distance from the flange of

$$h_{11} = 12,5 \text{ mm maximum}$$

2.1.4.10 Removal of the top cover

It must be possible to remove the top cover when the lockshaft has penetrated into the spindle lock at least to a distance from the flange of

$$h_{12} = 13,3 \text{ mm minimum}$$

2.1.5 Sector Disk (see Fig. 5)

2.1.5.1 Diameter

The diameter of the sector disk is

$$d_7 = 362,74 \pm 0,25 \text{ mm}$$

2.1.5.2 Thickness

The thickness of the sector disk is

$$e_1 = 1,3 \pm 0,08 \text{ mm}$$

2.1.5.3 Notches

2.1.5.3.1 This sector disk has at its circumference 21 rectangularly shaped notches (numbered from 1 to 21 in Fig. 5).

2.1.5.3.2 The angle $\alpha$ between the leading edges of two adjacent notches in the range 1 to 20 is

$$\alpha = 18^{\circ}0' \pm 4'$$

This tolerance is not cumulative.

The angle $\beta$ between the leading edges of notches 21 and 1 is

$$\beta = 2^{\circ}23' \pm 4'$$

2.1.5.3.3 Depth

The radial depth of the notches is limited by the radius

$$r_1 = 178,0 \text{ mm maximum}$$

2.1.5.3.4 Width

The width $e_2$ of the notches is

$$e_2 = 1,9 \pm 0,2 \text{ mm}$$

2.1.5.3.5 Distance to the reference line

The distance $h_{13}$ (see Fig. 6) from the bottom surface of the sector disk to the reference line is

$$h_{13} = 17,95 \pm 0,55 \text{ mm}$$

2.1.5.3.6 Edges and corners

All edges and corners can have a radius

$$r_2 = 0,4 \text{ mm maximum}$$

2.1.6 Disk support (see Fig. 6)

The radius $r_3$ is

$$r_3 = 95,3 \text{ mm maximum}$$

2.1.7 Recording Disks (see Fig. 6 and 7)

2.1.7.1 Diameter

The diameter $d_8$ of all disks is

$$d_8 = 356,4 \begin{matrix} + 0,0 \\ - 0,25 \end{matrix} \text{ mm}$$

2.1.7.2 Thickness

The thickness $e_3$ of the disks is

$$e_3 = 1,27 \pm 0,05 \text{ mm}$$

2.1.7.3 Disk edge relief

For a distance

$$e_4 = 1,3 \text{ mm maximum}$$

from the outside edge of the recording disk, the disk contour may be relieved within the extended boundaries of the disk surfaces.

2.1.8 Location of the Disks (see Fig. 6)

The disks are located with regard to the reference line as follows:

1st disk: distance from the upper surface to the reference line:

$$h_{14} = 20,83 \pm 0,52 \text{ mm}$$

2nd disk to 6th disk: distance from the lower surface to the reference line:

$$h_{15} = 29,72 \pm 0,51 \text{ mm}$$
$$h_{16} = 39,88 \pm 0,45 \text{ mm}$$
$$h_{17} = 50,04 \pm 0,37 \text{ mm}$$
$$h_{18} = 60,20 \pm 0,43 \text{ mm}$$
$$h_{19} = 70,36 \pm 0,50 \text{ mm}$$

2.1.9 Minimum Clearance of lowest Element (see Fig. 6)

The clearance of the lowest element of the disk pack is

$$h_{20} = 12 \text{ mm minimum}$$

in the area between a radius $r_4$ and a radius $r_5$:

$$r_4 = 74 \text{ mm minimum}$$
$$r_5 = 90 \text{ mm maximum}$$

Inside $r_4$ the clearance is (see Fig. 3)

$$h_6 = 20,5 \text{ mm minimum}$$

2.1.10 Overall Height without Top Cover (see Fig. 6)

The overall height of the disk pack without cover above the reference line is

$$h_{21} = 95,3 \text{ mm maximum}$$

2.1.11 Hub/Disks Relationship

2.1.11.1 Axial runout of disks

The axial runout of the recording disks and of the sector disk at any diameter is included in the dimensions of clause 2.1.8. The actual axial runout (i.e. the total indicator reading), at any speed shall not exceed:

0,3 mm for the recording disks,

0,5 mm for the sector disk.

2.1.11.2 Acceleration of axial runout

The acceleration of the disk surface in axial direction shall not exceed 280 m/sec$^2$, at any speed within the range 2352 to 2448 revolutions per minute.

2.1.11.3 Radial runout of disks

The total indicated radial runout is:

a) for the sector disk and the bottom two recording disks:

0,25 mm maximum

b) for the other disks:

0,5 mm maximum

2.1.11.4 Angular shift between disks and hub

Up to a positive or negative acceleration of 3000 rad/s$^2$ the angular shift between disks and hub must remain equal to zero.

2.1.12 Location of Magnetic Surface

The area of the magnetic coating extends from an inside diameter of 208,3 mm maximum to an outside diameter of 353,6 mm minimum.

2.2 Moment of Inertia

The moment of inertia of the disk pack without covers shall not exceed 570 . $10^{-4}$ kgm$^2$.

2.3 Balance

The disk pack shall be balanced within 200 gmm in a single plane parallel to the disk surfaces. This plane is located 69,0 $\pm$ 3,0 mm above the reference line.

2.4 Maximum Speed

The disk pack shall be capable of rotating at a speed of 2500 revolutions per minute counterclock-wise as seen from the top.

2.5 Locking Pull

The disk pack shall be held to the disk drive spindle by a force of 925 $\pm$ 145 N, exerted by the downward pull of the disk drive lockshaft on the disk pack spindle lock.

2.6 Air Feed Openings

At least 12 openings having a minimum total area of 710 mm$^2$ are equally distributed around the disk support between each pair of recording disks.

## 2.7 Air Filter

### 2.7.1 Filter Media

The filter media shall be a screen type construction having a maximum spacing between strands of 44 micrometre. The material shall not contain tendrils or loose particles which can separate from the filter and enter the filtered system.

### 2.7.2 Air Flow and Pressure Drop

The pressure drop across a clean air filter shall not exceed 11 mm of water while passing 0,95 $\pm$ 0,1 $m^3$ of air per minute.

## 2.8 Air Flow

Refer to Figure 8 for location of measuring points and for description of the test configuration. With the disk pack rotating at 2400 $\pm$ 48 revolutions per minute, the static pressure drop measured at the static pressure tap shall not exceed 13,5 mm of water with an air flow through the disk pack of 0,95 $\pm$ 0,1 $m^3$ per minute of air measured at the air intake.

## 2.9 Thermal Time Constant

Within the conditions specified in clause 2.8, the disk pack thermal time constant shall not exceed 1 minute. The thermal time constant is the time required to reduce an initial temperature difference between the pack and the drive by 2/3.

## 2.10 Operational Earthing

The disk pack shall provide a discharge path from the disks to the drive spindle through the hub mechanism.

## 2.11 Physical Characteristics of Magnetic Surfaces

### 2.11.1 Surface Roughness

The finished magnetic surface shall have a surface roughness less than 0,09 micrometre arithmetic average, with a maximum deviation in height of 0,76 micrometre from the average, when measured with a 0,0025 mm stylus and a 0,75 mm cutoff range.

### 2.11.2 Durability of Magnetic Surface

#### 2.11.2.1 Resistance to chemical cleaning fluid

The magnetic surface of recording disks shall not be adversely affected by 91% reagent grade isopropyle alcohol mixed with 9% distilled or deionized water by volume when used for cleaning.

2.11.2.2 Coating adhesion

The nature of the coating shall be such as to assure wear resistance under operating conditions and maintainance of adhesion and abrasive wear resistance. A possible test method for assuring the durability of the coating is given in Appendix B.

2.11.2.3 Abrasive wear resistance

The coating has to be able to withstand operational wear. A possible test method is described in Appendix B.

## NOTE ON THE DRAWINGS

(i) The drawings show a typical Disk Pack assembly for illustration purposes only. The Standard does not apply to a specific design, it defines only the parameter relevant for interchange.

(ii) The figures represent:

Fig. 1 A Disk Pack with top and bottom cover, partially in vertical cross section.

Fig. 2 A Disk Pack without covers, partially in vertical cross section.

Fig. 3 A simplified cross section of the hub.

Fig. 4 An enlarged and broken view of the lower end of the spindle.

Fig. 5 The Sector Disk (Top view).

Fig. 6 An enlarged, partial and simplified cross section of the Disk Pack.

Fig. 7 An enlarged view of the end of a disk.

Fig. 8 Air Flow test configuration.

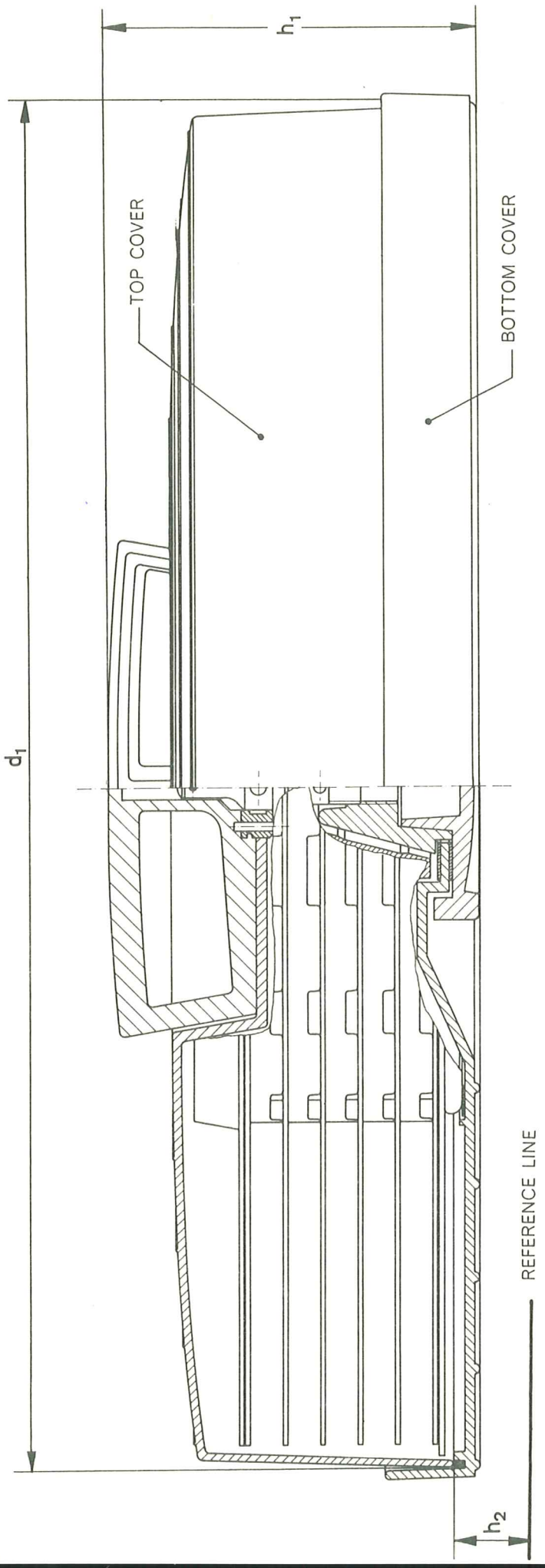



Fig. 1

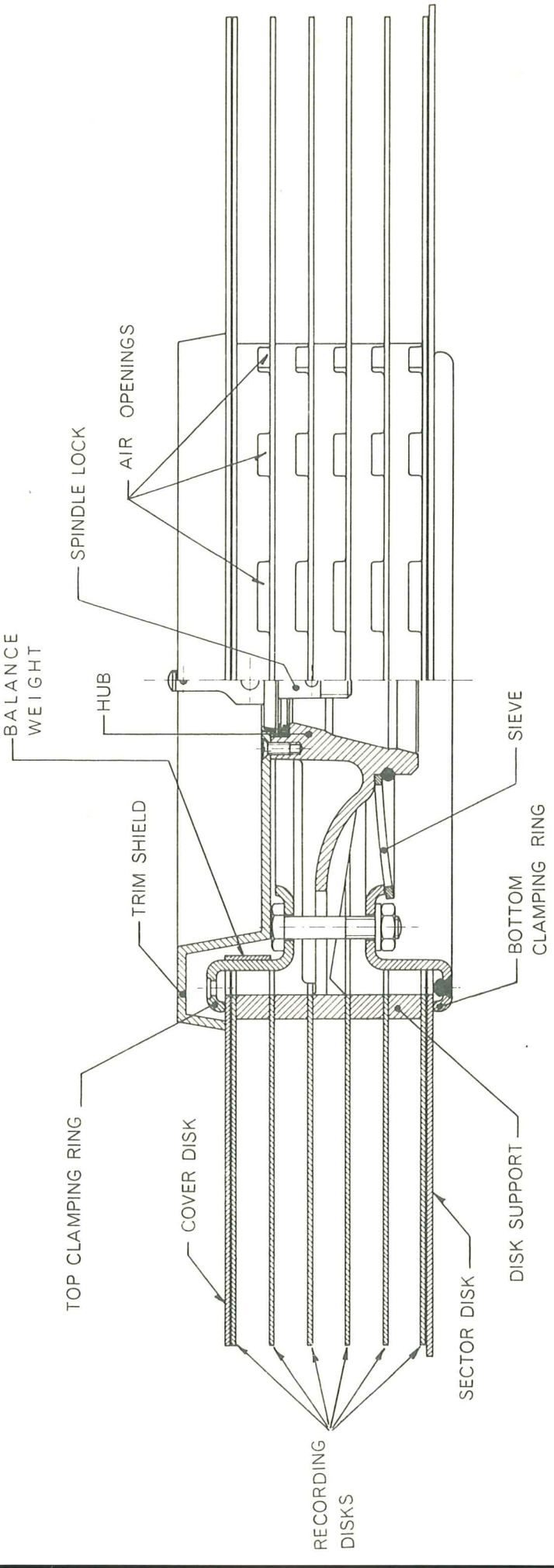

BALANCE WEIGHT
HUB
SPINDLE LOCK
AIR OPENINGS
TRIM SHIELD
SIEVE
BOTTOM CLAMPING RING
TOP CLAMPING RING
COVER DISK
DISK SUPPORT
SECTOR DISK
RECORDING DISKS

Fig. 2

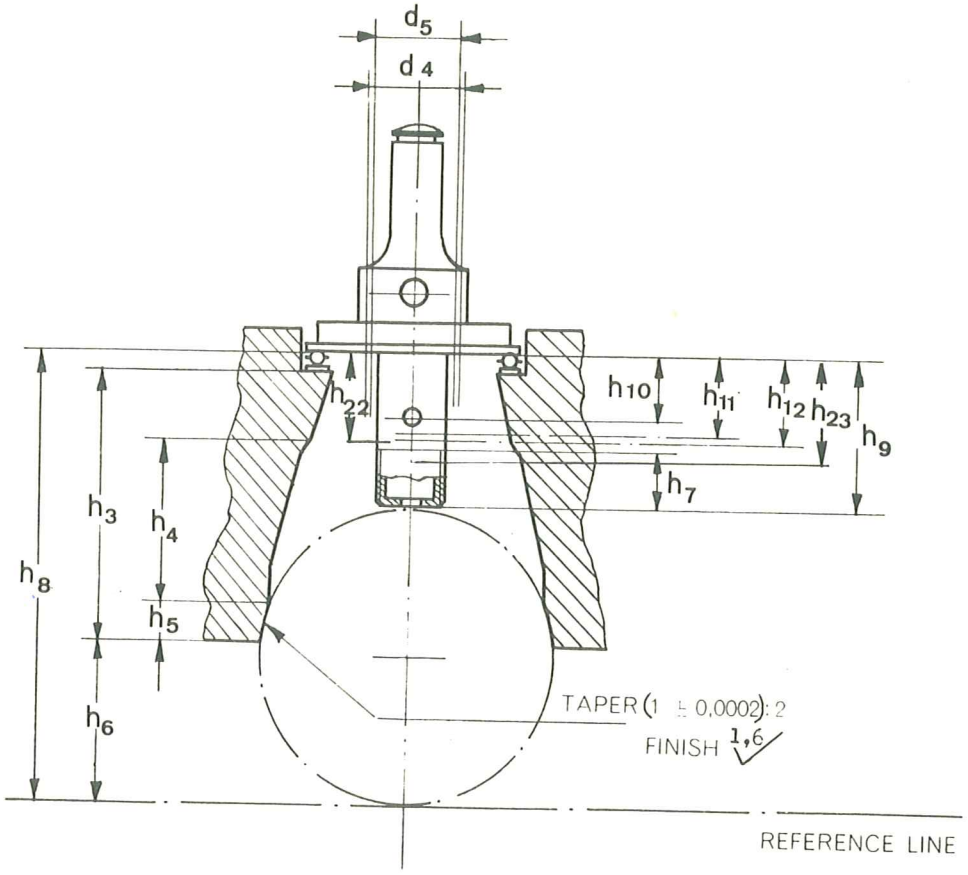

$d_5$
$d_4$
$h_{22}$
$h_{10}$
$h_{11}$
$h_{12}$
$h_{23}$
$h_9$
$h_7$
$h_3$
$h_4$
$h_8$
$h_5$
$h_6$
TAPER (1 ± 0,0002): 2
FINISH 1,6
REFERENCE LINE

Fig. 3

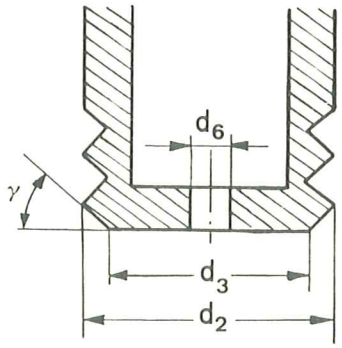
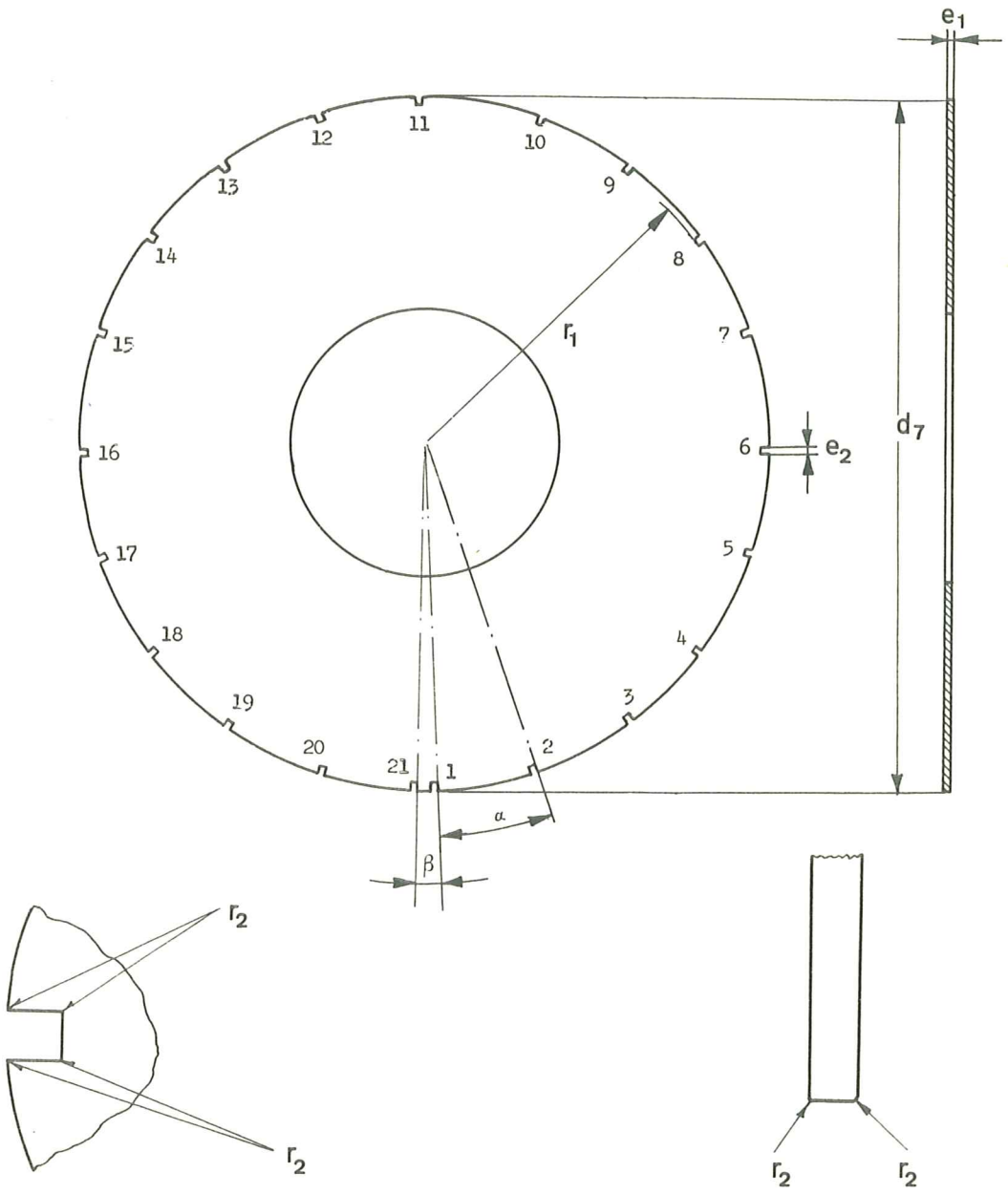

$d_6$
$\gamma$
$d_3$
$d_2$

Fig. 4


e1
d7
e2
r1
r2
r2
r2
r2
α
β
1
2
3
4
5
6
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8
9
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11
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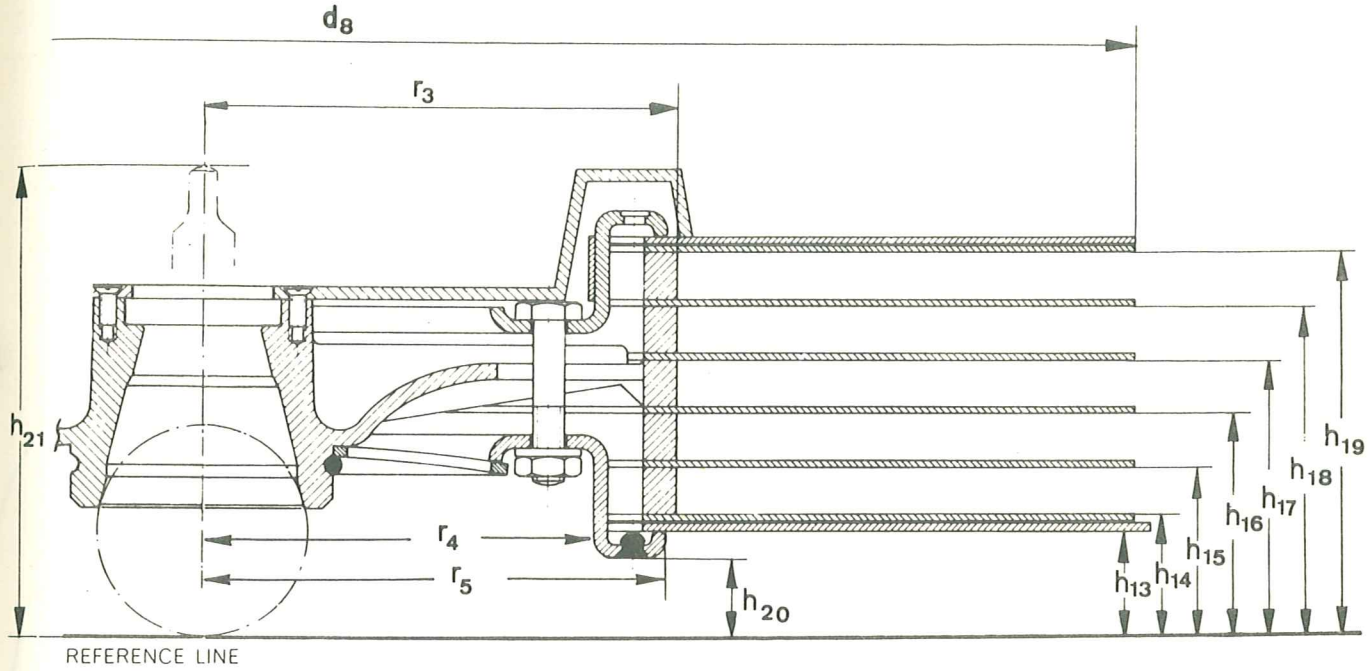
14
15
16
17
18
19
20
21

Fig. 5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$r_3$
$h_{21}$
$r_4$
$r_5$
$h_{20}$
$h_{13}$
$h_{14}$
$h_{15}$
$h_{16}$
$h_{17}$
$h_{18}$
$h_{19}$
REFERENCE LINE

Fig. 6

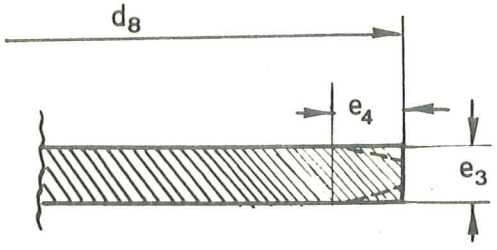

$d_8$
$e_4$
$e_3$

Fig. 7

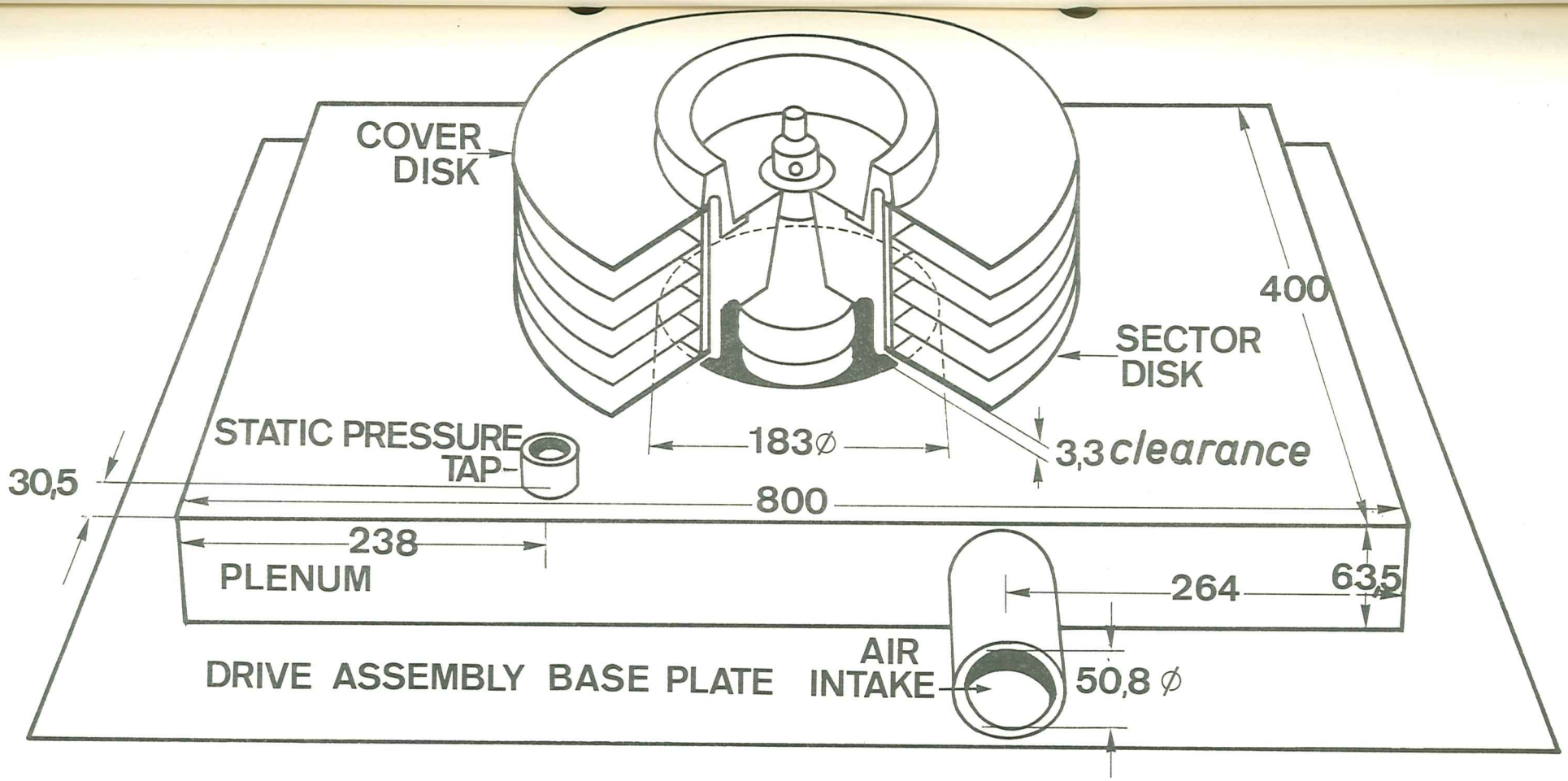



Fig. 8

1. Plenum completely sealed except for air intake and 183 ∅ Hole
2. Plenum pressure controlled by throttling air intake.
3. Tolerance on 183 ∅ is ± 0,1 mm
4. Tolerance on clearance 3,3 is 0,25 mm
5. Tolerance on all other dimensions is ± 1 mm.

# SECTION II

## MAGNETIC CHARACTERISTICS

# 1. TRACK AND RECORDING INFORMATION

## 1.1 General Geometry

Surface Geometry: The recording transducers are disposed as in Figure 1. Head and surface details are as below (surfaces taken consecutively from top).

| Number (Head or Surface) | Type | Head Orientation |
|---|---|---|
| 0 | B | Up |
| 1 | A | Down |
| 2 | A | Up |
| 3 | B | Down |
| 4 | B | Up |
| 5 | A | Down |
| 6 | A | Up |
| 7 | B | Down |
| 8 | B | Up |
| 9 | A | Down |

## 1.2 Track Geometry

1.2.1 Number of Tracks: There are 203 discrete concentric tracks per disk surface.

1.2.2 Width of Track: The recorded track width on the disk surface shall be 0,140 ± 0,013 mm. The area between the tracks shall be erased. A suggested method of measuring effective track width is given in Appendix C.

1.2.3 Track Locations

1.2.3.1 Nominal Locations: The geometry of the head disk system is defined in Figure 1. The dimensional constants are:

| | | |
|---|---|---|
| Incremental head movement | S = | 0,2567 mm |
| Lesser gap distance | FA = | 10,861 mm |
| Greater gap distance | FB = | 11,999 mm |
| Centreline radius-track 73 | R73 = | 146,507 mm |
| Head offset angle | θ = | $4^{o}54'$ |

The nominal track centreline radii in mm derived from these constants are given in Table 1.

1.2.3.2 Track Location Tolerance: The centreline of the recorded tracks, measured at (23 ± 1)°C, shall be within ± 0,025 mm of the nominal positions.

NOTE: At other temperatures (within those specified in this Standard) the nominal track centreline can be calculated using an appropriate coefficient of linear expansion; for example Aluminium Alloys $24.10^{-6}$ per °C.

1.2.3.3 Recording Offset Angle: At the instant of writing or reading a magnetic transition, it shall make an angle of 4°54' ± 30' with the appropriate line of access as defined in Figure 1.

1.2.4 Identification: For the purposes of testing the following identifying system is used:

1.2.4.1 Track Identification: Track identification shall be by a three digit decimal number (000 to 202) which counts tracks consecutively starting at the outermost tracks.

1.2.4.2 Surface Identification: Surfaces shall be numbered 00 - 09 corresponding with the surface numbers of Section 1.1.

1.2.4.3 Cylinder Address: A cylinder is defined as all tracks on the disk pack with a common track identification number.

1.2.4.4 Track Address: A five digit number is used for track address, with the three most significant digits defining the cylinder address and the remaining two digits defining the surface address.

1.2.5 Index: The index point of each track is the starting and ending point of the track. Its location with respect to the leading edge of the double notch on the sector disk is defined in Figure 2 where the angle is $\alpha = 69°0'54''$.

1.2.6 Test Areas

1.2.6.1 Header Area: For the purpose of testing the Header Area is defined as starting no later than 100 microseconds after index and ending no sooner than 700 microseconds after index with the disk pack rotating at 2400 rpm.

1.2.6.2 Data Area: For the purpose of testing, the data area is defined as that area starting no later than 700 microseconds after index and continuing to the next index with the disk pack rotating at 2400 rpm.

# 2. TEST CONDITIONS

## 2.1 General Conditions

2.1.1 Rotational Speed: The rotational speed shall be 2400 ± 24 rpm.

2.1.2 Temperature: The temperature of the air entering the disk pack shall be (27 ± 1)°C.

2.1.3 Relative Humidity: The relative humidity of the air entering the disk pack shall be between (10% and 60%) RH.

## 2.2 Reference Standards

2.2.1 Standard Reference Surface: The standard reference surface is a surface held by an approved Bureau of Standards as the reference by which all secondary standards will be calibrated.

2.2.2 Standard Reference Surface Characteristics: The Standard reference surface shall be characterized in areas designated by a scratch and defined as beginning 50 microseconds after the edge of a scratch and ending 275 microseconds from the same point. The mean voltage outputs when used with a test head (see Section 2.3) shall be as follows (see Section 2.4.2 for definitions of 1F and 2F).

| | | |
|---|---|---|
| Track 200 | 1F | 10,8 millivolt peak-to-peak |
| Track 200 | 2F | 5,4 millivolt " |
| Track 000 | 1F | 17,3 millivolt " |

2.2.3 Secondary Standard Reference Surfaces: These surfaces are calibrated from the Standard Reference Surface using a test transducer (Section 2.3.1). An output calibration factor ($C_D$) is derived from

$$C_D = \frac{\text{Standard Reference Surface Output}}{\text{Secondary Standard Reference Surface Output}}$$

where $0{,}90 \leqslant C_D \leqslant 1{,}10$.

## 2.3 Test Heads

2.3.1 Description: Disk measurements will be taken with a suitable test transducer (based on IBM 2316 [2311 Type] Amplitude Test Head).

2.3.2 Write Current: The write current waveform measured at 1F must conform to Figure 3 where:

| | | |
|---|---|---|
| $I_W$ | = | 35 mA ± 1mA (based on IBM 2316 Amplitude Test Head) |
| Overshoot | = | 6% - 10% $I_W$ |
| $T_R$ | = | 200 nanoseconds max. |

2.4 Test Parameters

2.4.1 Erasing: The DC current supplied to the read/write element when DC erase is specified shall be 35mA.

2.4.2 Test Signals: The frequency specified as 1F shall be $(125 \pm 0,125).10^4$ transitions/sec. The frequency specified as 2F shall be $(250 \pm 0,250).10^4$ transitions/sec.

2.4.3 D.C. Edge Erase: D.C. Edge erasure shall be used for all tests unless otherwise indicated.

2.4.4 Magnetic Recording: Unless otherwise specified, all write operations shall be preceded by an erase operation as per 2.4.1.

2.4.5 Locations: The track quality test requirements (Section 3.3) shall be met anywhere within 0,025 mm of the nominal track positions defined in Section 1.2.3.

## 3. FUNCTIONAL TESTING

3.1 Surface Tests

3.1.1 Saturation Test

3.1.1.1 Procedure: Write at 0,95 1F at track 000. Without a DC erase overwrite at 2F.

3.1.1.2 Result: The maximum ensueing modulation at any position along the track, defined as

$$\frac{\text{Modulation amplitude}}{\text{Mean carrier (2F) amplitude}} \cdot 100\%$$

shall be $\leqslant$ 10%.

3.1.2 Amplitude Test

3.1.2.1 Procedure: Write on any part of the recording surface at 1F.

3.1.2.2 Result: The read back amplitude averaged over any 500 microsecond interval shall be as follows:

Minimum voltage output: $\geqslant$ 50% of reference voltage at track 200.

Maximum voltage output: $\leqslant$ 150% of the reference voltage at track 000.

3.1.3 Resolution Test

3.1.3.1 Procedure: On any part of the recording surface write at 1F and read back. After DC erasing write at the same position at 2F and read back.

3.1.3.2 Result: In all cases the ratio:

$$\frac{\text{Amplitude at 2F}}{\text{Amplitude at 1F}}$$

averaged over the same 500 microsecond sector shall be $0,5 \begin{smallmatrix} + 0,25 \\ - 0,1 \end{smallmatrix}$.

3.2 Track Quality Tests

3.2.1 Missing Pulse Test

3.2.1.1 Procedure: Write at 1F and read back.

3.2.1.2 Result: A missing pulse is defined as any pulse whose base-peak amplitude is less than 70% of the average base-peak amplitude of the preceding 500 microsecond sector.

3.2.2 Extra Pulse Test

3.2.2.1 Procedure: Write at a track position at 1F. Read back and note highest peak-peak amplitude averaged over 500 microseconds of track signal. Call this $V_A$. Overwrite with DC current through the write winding without edge erasure. Read back on this track.

3.2.2.2 Result: Any read back signal measured base-peak, shall be less than 30% of $V_A/2$.

3.2.3 Ease of Erasure Test

3.2.3.1 Procedure: As 3.2.2.1.

3.2.3.2 Results: The average level of the highest 500 microsecond sector of the read back signal shall be less than 10% of $V_A$.

## 3.3 Rejection Criteria

3.3.1 Surface Test Criteria: The Disk Pack shall meet the requirements of all the tests specified in 3.1.

3.3.2 Track Quality Criteria

3.3.2.1 Error: An error is a failure to meet any of the requirements of 3.2.

3.3.2.2 Error-free Areas: There shall be no errors in Track of Address 00000 nor in any Header Area (Section 1.2.7.1). In addition there shall be at least 2000 error-free tracks on the disk pack.

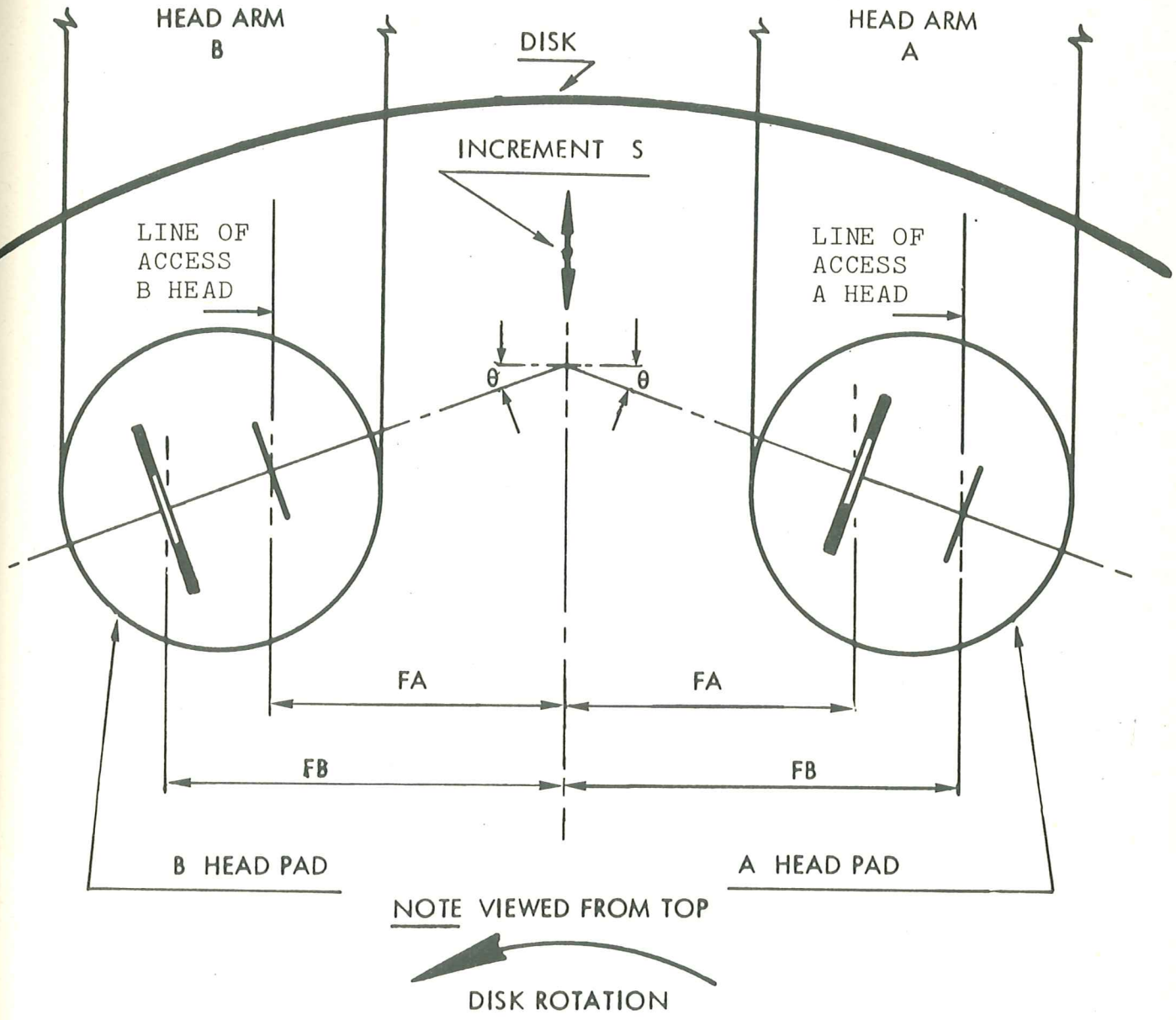
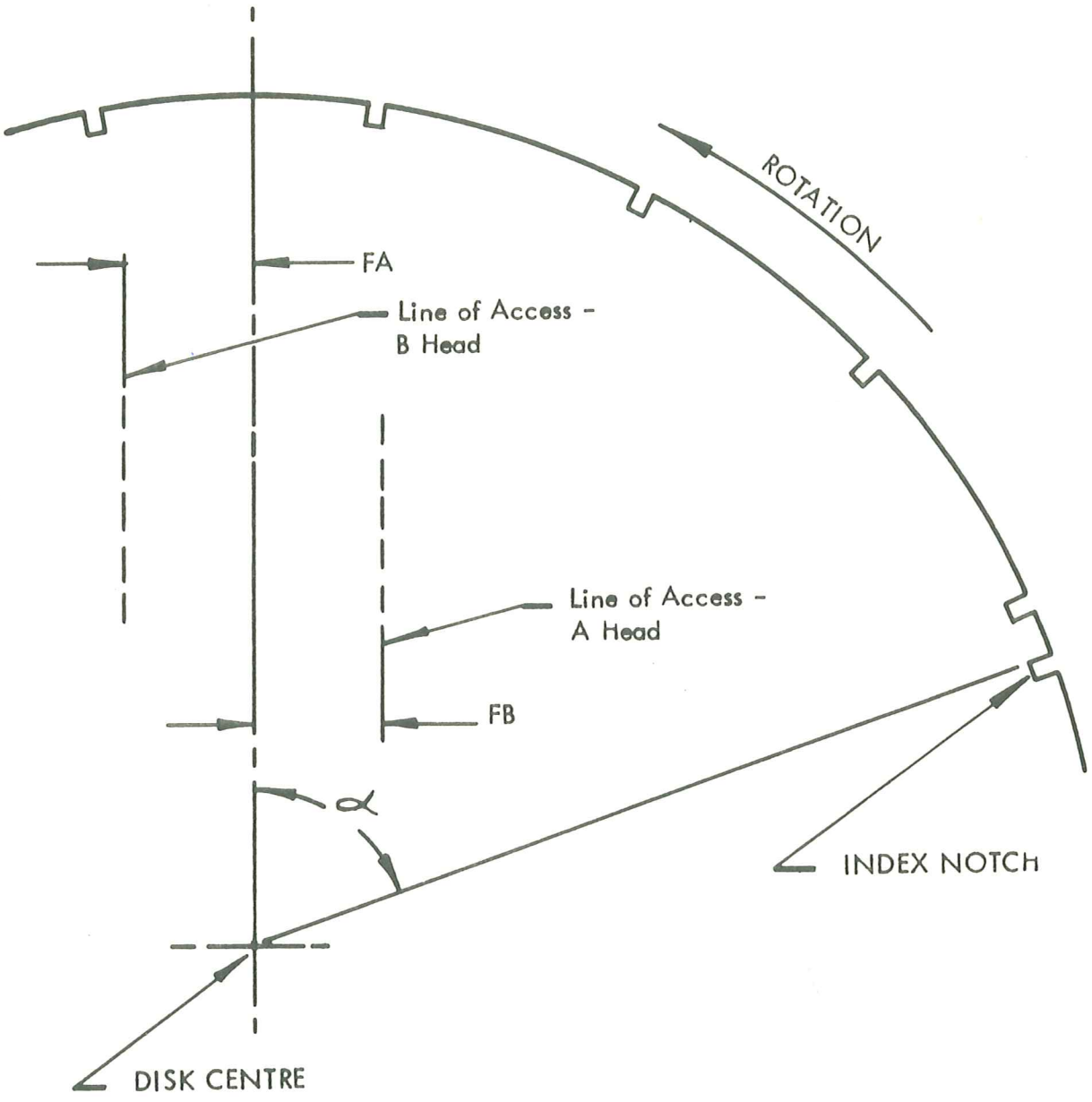
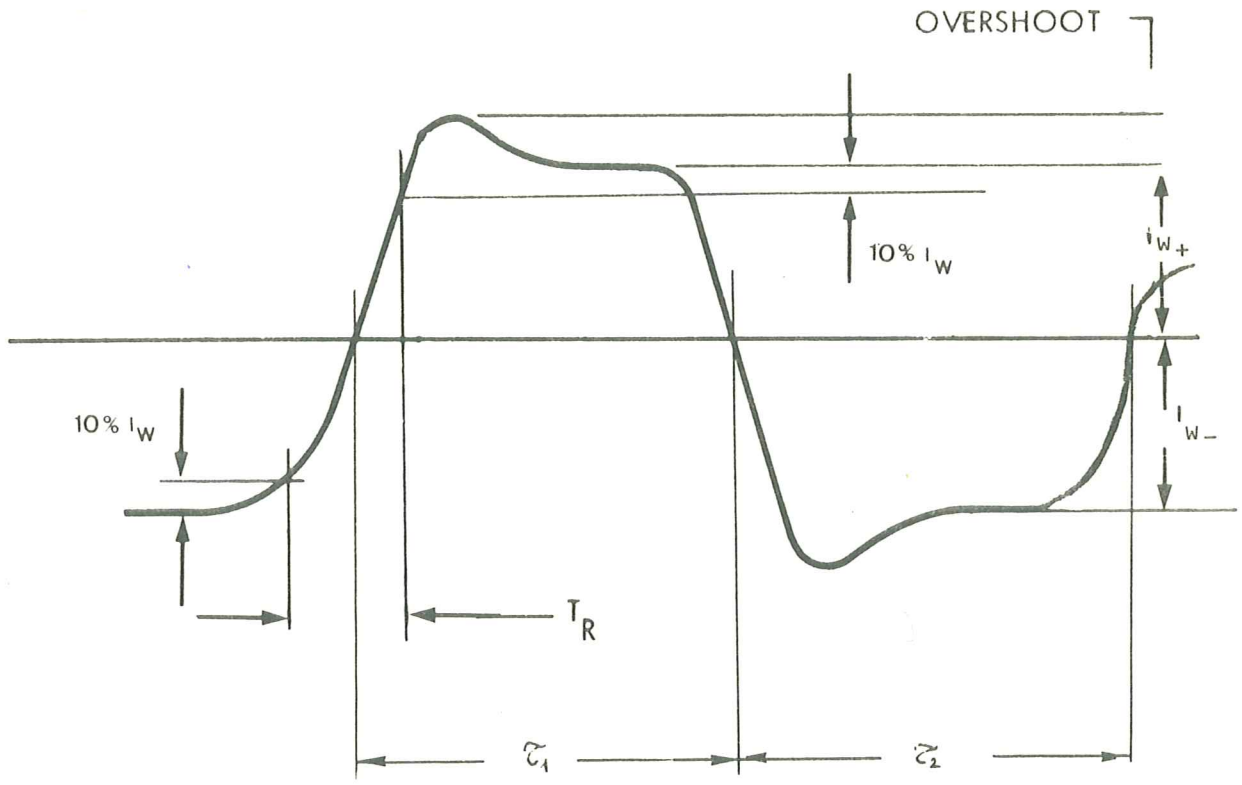

HEAD ARM
B
DISK
HEAD ARM
A
INCREMENT S
LINE OF
ACCESS
B HEAD
LINE OF
ACCESS
A HEAD
θ
θ
FA
FA
FB
FB
B HEAD PAD
A HEAD PAD
NOTE VIEWED FROM TOP
DISK ROTATION

FIGURE 1




TRACK INDEX

FIGURE 2




$\tau_1 = \tau_2 \pm 2\ \%$

$I_{W+} = I_{W-} \pm 3\ \%$

FIGURE 3

TABLE I

| TRACK NO | A HEAD RADIUS | B HEAD RADIUS | TRACK NO | A HEAD RADIUS | B HEAD RADIUS |
|---|---|---|---|---|---|
| 0 | 165.200 | 165.190 | 53 | 151.627 | 151.624 |
| 1 | 164.944 | 164.934 | 54 | 151.371 | 151.369 |
| 2 | 164.688 | 164.678 | 55 | 151.115 | 151.113 |
| 3 | 164.432 | 164.422 | 56 | 150.859 | 150.857 |
| 4 | 164.176 | 164.166 | 57 | 150.603 | 150.601 |
| 5 | 163.920 | 163.910 | 58 | 150.347 | 150.345 |
| 6 | 163.664 | 163.654 | 59 | 150.091 | 150.089 |
| 7 | 163.407 | 163.398 | 60 | 149.835 | 149.833 |
| 8 | 163.151 | 163.142 | 61 | 149.579 | 149.577 |
| 9 | 162.895 | 162.886 | 62 | 149.323 | 149.322 |
| 10 | 162.639 | 162.630 | 63 | 149.067 | 149.066 |
| 11 | 162.383 | 162.374 | 64 | 148.811 | 148.810 |
| 12 | 162.127 | 162.118 | 65 | 148.555 | 148.554 |
| 13 | 161.871 | 161.862 | 66 | 148.299 | 148.298 |
| 14 | 161.615 | 161.606 | 67 | 148.043 | 148.042 |
| 15 | 161.358 | 161.350 | 68 | 147.787 | 147.786 |
| 16 | 161.102 | 161.094 | 69 | 147.531 | 147.531 |
| 17 | 160.846 | 160.838 | 70 | 147.275 | 147.275 |
| 18 | 160.590 | 160.582 | 71 | 147.019 | 147.019 |
| 19 | 160.334 | 160.326 | 72 | 146.763 | 146.763 |
| 20 | 160.078 | 160.070 | 73 | 146.507 | 146.507 |
| 21 | 159.822 | 159.814 | 74 | 146.251 | 146.251 |
| 22 | 159.566 | 159.558 | 75 | 145.995 | 145.995 |
| 23 | 159.310 | 159.302 | 76 | 145.739 | 145.740 |
| 24 | 159.053 | 159.046 | 77 | 145.483 | 145.484 |
| 25 | 158.797 | 158.790 | 78 | 145.227 | 145.228 |
| 26 | 158.541 | 158.535 | 79 | 144.971 | 144.972 |
| 27 | 158.285 | 158.279 | 80 | 144.715 | 144.716 |
| 28 | 158.029 | 158.023 | 81 | 144.459 | 144.461 |
| 29 | 157.773 | 157.767 | 82 | 144.203 | 144.205 |
| 30 | 157.517 | 157.511 | 83 | 143.947 | 143.949 |
| 31 | 157.261 | 157.255 | 84 | 143.691 | 143.693 |
| 32 | 157.005 | 156.999 | 85 | 143.435 | 143.437 |
| 33 | 156.749 | 156.743 | 86 | 143.179 | 143.182 |
| 34 | 156.493 | 156.487 | 87 | 142.924 | 142.926 |
| 35 | 156.237 | 156.231 | 88 | 142.668 | 142.670 |
| 36 | 155.980 | 155.975 | 89 | 142.412 | 142.414 |
| 37 | 155.724 | 155.719 | 90 | 142.156 | 142.158 |
| 38 | 155.468 | 155.463 | 91 | 141.900 | 141.903 |
| 39 | 155.212 | 155.207 | 92 | 141.644 | 141.647 |
| 40 | 154.956 | 154.951 | 93 | 141.388 | 141.391 |
| 41 | 154.700 | 154.695 | 94 | 141.132 | 141.135 |
| 42 | 154.444 | 154.439 | 95 | 140.876 | 140.880 |
| 43 | 154.188 | 154.184 | 96 | 140.620 | 140.624 |
| 44 | 153.932 | 153.928 | 97 | 140.364 | 140.368 |
| 45 | 153.676 | 153.672 | 98 | 140.108 | 140.112 |
| 46 | 153.420 | 153.416 | 99 | 139.852 | 139.856 |
| 47 | 153.164 | 153.160 | 100 | 139.596 | 139.601 |
| 48 | 152.908 | 152.904 | 101 | 139.340 | 139.345 |
| 49 | 152.652 | 152.648 | 102 | 139.084 | 139.089 |
| 50 | 152.396 | 152.392 | 103 | 138.829 | 138.834 |
| 51 | 152.140 | 152.136 | 104 | 138.573 | 138.578 |
| 52 | 151.884 | 151.880 | 105 | 138.317 | 138.322 |

| TRACK NC | A HEAD RADIUS | B HEAD RADIUS |
|---|---|---|
| 106 | 138.061 | 138.066 |
| 107 | 137.805 | 137.811 |
| 108 | 137.549 | 137.555 |
| 109 | 137.293 | 137.299 |
| 110 | 137.037 | 137.043 |
| 111 | 136.781 | 136.788 |
| 112 | 136.525 | 136.532 |
| 113 | 136.270 | 136.276 |
| 114 | 136.014 | 136.021 |
| 115 | 135.758 | 135.765 |
| 116 | 135.502 | 135.509 |
| 117 | 135.246 | 135.254 |
| 118 | 134.990 | 134.998 |
| 119 | 134.734 | 134.742 |
| 120 | 134.479 | 134.487 |
| 121 | 134.223 | 134.231 |
| 122 | 133.967 | 133.975 |
| 123 | 133.711 | 133.719 |
| 124 | 133.455 | 133.464 |
| 125 | 133.199 | 133.208 |
| 126 | 132.943 | 132.953 |
| 127 | 132.688 | 132.697 |
| 128 | 132.432 | 132.441 |
| 129 | 132.176 | 132.186 |
| 130 | 131.920 | 131.930 |
| 131 | 131.664 | 131.674 |
| 132 | 131.408 | 131.419 |
| 133 | 131.153 | 131.163 |
| 134 | 130.897 | 130.907 |
| 135 | 130.641 | 130.652 |
| 136 | 130.385 | 130.396 |
| 137 | 130.129 | 130.141 |
| 138 | 129.874 | 129.885 |
| 139 | 129.618 | 129.629 |
| 140 | 129.362 | 129.374 |
| 141 | 129.106 | 129.118 |
| 142 | 128.850 | 128.863 |
| 143 | 128.595 | 128.607 |
| 144 | 128.339 | 128.351 |
| 145 | 128.083 | 128.096 |
| 146 | 127.827 | 127.840 |
| 147 | 127.572 | 127.585 |
| 148 | 127.316 | 127.329 |
| 149 | 127.060 | 127.074 |
| 150 | 126.804 | 126.818 |
| 151 | 126.548 | 126.563 |
| 152 | 126.293 | 126.307 |
| 153 | 126.037 | 126.052 |
| 154 | 125.781 | 125.796 |
| 155 | 125.526 | 125.540 |
| 156 | 125.270 | 125.285 |
| 157 | 125.014 | 125.029 |
| 158 | 124.758 | 124.774 |

| TRACK NO | A HEAD RADIUS | B HEAD RADIUS |
|---|---|---|
| 159 | 124.503 | 124.518 |
| 160 | 124.247 | 124.263 |
| 161 | 123.991 | 124.007 |
| 162 | 123.735 | 123.752 |
| 163 | 123.480 | 123.496 |
| 164 | 123.224 | 123.241 |
| 165 | 122.968 | 122.985 |
| 166 | 122.713 | 122.730 |
| 167 | 122.457 | 122.475 |
| 168 | 122.201 | 122.219 |
| 169 | 121.946 | 121.964 |
| 170 | 121.690 | 121.708 |
| 171 | 121.434 | 121.453 |
| 172 | 121.179 | 121.197 |
| 173 | 120.923 | 120.942 |
| 174 | 120.667 | 120.686 |
| 175 | 120.412 | 120.431 |
| 176 | 120.156 | 120.176 |
| 177 | 119.900 | 119.920 |
| 178 | 119.645 | 119.665 |
| 179 | 119.389 | 119.409 |
| 180 | 119.133 | 119.154 |
| 181 | 118.878 | 118.899 |
| 182 | 118.622 | 118.643 |
| 183 | 118.367 | 118.388 |
| 184 | 118.111 | 118.132 |
| 185 | 117.855 | 117.877 |
| 186 | 117.600 | 117.622 |
| 187 | 117.344 | 117.366 |
| 188 | 117.089 | 117.111 |
| 189 | 116.833 | 116.856 |
| 190 | 116.577 | 116.600 |
| 191 | 116.322 | 116.345 |
| 192 | 116.066 | 116.090 |
| 193 | 115.811 | 115.834 |
| 194 | 115.555 | 115.579 |
| 195 | 115.300 | 115.324 |
| 196 | 115.044 | 115.068 |
| 197 | 114.788 | 114.813 |
| 198 | 114.533 | 114.558 |
| 199 | 114.277 | 114.303 |
| 200 | 114.022 | 114.047 |
| 201 | 113.766 | 113.792 |
| 202 | 113.511 | 113.537 |

# APPENDIX A

## RECOMMENDED PROCEDURE FOR TESTING VIBRATION AND SHOCK

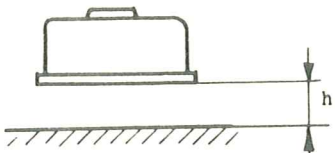
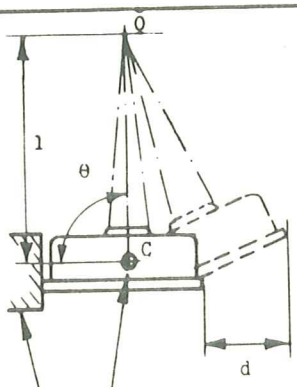
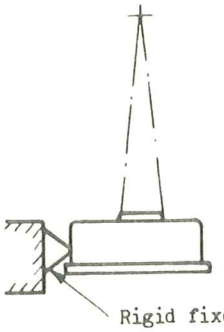
### A.1 Vibration

The disk pack with cover shall be subjected to simple harmonic motion having a constant amplitude (zero to peak displacement) of 0,15 mm ± 10% in the frequency range from 5 to 60 Hz, and a constant peak acceleration amplitude of twice the acceleration of free fall ± 10% in the frequency range of 60 to 500 Hz. The frequency shall be varied at a logarithmic rate and the entire frequency range of 5 to 500 Hz shall be traversed with 1 octave per minute in both directions. Testing shall continue for 2 hours with direction of motion perpendicular to the surfaces and for an additional 2 hours with direction of motion parallel to the disk surfaces.

For test method see IEC Publication 68-2-6, Basic environmental testing procedures for electronic components and electronic equipment, Part 2: Tests - Test F: Vibration.

### A.2 Shock

The disk pack should withstand three exposures of the first two following tests (a and b) and one exposure of the third test (c).

| Test | Schematic | With Top and Bottom Covers On* | With Bottom Cover Removed* |
|---|---|---|---|
| Free Fall |  Hard smooth rigid surface (such as concrete floor) | h = 100 mm | h = 60 mm |
| Side Impact (Flat surface) |  Lightweight rigid suspension which rotates freely about pivot O but prevents rotation about axis O-C and maintains θ = 90° <br> pack center of gravity <br> Fixed rigid flat impact surface ** | l = 760 mm <br> d = 300 mm | d = 150 mm |
| Side Impact (Sharp Corner) |  Same test set up as above <br> Rigid fixed square based pyramid having 90° apex with a radius of 1,6 ± 0,1 mm ** | d = 250 mm <br> Impact against edge of 4th data disk from top | d = 230 mm <br> Impact against edge of bottom sector disk |

* Tolerance on dimensions is ± 3 mm

** Recommend use of massive steel or aluminum impact elements.

# APPENDIX B

## COATING ADHESION AND ABRASIVE WEAR

### B.1 Coating adhesion

The adhesion of the coating to the substrate should be maintained following bending around the 25,4 ± 3,2 mm diameter of the conical mandrel specified in ASTM D 522-60. The criterion for failure is coating removal exceeding 10% of the area after peeling of the prescribed pressure sensitive tape.

The equipment and materials required for this test are as follows:

- Conical mandrel tester (ASTM D 522-60)
- Number 1 brown kraft wrapping paper, substance 30, lubricated with talc (see ASTM D 522-60)
- Pressure sensitive tape (3M Company No. 202 masking tape or equivalent)

Test sample as shown in Figure B.I, a = 119,4 ± 5,1 mm.

Test procedure

(a) Clean sample with isopropyl alcohol.

(b) Mount sample in conical mandrel tester as shown in Figure B.I, b = 25 ± 2,5 mm.

(c) Bend as described in ASTM 522-60 (the lubricated kraft paper is used in this step).

(d) Maintain sample in bent condition. Clamping the operating lever to the base plate is desirable.

(e) Wipe upper surface with a soft paper tissue. (Loose talc which would reduce the effectiveness of pressure sensitive tape should be removed by this wiping).

(f) Apply a 6,35 mm wide strip of pressure sensitive tape to the upper surface as shown in Figure B.I.

(g) Peel tape at an angle of 90 degrees and a rate of approximately 25 mm/s. Peel force should be 3,0 ± 0,5 N on unbent samples if tape was properly applied.

(h) Examine for coating removal.

## B.2 Abrasive wear resistance

Coating wear in the modified Taber Abraser (1) Test shall be less than 0,0006 $mm^2$ of cross sectional area in a test performed with the equivalent of a 6 micrometer silicon carbide abrasive. The equipment and materials required for this test are as follows:

Taber Abraser (1) Wear Tester - Model 503 or equivalent. Abrasive mounting wheel positioned to provide a 66,55 mm diameter wear scar (see Fig. B.II).

Thin double backed tape (Scotch(2) Double Stick Tape, 3M Company catalog No. 136 or equivalent).

Silicon carbide coated abrasives of approximately 3 and 8 micrometre particle size (Charles Pfizer Company silicon carbide Ultralap (3) abrasive on 0,073 mm polyester backing or equivalent).

Acrylic plastic sheet of 1,27 mm thickness (Rohm and Haas Company grade G Plexiglas (4) or equivalent).

Profilometer having a 0,0025 mm radius stylus. Test sample as shown in Figure B.II.

Test Procedure

(a) Fasten a strip of new abrasive to the periphery of the mounting wheel with double back tape. The strip should be 3,2 to 4,8 mm wide and firmly attached with a minimum amount of tension. The ends must not overlap but should have less than 0,8 mm spacing.

(b) Place the wheel and sample on the Taber Abraser. It should be noted that the Taber Abraser vacuum attachment is not required in this test.

(c) Abrade samples with the nominal 3 and 8 micrometres silicon carbide abrasives. The test should be performed using a 440 g total load (wheel plus arm) and 50 revolutions of the sample.

(1) Trademark of the Taber Instrument Corporation, 111 Goundry Street, North Tonawanda, New York.

(2) Trademark of 3M Company, 3M Center, St. Paul, Minnesota.

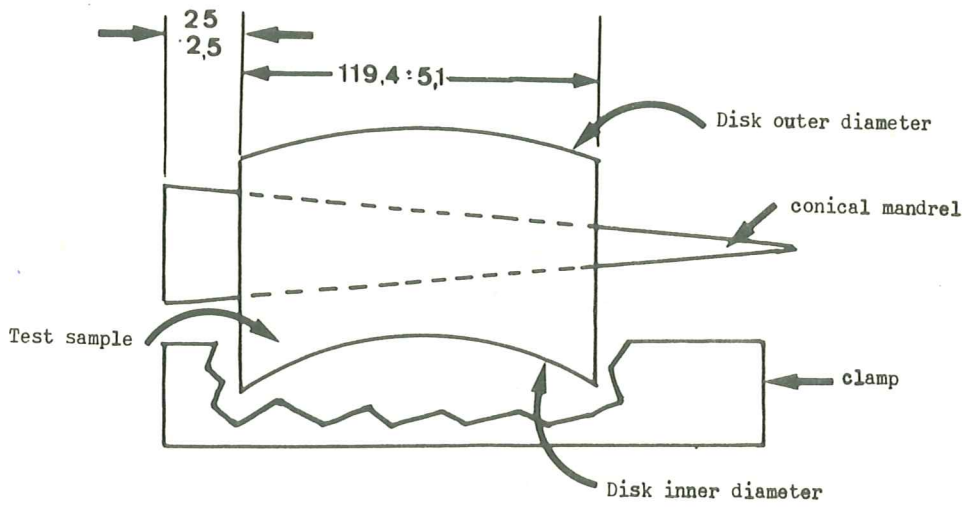
(3) Trademark of Charles Pfizer and Company, Inc., 325 East 42nd Street, New York, N.Y.

(4) Trademark of Rohm and Haas Company, Independence Hall, West Philadelphia, Pennsylvania.

(d) Record the profile of the wear scar at the eight locations shown in Figure B.II. The cross sectional area of the profilometer trace of the wear scar may be determined after drawing a straight line representing the unworn surface.

The nominal 3 and 8 micrometre abrasives will be calibrated by means of tests employing acrylic plastic samples. The measured wear values will be used to determine the equivalent standard particle size by referring to the calibration curve. In subsequent tests of actual coatings the wear values are then plotted versus the standard particle size. The wear value for a 6 micrometre abrasive is obtained by drawing a straight line between wear values obtained with abrasives both coarser and finer than 6 micrometre.

SAMPLE CONFIGURATION AND MOUNTING LOCATION




FASTENING AND REMOVAL OF PRESSURE SENSITIVE TAPE

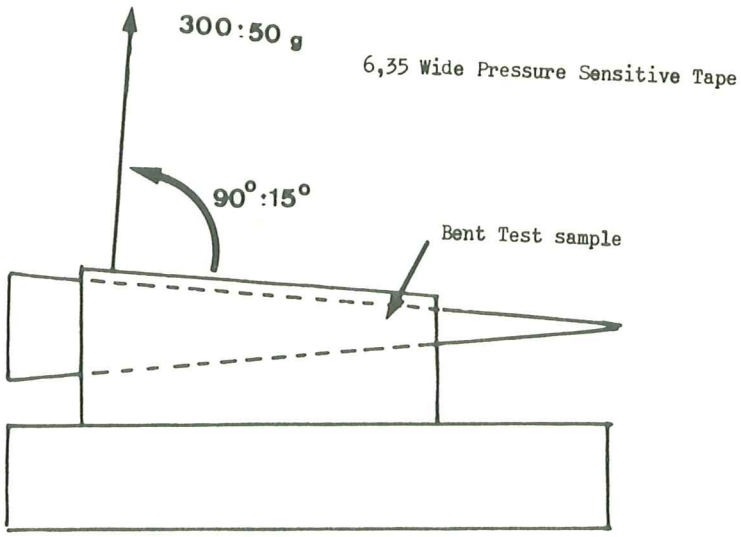
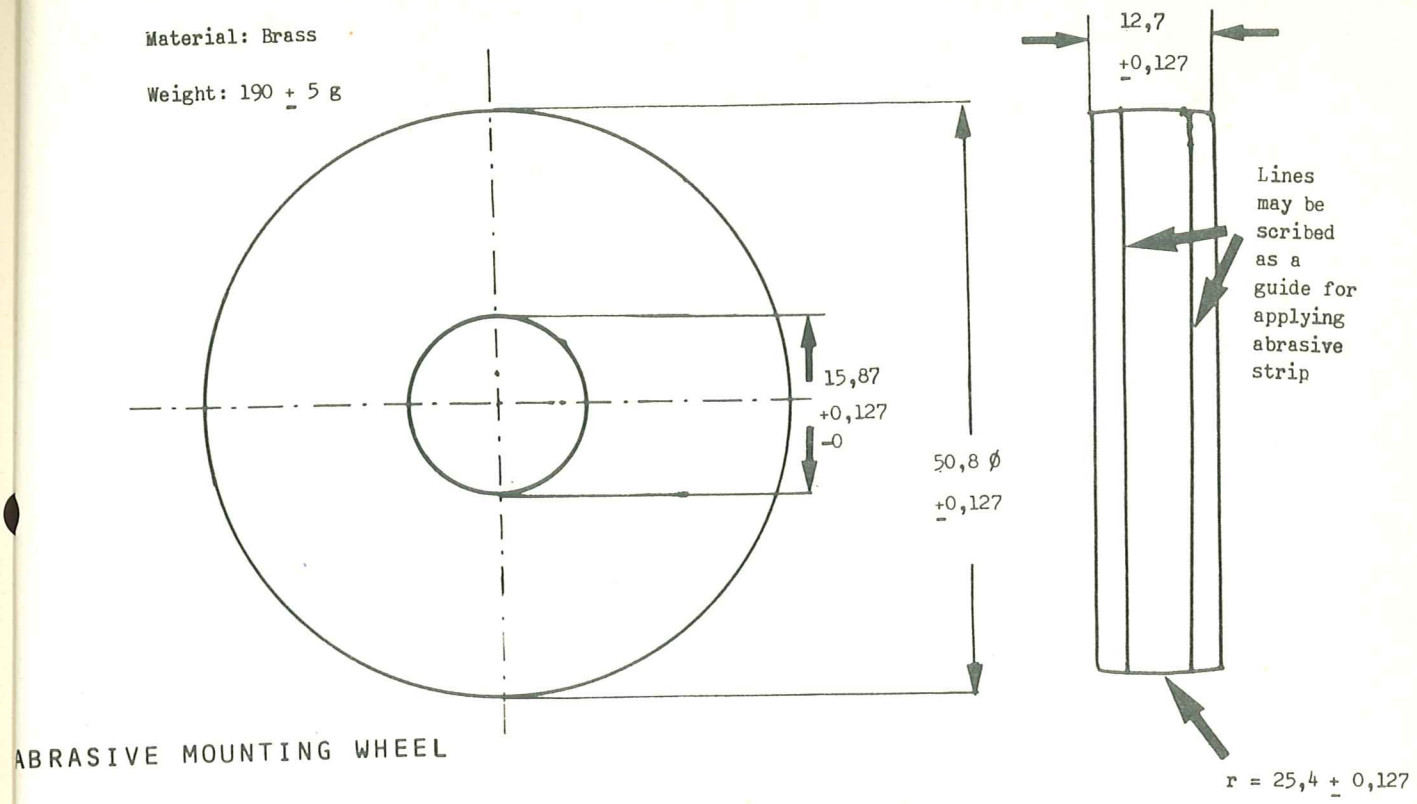
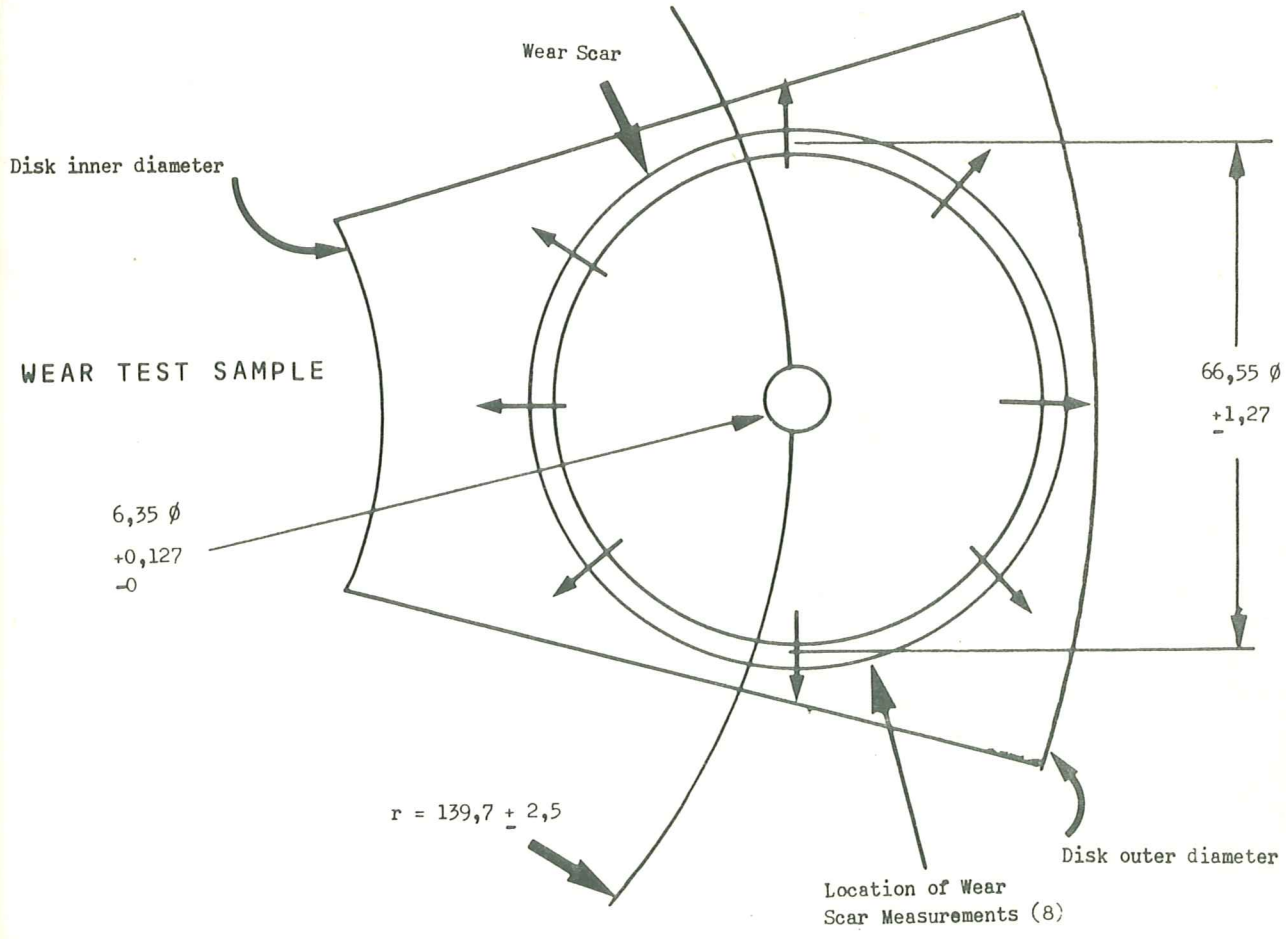



Fig. B.I - ADHESION TEST




ABRASIVE MOUNTING WHEEL




WEAR TEST SAMPLE

Fig. B.II - ABRASIVE WEAR RESISTANCE TEST

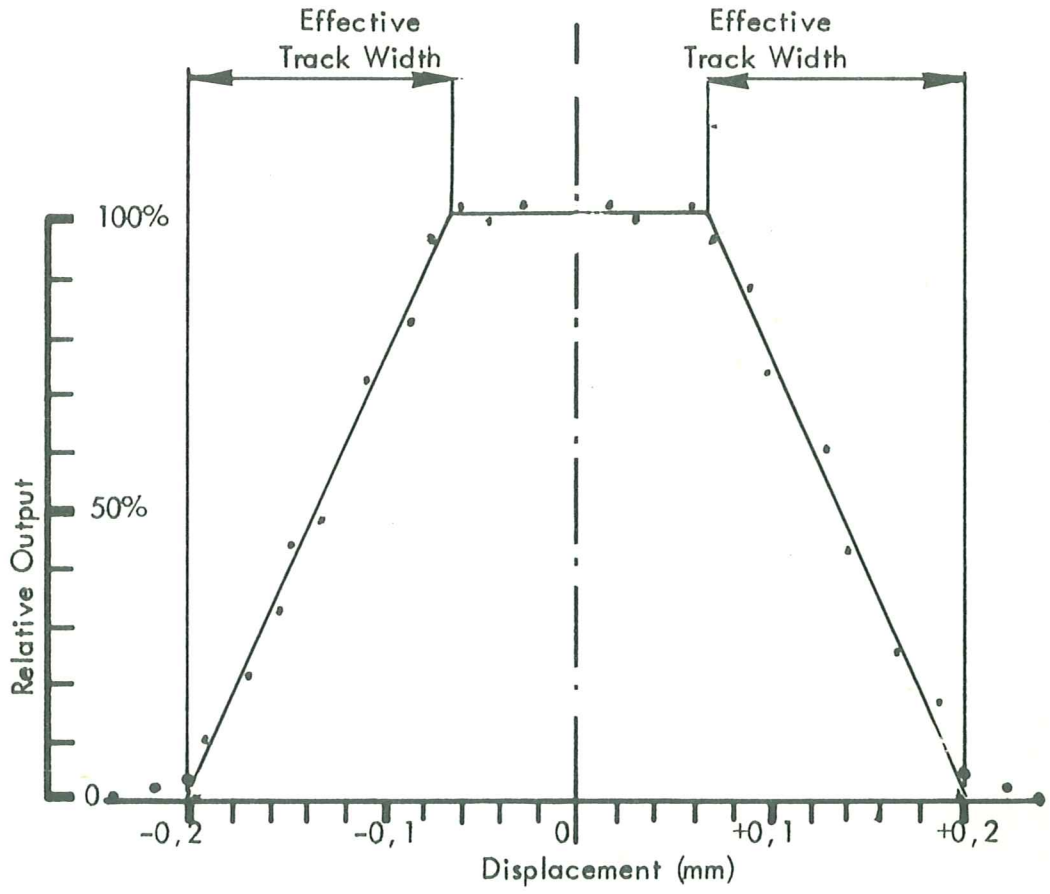
## APPENDIX C

### Measuring Effective Track Width

DC erase a seven track wide band with track location 200 in the centre of the band and record a 1F frequency pattern in track location 200. Then move the head radially over the disk in increments of 0,025 mm to the left and to the right of track 200 until the read back signal becomes zero. Determine read back signal amplitude at each incremental move and plot amplitude (Y axis) vs. displacement (X axis).

See diagram for reading track width.

The fringing at both ends of the curve is to be ignored when the track width is determined.




TRACK WIDTH DIAGRAM