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INTERNATIONAL STANDARD ISO 3564

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Information processing — Interchangeable magnetic eleven-disk pack — Physical and magnetic characteristics

Traitement de l'information — Chargeur interchangeable à onze disques magnétiques — Caractéristiques mécaniques et magnétiques

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FOREWORD

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Draft International Standards adopted by the Technical Committees are circulated to the Member Bodies for approval before their acceptance as International Standards by the ISO Council.

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It has been approved by the Member Bodies of the following countries :

Australia	Hungary	Spain
Belgium	Ireland	Switzerland
Bulgaria	Italy	Turkey
Canada	Netherlands	United Kingdom
Czechoslovakia	New Zealand	U.S.A.
France	Poland	U.S.S.R.
Germany	Romania	Yugoslavia

No Member Body expressed disapproval of the document.

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Information processing — Interchangeable magnetic eleven-disk pack — Physical and magnetic characteristics

1 SCOPE AND FIELD OF APPLICATION

This International Standard specifies the general, physical, and magnetic characteristics for the physical interchange of magnetic eleven-disk packs for use in electronic data processing systems.

It does not apply to a specific design. It defines only the parameters relevant for interchange.

2 DEFINITIONS

The terms for elements of eleven-disk packs are defined by figures 1 and 2.

Figures 1 to 5 show a typical disk pack assembly for illustration purposes only.

3 GENERAL REQUIREMENTS

3.1 Operating, storage and test environment

3.1.1 *Operating environment*

The operating temperature shall lie within the range 15 to 50 °C (60 to 120 °F) at a relative humidity of 8 to 80 %. The wet bulb reading shall not exceed 26 °C (78 °F). Before a disk pack is placed into operation, it shall be conditioned within its covers for a minimum of 2 h in the same environment as that in which the disk drive is operating. The above specified range does not necessarily apply to the disk drive.

The ambient stray magnetic field intensity shall not exceed 4 000 A/m.

3.1.2 *Storage environment*

3.1.2.1 UNRECORDED DISKS

The storage temperature shall lie within the range − 40 °C to + 65 °C (− 40 °F to + 150 °F), the wet bulb reading not exceeding 30 °C (85 °F). For wet bulb temperatures between 0,5 °C (33 °F) and 30 °C (85 °F), the disk pack shall be able to withstand a relative humidity of 8 to 80 %.

3.1.2.2 RECORDED DISKS

The storage temperature shall lie within the range − 40 °C to + 65 °C (− 40 °F to + 150 °F), the wet bulb reading not exceeding 30 °C (85 °F). For wet bulb temperatures between 0,5 °C (33 °F) and 30 °C (85 °F), the disk pack shall be able to withstand a relative humidity of 8 to 80 %. The stray magnetic field intensity shall not exceed 4 000 A/m.

A suggested accelerated storage life test is included in annex A.

3.1.3 *Test environment*

Unless otherwise stated, measurements shall be carried out at 23 ± 3 °C (73 ± 5 °F), 40 to 60 % relative humidity after 24 h of acclimatization. Tests shall be carried out with the disk pack in the upright position, unless otherwise stated.

3.2 Resistance to shock and vibration

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

A recommended test procedure is described in annex B. Any damage to the cover shall not be a failure criterion.

3.3 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 International Standard are maintained. The material and surface finish of the index disk are given in 4.1.5.5.

The materials and design of the disk pack shall be based on an intended lifetime of minimum 5 years.

4 PHYSICAL REQUIREMENTS

4.1 Dimensions

Reference line : The reference line is the line on which rests a reference ball having a diameter of 38,894 mm (1.531 25 in) (see figures 2 and 5).

4.1.1 *Overall height* (see figure 2)

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

$$h_1 \leqslant 167 \text{ mm (6.6 in).}$$

4.1.2 *Top cover* (see figure 2)

4.1.2.1 Outside diameter

The outside diameter of the top cover is

$$d_1 \leqslant 373{,}9 \text{ mm (14.72 in).}$$

4.1.2.2 Concentricity

The top cover shall be concentric with the cover centreline within 1,65 mm (0.065 in) total indicated runout.

4.1.2.3 Vertical distance

The vertical distance to the lower edge of the top cover from the reference line is

$$h_2 = 15{,}9 \pm 3{,}2 \text{ mm } (0.625 \pm 0.125 \text{ in}).$$

4.1.3 *Hub* (see figure 3)

4.1.3.1 Height of the taper

The height of the taper is

$$h_3 = 35{,}3 \pm 0{,}4 \text{ mm } (1.390 \pm 0.015 \text{ in}).$$

4.1.3.2 Bore relieve

The bore shall be relieved in the zone having a height

$$h_4 = 20{,}6 \pm 1{,}5 \text{ mm } (0.81 \pm 0.06 \text{ in}).$$

extending above height

$$h_5 = 6{,}3 \pm 0{,}8 \text{ mm } (0.25 \pm 0.03 \text{ in}).$$

4.1.3.3 Height of the hub over the reference line

The height of the hub over the reference line is

$$h_6 = 21 \pm 0{,}5 \text{ mm } (0.822 \pm 0.012 \text{ in}).$$

4.1.3.4 Taper

The taper of the hub bore is

$$(1 \pm 0{,}000\,2) : 2$$

4.1.3.5 Finish of the bore

The finish shall be of class N 7 to N 6 [1,6 to 0,8 μm (63 to 32 μin) arithmetical mean deviation, see ISO/R 1302].

4.1.4 *Spindle lock* (see figure 3)

4.1.4.1 Thread of the spindle lock

The thread of the spindle lock is a double lead thread of type 16 UNC-2A. The nominal diameter of the spindle lockshaft is

$$d_2 = 9{,}52 \text{ mm (0.375 in).}$$

4.1.4.2 Minimum full thread length

The full thread length of the spindle lock is

$$h_7 \geqslant 7{,}4 \text{ mm (0.29 in).}$$

4.1.4.3 Chamfer

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

$$d_3 = 7{,}3 \pm 0{,}3 \text{ mm } (0.29 \pm 0.012 \text{ in}).$$

and an angle

$$\gamma = 30 \text{ to } 45^\circ$$

4.1.4.4 Location of the shoulder of the spindle lock

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

$$h_8 = 59{,}05 \pm 0{,}56 \text{ mm } (2.325 \pm 0.022 \text{ in}).$$

The diameter of the spindle above the shoulder is

$$d_4 = 12{,}7\,^{+\,0{,}8}_{\;\;\,0} \text{ mm } (0.5\,^{+\,0.03}_{\;\;\,0} \text{ in}).$$

4.1.4.5 Length of the lower part of the spindle lock from the shoulder

The length of the lower part of the spindle lock from the shoulder is

$$h_9 = 19{,}65 \pm 0{,}15 \text{ mm } (0.774 \pm 0.006 \text{ in}).$$

4.1.4.6 Maximum diameter of the lower part of the spindle lock

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

$$d_5 = 10{,}97\,^{\;\;\,0}_{-\,0{,}25} \text{ mm } (0.432\,^{\;\;\,0}_{-\,0.010} \text{ in}).$$

The safety balls shall not extend before the lockshaft pin is at a distance of

$$h_{10} \leqslant 18{,}5 \text{ mm (0.728 in)}$$

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

$$h_{11} \geqslant 14{,}3 \text{ mm } (0.563 \text{ in})$$

from the shoulder of the spindle lock.

The diameter with relaxed balls is

$$d_6 \leqslant 9{,}65 \text{ mm } (0.38 \text{ in}).$$

4.1.4.7 LOCATION OF THE SAFETY BALLS

The centres of the safety balls are located with regard to the shoulder of the spindle lock at a distance of

$$h_{12} = 8{,}66 \pm 0{,}24 \text{ mm } (0.341 \pm 0.009 \text{ in}).$$

4.1.4.8 HOLE FOR THE PENETRATION OF THE LOCKSHAFT PIN

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

$$d_7 = 3{,}18\,^{0}_{-0{,}13} \text{ mm } (0.125\,^{0}_{-0.005} \text{ in}).$$

4.1.4.9 DEPTH OF PENETRATION OF THE LOCKSHAFT PIN

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

$$h_{13} \leqslant 12{,}5 \text{ mm } (0.492 \text{ in}).$$

4.1.4.10 REMOVAL OF THE TOP COVER

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

$$h_{14} = 13{,}8 \pm 0{,}5 \text{ mm } (0.543 \pm 0.020 \text{ in}).$$

4.1.5 *Index disk* (see figure 4)

4.1.5.1 DIAMETER

The diameter of the index disk is

$$d_8 = 362{,}74 \pm 0{,}25 \text{ mm } (14{,}281 \pm 0.010 \text{ in}).$$

4.1.5.2 THICKNESS

The thickness of the index disk is

$$e_1 = 1{,}30 \pm 0{,}08 \text{ mm } (0.051 \pm 0.003 \text{ in}).$$

4.1.5.3 NOTCH

4.1.5.3.1 This index disk has at its circumference a single rectangular notch.

4.1.5.3.2 Depth

The radial depth of the notch is limited by the radius

$$r_1 = 177{,}8 \pm 0{,}02 \text{ mm } (7.000 \pm 0.008 \text{ in}).$$

4.1.5.3.3 Width

The width of the notch is

$$e_2 = 1{,}90 \pm 0{,}13 \; (0.075 \pm 0.005 \text{ in}).$$

4.1.5.4 EDGES AND CORNERS

All edges and corners have a radius of

$$r_2 \leqslant 0{,}5 \text{ mm } (0.02 \text{ in}).$$

4.1.5.5 MATERIAL

The index disk shall be constructed from an aluminium alloy and meet the related physical and functional requirements of this International Standard. The material and surface finish of the index disk shall permit reading the notch by eddy current and optical transducers.

4.1.6 *Disk support* (see figure 5)

The radius of all disk supports is

$$r_3 \leqslant 95{,}3 \text{ mm } (3.75 \text{ in}).$$

4.1.7 *Recording disks* (see figure 5)

4.1.7.1 DIAMETER

The outer diameter of all recording disks is

$$d_9 = 356{,}25 \pm 0{,}15 \text{ mm } (14.026 \pm 0.006 \text{ in}).$$

4.1.7.2 THICKNESS

The thickness of all recording disks is

$$e_3 = 1{,}27 \pm 0{,}03 \text{ mm } (0.050 \pm 0.001 \text{ in}).$$

4.1.7.3 EDGE CHAMFER

The edges of all recording disks may be chamfered as shown in figure 5 or may have any smooth nonsharp functionally acceptable geometry, such as a parabola or ellipse, providing the profile of the edge remains within the chamfered dimension

$$e_4 \leqslant 1{,}3 \text{ mm } (0.05 \text{ in})$$

and an angle

$$\alpha = 15^\circ \text{ nominal.}$$

4.1.8 *Location of the disks* (see figure 5)

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

INDEX DISK : The distance below the reference line of the lower surface of the index disk is

$$h_{15} = 12{,}22 \,^{+\,0{,}51}_{-\,0{,}64} \text{ mm } (0.481 \,^{+\,0.020}_{-\,0.025} \text{ in}).$$

1st RECORDING DISK : The distance below the reference line of the upper surface of the 1st recording disk is

$$h_{16} = 9{,}65 \pm 0{,}41 \text{ mm } (0.380 \pm 0.016 \text{ in}).$$

2nd RECORDING DISK : The distance below the reference line of the lower surface of the 2nd recording disk is

$$h_{17} = 0{,}76 \pm 0{,}41 \text{ mm } (0.030 \pm 0.016 \text{ in}).$$

3rd THROUGH 11th RECORDING DISK : The distance above the reference line of the lower surface of the 3rd through 11th recording disk is

$$h_{18} = 9{,}40 \pm 0{,}41 \text{ mm } (0.370 \pm 0.016 \text{ in})$$

$$h_{19} = 19{,}56 \pm 0{,}41 \text{ mm } (0.770 \pm 0.016 \text{ in})$$

$$h_{20} = 29{,}72 \pm 0{,}41 \text{ mm } (1.170 \pm 0.016 \text{ in})$$

$$h_{21} = 39{,}88 \pm 0{,}41 \text{ mm } (1.570 \pm 0.016 \text{ in})$$

$$h_{22} = 50{,}04 \pm 0{,}41 \text{ mm } (1.970 \pm 0.016 \text{ in})$$

$$h_{23} = 60{,}20 \pm 0{,}41 \text{ mm } (2.370 \pm 0.016 \text{ in})$$

$$h_{24} = 70{,}36 \pm 0{,}41 \text{ mm } (2.770 \pm 0.016 \text{ in})$$

$$h_{25} = 80{,}52 \pm 0{,}41 \text{ mm } (3.170 \pm 0.016 \text{ in})$$

$$h_{26} = 90{,}68 \pm 0{,}41 \text{ mm } (3.570 \pm 0.016 \text{ in}$$

TOP COVER DISK : The distance above the reference line of the upper surface of the top cover disk is

$$h_{27} = 93{,}22 \pm 0{,}48 \text{ mm } (3.670 \pm 0.019 \text{ in}).$$

4.1.9 *Minimum clearance of lowest element* (see figure 5)

The distance of the lowest element of the disk pack below the reference line is

$$h_{28} \leqslant 18{,}42 \text{ mm } (0.725 \text{ in})$$

in the area with a radius

$$r_4 \leqslant 90 \text{ mm } (3.543 \text{ in}).$$

The distance of the lowest element of the disk pack above the reference line is

$$h_{29} \geqslant 24{,}9 \text{ mm } (0.98 \text{ in})$$

in the area between the radii

$$r_5 = 32{,}5 \text{ mm } (1.28 \text{ in}) \text{ and}$$

$$r_6 = 40{,}4 \text{ mm } (1{,}59 \text{ in})$$

and limited by a distance

$$h_{30} \geqslant 20{,}1 \text{ mm } (0.79 \text{ in})$$

in the remaining areas within a radius

$$r_7 = 42{,}2 \text{ mm } (1.66 \text{ in}).$$

4.1.10 *Overall height without covers*

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

$$h_{31} \leqslant 115{,}2 \text{ mm } (4.535 \text{ in}).$$

4.1.11 *Hub/disks relationship*

4.1.11.1 AXIAL POSITION LIMITS OF DISK SURFACES

With the disk pack revolving at 2 400 ± 48 revolutions per minute, the axial runout of the recording disks and of the index disk (defined by stacking dimensions h_{15} to h_{27} in figure 5) shall remain within the axial position limits defined for each surface by the plus and minus tolerance around the datum dimension expressed as a dimension from the reference line for that surface (dimensions h_{15} to h_{27}). This requirement shall apply to the area of all disk surfaces between a radius of 177,4 mm (6.985 in) minimum and a radius of 104,9 mm (4.130 in) maximum. (A possible test method is given in C.2.1.1.)

4.1.11.2 AXIAL RUNOUT OF DISKS

With the disk pack revolving at 2 400 ± 48 rev/min, the axial runout of the recording disks shall not exceed 0,30 m (0.012 in) T.I.R. (total indicator reading). This requirement shall apply to the recording area of all disk surfaces between a radius of 177,4 mm (6.985 in) minimum and a radius of 104,9 mm (4.130 in) maximum.

At a rotational speed of less than 10 rev/min, the axial runout of the index disk shall not exceed 0,51 mm (0.020 in) T.I.R. between a radius of 177,4 mm (6.985 in) minimum and a radius of 104,9 mm (4.130 in) maximum. (A possible test method is given in C.2.1.2.)

4.1.11.3 ACCELERATION (SECOND DERIVATIVE) OF AXIAL RUNOUT

With the disk pack revolving at 2 400 ± 48 rev/min, the acceleration of axial runout of the recording disk surfaces (measured with a high frequency cut-off defined by the flat response/high frequency asymptote intercept of 1 500 Hz and a high frequency fall off of 18 dB per octave) in the area between a radius of 177,4 mm (6.985 in) minimum and a radius of 104,9 mm (4.130 in) maximum shall not exceed a peak acceleration from the base line of 140 m/s^2 (5 500 in/s^2). (A possible test method is given in C.2.1.3.)

4.1.11.4 HORIZONTAL RUNOUT OF DISKS

The horizontal runout (i.e. the total indicator reading) shall not exceed 0,25 mm (0.010 in) for the index disk and the bottom two recording disks; and 0,51 mm (0.020 in) for the other disks as referenced to the centreline of the disk pack hub.

4.1.11.5 Angular shift between disks and hub

After the disk pack has experienced a positive or negative acceleration up to 3 000 rad/s^2 the angular shift between disks and hub must remain equal to zero when measured with a device capable of detecting a shift of 3″ of arc.

4.1.12 *Location of magnetic surfaces*

The area of the magnetic surface of the recording disks extends from an inside diameter of 209,8 mm (8.26 in) maximum to an outside diameter of 354,8 mm (13.97 in) minimum.

4.2 Moment of inertia

The moment of inertia of the disk pack without covers shall not exceed 85 g·m^2 (291 lb·in^2). (A possible test method is given in C.2.2.)

4.3 Balance

The disk pack shall be dynamically balanced within 100 g·mm (0.14 oz·in), when measured at 2 400 rev/min in each of two planes parallel to the disk surface at 6,6 ± 0,2 mm (0.26 ± 0,05 in) below the top disk surface and above the bottom disk surface respectively.

4.4 Maximum speed

The disk pack shall be capable of withstanding the effect of stress at a speed of 2 500 rev/min counter-clockwise as seen from the top.

4.5 Locking pull

The disk pack shall be held to the disk drive spindle by a force of 925 ± 145 N (206 ± 32 lbf), exerted by the downward pull of the disk drive lockshaft on the disk pack spindle lock.

4.6 Air feed openings

At least 12 openings having a minimum total area of 710 mm^2 (1.1 in^2) are equally distributed around the disk support between each pair of recording disks.

4.7 Air filter

4.7.1 *Filter media*

The filter media shall be a screen-type construction having a maximum spacing between strands of 44 μm (0.001 73 in). The material shall not contain tendrils or loose particles which can separate from the filter and enter the filtered system.

4.7.2 *Air flow and pressure drop*

The pressure drop across a clean air filter shall not exceed 1,05 mbar (0.42 in of water) while passing 1,6 ± 0,1 m^3 (55 ± 3 ft^3) of air (in standard condition) per minute.

4.8 Thermal time constant

The thermal time constant is the time required to reduce an initial temperature difference between the pack and the drive by 2/3. The disk pack thermal time constant shall not exceed 1 min when measured with the disk pack rotating at 2 400 ± 48 rev/min and within the specified operating environment and conditions.

4.9 Operational earthing

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

4.10 Physical characteristics of magnetic surfaces

4.10.1 *Surface roughness*

The finished magnetic surface shall have a surface roughness less than 0,09 μm (3.5 μin), arithmetic average, with a maximum deviation in height of 0,76 μm (30 μin) from the average, when measured with a 2,5 μm (0.000 1 in) stylus and a 750 μm (0.03 in) cut-off range.

4.10.2 *Head gliding requirements*

In the band defined by the diameters 209,8 mm (8.26 in) and 354,8 mm (13.97 in), see 4.1.12, there shall be no head-to-disk contacts with heads flying at 1,25 μm (50 μin) at the inner diameter and increasing linearly to 1,65 μm (65 μin) at the outer diameter.

4.10.3 *Durability of magnetic surface*

4.10.3.1 Resistance to chemical cleaning fluid

The magnetic surface of the disk shall not be adversely affected when cleaned with a mixture consisting of 91 parts by volume of reagent grade isopropyl alcohol and 9 parts by volume of distilled or deionized water.

4.10.3.2 Coating adhesion

The nature of the coating shall be such as to ensure wear resistance under operating conditions and maintenance of adhesion and abrasive wear resistance. Suggested tests for checking the durability of the coating are given in annex D.

4.10.3.3 Abrasive wear resistance

The coating shall be able to withstand operational wear. A possible test method is described in annex D.

5 MAGNETIC REQUIREMENTS

5.1 General geometry, surfaces and heads

The twenty magnetic recording surfaces, with the associated head orientations, shall be as shown in figure 6.

5.2 Track geometry

5.2.1 *Number of tracks*

There shall be 203 discrete concentric tracks per disk surface.

5.2.2 *Width of tracks*

The recording track width on the disk surfaces after straddle erase shall be :

$$0{,}175\,^{0}_{-0{,}025}\text{ mm } (0.006\,9\,^{0}_{-0.001\,0}\text{ in}).$$

The area between the tracks shall be erased. A suggested method of measuring effective track width is given in annex E.

5.2.3 *Track locations*

5.2.3.1 Nominal locations

The nominal centreline locations of the tracks shall be as shown in table 1. The dimensional constants for deriving the track centreline radii as per the head-disk geometry of figure 7, defined at 23,0 °C (73.4 °F) are :

- incremental head movement (spacing)

$$S = 0{,}256\,7 \text{ mm } (0.010\,106 \text{ in})$$

- magnetic gap offset distances

$$F_{ar} = 12{,}125 \text{ mm } (0.477\,4 \text{ in})$$

$$F_{br} = 10{,}987 \text{ mm } (0.432\,6 \text{ in})$$

- centreline radius of track 73

$$R_{73} = 148{,}057 \text{ mm } (5.829\,0 \text{ in})$$

- head offset angle

$$\theta = 4^\circ\,54'$$

5.2.3.2 Track location tolerance

The centrelines of the recorded tracks measured at 23,0 °C (73.4 °F) shall be within ± 0,025 mm (0.001 in) of the nominal positions.

NOTES

1 As track 73 is used to set up the drive, it is to be expected that the position of track 73 will be within ± 7,5 μm (0.000 3 in) of the nominal position.

2 At other temperatures (within those specified in this International Standard) the nominal track centreline can be calculated using a linear coefficient of thermal expansion of $24 \times 10^{-6}/°C$ ($13.33 \times 10^{-6}/°F$).

5.2.3.3 Recording offset angle

At the instant of writing or reading, a magnetic transition shall make an angle of 4° 54′ ± 30′ with the appropriate line of access of the heads as defined in figure 7.

5.2.4 *Identification*

For the purposes of testing the following identifying system is used.

5.2.4.1 Track identification

Track identification shall be by a three-digit decimal number (000 to 202) which counts tracks consecutively starting at the outermost track of each surface.

5.2.4.2 Surface identification

The 20 recording surfaces shall be numbered from 00 to 19 starting with the lower surface of the top recording disk (see figure 6).

5.2.4.3 Cylinder address

A cylinder is defined as all tracks on the disk pack with a common identification number.

5.2.4.4 Track address

A five-digit decimal number shall be used for track address, with the three most significant digits defining the cylinder address and the remaining two digits defining the surface address.

5.2.5 *Index*

Index is the point which determines the beginning and end of a track. At the instant of detection of the leading edge of the index notch of the index disk, the index is under the read-write gap on its appropriate line of access (A or B, see figure 8). At this instant the angle ϵ between the radial access centreline and the radial line passing through the leading edge of the index notch (see figure 8) shall be

$$\epsilon = 42^\circ\,9'$$

5.2.6 *Test areas*

5.2.6.1 Header area

For the purpose of testing, the header area is defined as that area starting not later than 100 μs after index and ending not sooner than 700 μs after index with the disk rotating at 2 400 rev/min.

5.2.6.2 Data area

For the purpose of testing, the data area is defined as that area starting not later than 700 μs after index and continuing to the next index with the disk rotating at 2 400 rev/min.

5.3 Test conditions and equipment

5.3.1 *General conditions*

5.3.1.1 ROTATIONAL SPEED

The rotational speed shall be 2 400 ± 24 rev/min in any test period with the disk pack rotating counter-clockwise when viewed from above.

5.3.1.2 AIRFLOW

The flow of air (in standard condition) shall be 0,026 ± 0,001 4 m^3/s (55 ± 3 ft^3/min) at a pressure at the air intake to the disk pack not exceeding 0,5 mbar (0.2 in of water).

5.3.1.3 TEMPERATURE

The temperature at the air intake to the disk pack shall be 27 ± 1 °C (80 ± 2 °F).

5.3.1.4 RELATIVE HUMIDITY

The relative humidity of the air entering the disk pack shall be between 40 and 60 %.

5.3.1.5 CONDITIONING

Before measurements commence, the disk pack shall be conditioned for 24 h in the same environment as that in which the test equipment is operating.

5.3.2 *Standard reference surfaces*

There are two standard reference surfaces which are held by approved agencies[1] as the references by which all secondary standards will be calibrated.

5.3.2.1 STANDARD AMPLITUDE REFERENCE SURFACE

5.3.2.1.1 Characteristics

The standard amplitude reference surface shall be characterized in areas designated by a scratch and defined as beginning 50 μs after the edge of the scratch and ending 275 μs from this edge.

This surface when recorded at 1*f* (see 5.3.4.3) without tunnel erase, using an amplitude test head (see 5.3.3.1), gives the following output :

at a radius of 115,087 ± 0,254 mm (4.531 ± 0.001 0 in) :

7,0 mV peak-to-peak

at a radius of 166,726 ± 0,254 mm (6.564 ± 0.010 in) :

11,5 mV peak-to-peak.

5.3.2.1.2 Secondary standard amplitude reference surface

This is a surface whose output is related to the standard amplitude reference surface via a calibration factor C_{AD}.

The calibration factor C_{AD} is defined as :

$$C_{AD} = \frac{\text{standard amplitude reference surface output}}{\text{secondary standard amplitude reference surface output}}$$

To qualify as a secondary standard amplitude reference surface, the calibration factor C_{AD} for such disks shall satisfy $0{,}90 \leqslant C_{AD} \leqslant 1{,}10$ in in the measured areas as defined in 5.3.2.1.1.

5.3.2.2 STANDARD DATA REFERENCE SURFACE

5.3.2.2.1 Characteristics

The standard data reference surface shall be characterized in an area designated by a scratch and defined as beginning 50 μs after the edge of the scratch and ending 275 μs from this edge.

The surface when recorded with straddle erase using a data test head (see 5.3.3.2) at a radius of 115,087 ± 0,254 mm (4.531 ± 0.010 in) gives an output of

4,0 mV peak-to-peak if recorded at 2*f*;

2,0 mV peak-to-peak if recorded at 4*f* (see 5.3.4.3).

5.3.2.2.2 Secondary standard data reference surface

This is a surface whose output is related to the standard data reference surface via the calibration factors C_{DD2} (for 2*f*) and C_{DD4} (for 4*f*).

The calibration factor C_{DD} is defined as :

$$C_{DD} = \frac{\text{standard data reference surface output}}{\text{secondary standard data reference surface output}}$$

To qualify a secondary standard data reference surface, the calibration factors C_{DD} shall satisfy $0{,}90 \leqslant C_{DD} \leqslant 1{,}10$ for both frequencies in the measured area as defined in 5.3.2.2.1.

1) A calibration service is available from the National Bureau of Standards (NBS) in Gaithersburg, Maryland, U.S.A. and the Physikalisch-Technische Bundesanstalt (PTB), Braunschweig, Germany.

5.3.3 *Test heads*

5.3.3.1 Amplitude test heads

Amplitude test measurements shall be taken with a suitable test head.[1] To qualify as an amplitude test head the head calibration factor C_{AH} shall satisfy $0,90 \leqslant C_{AH} \leqslant 1,10$.

The calibration factor C_{AH} is defined as :

$$C_{AH} = \frac{\text{standard amplitude reference surface output}}{(\text{actual head voltage measured}) \times C_{AD}}$$

when measured on the two radii of the secondary standard amplitude reference surface at 1*f* (see 5.3.2.1.2).

5.3.3.2 Data test heads

All measurements other than amplitude test measurements shall be taken with a suitable test head.[2] To qualify as a data test head the head calibration factor C_{DH} shall satisfy $0,90 \leqslant C_{DH} \leqslant 1,10$.

The calibration factor C_{DH} is defined as :

$$C_{DH} = \frac{\text{standard data reference surface output}}{(\text{actual head voltage measured}) \times C_{DD2}}$$

when measured on a secondary standard data reference surface at 2*f* (see 5.3.2.2.2) at the 115,087 mm (4.531 in) radius.

5.3.3.2.1 Resolution

The resolution of the data test head is defined as the ratio of the 4*f* to 2*f* average read amplitudes at the 115,087 mm (4.531 in) radius on the standard data reference surface, when measured over the same 225 μs sector. The resolution of a data test head shall be 40 to 60 %.

5.3.3.2.2 Resonant frequency

The resonant frequency of each of the read/write coils, when measured at the head-cable connector, shall be 4,2 MHz minimum.

5.3.4 *Specific conditions*

5.3.4.1 Conditions for amplitude test head measurements

5.3.4.1.1 Write current

The 1*f* current waveform measured at the head termination connector shall conform to figure 9, where :

$$\text{Write current } I_W = \frac{I_{W1} + I_{W2}}{2} = 35 \pm 1 \text{ mA}$$

$$\text{Overshoot} = 5 \text{ to } 10 \text{ \% of } I_W.$$

The difference between the positive and negative amplitudes of the stationary write current I_W shall be

$$\left| I_{W1} - I_{W2} \right| < 1 \text{ mA}$$

$$T_R = 140 \text{ to } 200 \text{ ns}$$

$$T_F = 140 \text{ to } 200 \text{ ns}$$

$$\left| T_R - T_F \right| \leqslant 20 \text{ ns}$$

Two consecutive half-periods T_1, T_2 shall not differ by more than 2 %.

5.3.4.1.2 DC erase current

The DC erase current supplied to one of the read/write coils when DC erase is specified shall be

$$I_E = 35 \pm 1 \text{ mA}$$

5.3.4.1.3 Read electronics

The differential input impedance of the read electronics shall be 7,5 ± 0,37 kΩ in parallel with a distributed and lumped capacitance of 45 ± 5 pF, measured at the head termination connector (see figure 10). The amplifier shall have a passband flat within 5 % from 0,1 to 2,0 MHz.

5.3.4.2 Conditions for data test head measurements

5.3.4.2.1 Write current

The 2*f* write current waveform measured at the head termination connector shall conform to figure 9, where :

$$I_W = \frac{I_{W1} + I_{W2}}{2} = 35 \pm 1 \text{ mA for track 000 to track 127}$$

$I_W = 30 \pm 1$ mA for track 128 to track 202,

overshoot $\leqslant 8$ % of I_W.

The difference between the positive and negative amplitudes of the stationary write current I_W shall be

$$\left| I_{W1} - I_{W2} \right| < 1 \text{ mA}$$

$$T_R = 120 \text{ to } 160 \text{ ns}$$

$$T_F = 120 \text{ to } 160 \text{ ns}$$

$$\left| T_R - T_F \right| \leqslant 20 \text{ ns}$$

Two consecutive half-periods T_1, T_2 shall not differ by more than 2 %.

1) For example, IBM 2316 (2311 type) amplitude test head is a suitable test head.

2) For example, IBM 2316 (2314 type) data test head is a suitable test head.

5.3.4.2.2 DC erase current

The DC erase current supplied to one of the read/write coils when DC erase is specified shall be

$I_E = 35 \pm 1$ mA for track 000 to track 127

$I_E = 30 \pm 1$ mA for track 128 to track 202.

5.3.4.2.3 Read electronics

The differential input impedance of the read electronics shall be 4,20 ± 0,21 kΩ in parallel with a distributed and lumped capacitance of 30 ± 5 pF, measured at the head termination connector (see figure 10).

The read electronics shall be capable of accepting low impedance signal levels between 0,6 and 10,0 mV peak-to-peak. Linearity shall be within 3 % or 0,050 mV (whichever is larger) at frequencies between 0,5 and 3,0 MHz.

5.3.4.3 TEST SIGNALS

The frequencies specified as $1f$, $2f$ and $4f$ shall be

$1f = (1\,250 \pm 1{,}25) \times 10^3$ transitions/s

$2f = (2\,500 \pm 2{,}50) \times 10^3$ transitions/s

$4f = (5\,000 \pm 5{,}00) \times 10^3$ transitions/s.

5.3.4.4 DC EDGE ERASURE

Edge erasure shall be used for all surface tests and track quality tests unless otherwise specified.

When using the tunnel erase (TE) amplitude test head, the edge erasure current shall be

$$I_{TE} = 40 \pm 2 \text{ mA}$$

When using the straddle erase (SE) data test head, the edge erasure current shall be

$$I_{SE} = 35 \pm 1 \text{ mA}$$

5.3.4.5 MAGNETIC RECORDING

Unless otherwise specified, all write operations shall be preceded by a DC erase operation (see 5.3.4.1.2 and 5.3.4.2.2).

5.3.4.6 LOCATIONS

The track quality test requirements (see 5.4.2) shall also be met with an offset of 0,025 mm (0.001 in) from the nominal track position as defined in 5.2.3.

5.3.4.7 HEAD LOADING FORCE

The net head loading force shall be 3,43 ± 0,10 N (350 ± 10 gf), centre pivot loading or equivalent.

5.4 Functional testing

5.4.1 *Surface tests*

5.4.1.1 AMPLITUDE TEST

5.4.1.1.1 Procedure

Write on any part of the recording surface at $1f$ using an amplitude test head and read back.

5.4.1.1.2 Result

The corrected read-back amplitude averaged over the highest 50 µs sector shall be within the following peak-to-peak amplitude limits :

Maximum amplitude shall be 9,3 mV at the 115,087 mm (4.531 in) radius and increase proportionally to, but not exceed, 15,1 mV at the 166,726 mm (6.564 in) radius.

Minimum amplitude shall be 6,3 mV at the 115,087 mm (4.531 in) radius and increase proportionally to, or exceed, 10,0 mV at the 166,726 mm (6.564 in) radius.

5.4.1.2 RESOLUTION TEST

5.4.1.2.1 Procedure

On any part of the recording surface write at $2f$ and read back using a data test head. After DC erasing write at the same position at $4f$ and read back.

5.4.1.2.2 Result

In all cases the ratio $\dfrac{\text{amplitude at } 4f}{\text{amplitude at } 2f}$ averaged over the same 50 µs sector shall be 0,55 ± 0,20.

5.4.1.3 OVERWRITE TEST

5.4.1.3.1 Procedure

Write on track 000 at $2f$ and measure the average amplitude of $2f$ signal with a frequency-selective voltmeter. Without a DC erase overwrite once at $4f$, measure the average amplitude of $2f$ signal with a frequency-selective voltmeter. Qualified overwrite heads (see 5.4.1.3.3) shall be used.

5.4.1.3.2 Overwrite residual amplitude

The overwrite residual amplitude is defined as

$$r = \frac{\text{(average amplitude of selectively measured } 2f \text{ signal after overwrite with } 4f) \times 100}{\text{(average amplitude of selectively measured } 2f \text{ signal before overwrite with } 4f)}$$

5.4.1.3.3 Qualified overwrite heads

A data test head is qualified as an overwrite test head when the overwrite residual amplitude r of the standard data reference surface written and overwritten with this head is between 3 and 5 %.

5.4.1.3.4 Result

The ratio of the overwrite residual amplitude of the disk to be tested to the overwrite residual amplitude of the data reference surface shall not exceed 1,3.

5.4.1.4 POSITIVE MODULATION TEST

5.4.1.4.1 Procedure

Using a data test head, write a track at $2f$ and read back.

5.4.1.4.2 Result

The average base-to-peak amplitude measured at the highest amplitude 50 μs sector of that track location shall be less than 146 % of the average base-to-peak amplitude of the full track.

5.4.1.5 NEGATIVE MODULATION TEST

5.4.1.5.1 Procedure

Using a data test head, write a track at $2f$ and read back.

5.4.1.5.2 Result

The average base-to-peak amplitude measured at the lowest amplitude 50 μs sector of that track location shall be greater than 75 % of the average base-to-peak amplitude of that track.

5.4.2 *Track quality tests*

Data test heads shall be used for all track quality tests.

Two methods, A and B, are described below for the track quality tests. Although it is recognized that neither of them gives absolute correlation between computer and test equipment, both give acceptable correlation.

Method A is based on a fixed voltage reference.

Method B is based on track relative voltage references.

The method to be used shall be agreed between the interchange parties.

5.4.2.1 MISSING PULSE TEST

5.4.2.1.1 Method A

Procedure

Write on each track at $2f$ and read back.

Result

A missing pulse is any read pulse whose base-to-peak amplitude is less than 25 % of the standard data reference surface output at $2f$ (peak-to-peak), see 5.3.2.2.1, based on the peak amplitude occurring from 150 to 250 ns after the zero cross-over point of the analogue signal.

5.4.2.1.2 Method B

Procedure

Write on each track at $2f$ and read back.

Result

A missing pulse is any read pulse whose base-to-peak amplitude is less than 60 % of the average base-to-peak amplitude of the preceding 50 μs sector.

5.4.2.2 EXTRA PULSE TEST

5.4.2.2.1 Method A

Procedure

Write on each track at $2f$ and read back. Then DC erase and read the residual amplitude.

Result

An extra pulse is any spurious read pulse whose amplitude is more than 40 % of the average base-to-peak $2f$ amplitude of the tested track.

The maximum base-to-peak amplitude of any spurious read pulse(s) shall not exceed 22,5 % of the standard data reference surface output at $2f$ (peak-to-peak), see 5.3.2.2.1.

5.4.2.2.2 Method B

Procedure

Write on each track at $2f$. Read back and note the highest peak-to-peak amplitude averaged over 50 μs of track signal. Call this V_A. DC erase as in 5.3.4.2.2 and read the residual amplitude.

Result

Any read back signal measured base-to-peak, shall not exceed 25 % of 1/2 V_A.

5.4.2.3 EASE OF ERASURE TEST

5.4.2.3.1 Method A

Procedure

Write on each track at $2f$ and read back. DC erase as in 5.3.4.2.2, and read the residual amplitude.

Result

The peak-to-peak amplitude of the residual signal averaged over any 50 μs sector of the erased track shall not exceed 4 % of the highest peak-to-peak amplitude averaged over a 50 μs sector of that track. (The residual signal is measured independent of test system noise.)

The maximum peak-to-peak amplitude of the residual signal shall not exceed 10 % of the standard data reference surface output at $2f$, see 5.3.2.2.1.

5.4.2.3.2 Method B

Procedure

Write on each track at $2f$, read back and note the highest peak-to-peak amplitude averaged over 50 µs of track signal. Call this V_A. DC erase as in 5.3.4.2.2 and read the residual amplitude.

Result

The average level of the highest 50 µs sector of the read back signal shall not exceed 10 % of V_A.

5.4.3 *Rejection criteria*

5.4.3.1 SURFACE TEST CRITERIA

The disk pack shall meet the requirements of all the surface tests specified in 5.4.1.

5.4.3.2 TRACK QUALITY CRITERIA

5.4.3.2.1 Error

An error is a failure to meet any of the requirements of 5.4.2 (according to the agreed method).

5.4.3.2.2 Error-free areas

There shall be no errors in track of address 00000 not in any header area (see 5.2.6.1). In addition, for purposes of data interchange, there shall be at least 4 000 error-free tracks on the disk pack.

TABLE 1 — **Disk track radii**[1)]

Conditions : Disk temperature : 23,0 °C (73.4 °F)
Disk speed : 2 400 rev/min

Track number : The tracks are numbered consecutively beginning at the outer edge of the recording disks. Track 202 corresponds to the track nearest the disk centre of rotation.

A Head track radius : The nominal radius in millimetres (table 1a) and in inches (table 1b) from the centre of rotation to the geometric centre of the track recorded by head Nos. 1, 2, 5, 6, 9, 10, 13, 14, 17 and 18 (see figure 6).

B Head track radius : The nominal radius from the centre of rotation to the geometric centre of the track recorded by head Nos. 0, 3, 4, 7, 8, 11, 12, 15, 16 and 19.

TABLE 1 a)

Values in millimetres

Track No.	A Head track radius	B Head track radius	Track No.	A Head track radius	B Head track radius
0	166,741 5	166,748 0	37	157,269 5	157,272 9
1	166,485 5	166,491 9	38	157,013 5	157,016 8
2	166,229 5	166,235 8	39	156,757 6	156,760 8
3	165,973 4	165,979 6	40	156,501 6	156,504 7
4	165,717 4	165,723 5	41	156,245 7	156,248 7
5	165,461 4	165,467 4	42	155,989 7	155,992 7
6	165,205 3	165,211 3	43	155,733 8	155,736 6
7	164,949 3	164,955 2	44	155,477 8	155,480 6
8	164,693 3	164,699 1	45	155,221 9	155,224 5
9	164,437 2	164,443 0	46	154,965 9	154,968 5
10	164,181 2	164,186 9	47	154,710 0	154,712 5
11	163,925 2	163,930 7	48	154,454 1	154,456 5
12	163,669 2	163,674 7	49	154,198 1	154,200 4
13	163,413 2	163,418 6	50	153,942 2	153,944 4
14	163,157 2	163,162 5	51	153,686 3	153,688 4
15	162,901 2	162,906 4	52	153,430 4	153,432 4
16	162,645 1	162,650 3	53	153,174 5	153,176 4
17	162,389 1	162,394 2	54	152,918,5	152,920 4
18	162,133 1	162,138 1	55	152,662 6	152,664 4
19	161,877 1	161,882 1	56	152,406 7	152,408 4
20	161,621 1	161,626 0	57	152,150 8	152,152 4
21	161,365 1	161,369 9	58	151,894 9	151,896 3
22	161,109 1	161,113 8	59	151,639 0	151,640 3
23	160,853 2	160,857 7	60	151,383 1	151,384 3
24	160,597 2	160,601 7	61	151,127 2	151,128 4
25	160,341 2	160,345 6	62	150,871 3	150,872 3
26	160,085 2	160,089 5	63	150,615 4	150,616 4
27	159,829 2	159,833 4	64	150,359 5	150,360 4
28	159,573 2	159,577 4	65	150,103 6	150,104 4
29	159,317 2	159,321 3	66	149,847 7	149,848 4
30	159,061 3	159,065 2	67	149,591 8	149,592 4
31	158,805 3	158,809 2	68	149,336 0	149,336 5
32	158,549 3	158,553 1	69	149,080 1	149,080 5
33	158,293 3	158,297 1	70	148,824 2	148,824 5
34	158,037 4	158,041 0	71	148,568 3	148,568 5
35	157,781 4	157,785 0	72	148,312 5	148,312 6
36	157,525 4	157,528 9	*73	148,056 6	148,056 6

1) See 5.2.3.1.

TABLE 1 a) (*continued*)

Values in millimetres

Track No.	A Head track radius	B Head track radius	Track No.	A Head track radius	B Head track radius
74	147,800 8	147,800 6	125	134,755 9	134,750 3
75	147,544 9	147,544 7	126	134,500 2	134,494 5
76	147,289 0	147,288 7	127	134,244 6	134,238 6
77	147,033 2	147,032 8	128	133,988 9	133,982 8
78	146,777 3	146,776 8	129	133,733 2	133,727 0
79	146,521 5	146,520 9	130	133,477 5	133,471 2
80	146,265 6	146,264 9	131	133,221 9	133,215 4
81	146,009 8	146,009 0	132	132,966 2	132,959 7
82	145,753 9	145,753 0	133	132,710 5	132,703 9
83	145,498 1	145,497 1	134	132,454 9	132,448 1
84	145,242 3	145,241 2	135	132,199 2	132,192 3
85	144,986 5	144,985 2	136	131,943 6	131,936 5
86	144,730 6	144,729 3	137	131,687 9	131,680 8
87	144,474 8	144,473 4	138	131,432 3	131,425 0
88	144,219 0	144,217 4	139	131,176 7	131,169 2
89	143,963 1	143,961 5	140	130,921 0	130,913 5
90	143,707 3	143,705 6	141	130,665 4	130,657 7
91	143,451 5	143,449 7	142	130,409 8	130,402 0
92	143,195 7	143,193 8	143	130,154 1	130,146 2
93	142,939 9	142,937 8	144	129,898 5	129,890 5
94	142,684 1	142,681 9	145	129,642 9	129,634 7
95	142,428 3	142,426 0	146	129,387 2	129,379 0
96	142,172 5	142,170 1	147	129,131 7	129,123 2
97	141,916 7	141,914 2	148	128,876 1	128,867 5
98	141,660 9	141,658 3	149	128,620 5	128,611 8
99	141,405 2	141,402 4	150	128,364 9	128,356 1
100	141,149 4	141,146 6	151	128,109 3	128,100 4
101	140,893 6	140,890 7	152	127,853 8	127,844 6
102	140,637 8	140,634 8	153	127,598 2	127,588 9
103	140,382 0	140,378 9	154	127,342 6	127,333 2
104	140,126 3	140,123 0	155	127,087 0	127,077 5
105	139,870 5	139,867 1	156	126,831 5	126,821 8
106	139,614 7	139,611 3	157	126,575 9	126,566 1
107	139,359 0	139,355 4	158	126,320 4	126,310 4
108	139,103 2	139,099 5	159	126,064 8	126,054 7
109	138,847 5	138,843 7	160	125,809 3	125,799 1
110	138,591 7	138,587 8	161	125,553 7	125,543 4
111	138,336 0	138,331 9	162	125,298 2	125,287 7
112	138,080 2	138,076 1	163	125,042 7	125,032 0
113	137,824 5	137,820 2	164	124,787 1	124,776 4
114	137,568 8	137,564 4	165	124,531 6	124,520 7
115	137,313 0	137,308 5	166	124,276 1	124,265 1
116	137,057 3	137,052 7	167	124,020 6	124,009 4
117	136,801 6	136,796 9	168	123,765 1	123,753 8
118	136,545 9	136,541 0	169	123,509 6	123,498 1
119	136,290 2	136,285 2	170	123,254 1	123,242 5
120	136,034 5	136,029 3	171	122,998 6	122,986 8
121	135,778 7	135,773 5	172	122,743 1	122,731 2
122	135,523 0	135,517 7	173	122,487 6	122,475 6
123	135,266 1	135,261 9	174	122,232 1	122,220 0
124	135,011 6	135,006 1	175	121,976 6	121,964 3

TABLE 1a) (*concluded*)

Values in millimetres

Track No.	A Head track radius	B Head track radius
176	121,721 2	121,708 7
177	121,465 7	121,453 1
178	121,210 3	121,197 5
179	120,954 8	120,941 0
180	120,699 4	120,686 3
181	120,443 9	120,430 7
182	120,188 5	120,175 2
183	119,933 1	119,919 6
184	119,677 6	119,664 0
185	119,422 2	119,408 4
186	119,166 8	119,152 9
187	118,911 4	118,897 3
188	118,656 0	118,641 7
189	118,400 6	118,386 2
190	118,145 2	118,130 6
191	117,889 8	117,875 1
192	117,634 5	117,619 6
193	117,379 1	117,364 0
194	117,123 7	117,108 5
195	116,868 4	116,853 0
196	116,613 0	116,597 5
197	116,357 7	116,342 0
198	116,102 3	116,086 4
199	115,847 0	115,830 9
200	115,591 6	115,575 4
201	115,336 3	115,320 0
202	115,081 0	115,064 5

TABLE 1b)

Values in inches

Track No.	A Head track radius	B Head track radius	Track No.	A Head track radius	B Head track radius
0	6.564 63	6.564 88	51	6.050 64	6.050 72
1	6.554 55	6.554 80	52	6.040 57	6,040 65
2	6.544 47	6.544 72	53	6.030 49	6.030 57
3	6.534 39	6.534 63	54	6.020 42	6.020 49
4	6.524 31	6.524 55	55	6.010 34	6.010 41
5	6.514 23	6.514 47	56	6.000 26	6.000 33
6	6.504 15	6.504 38	57	5.990 19	5.990 25
7	6.494 07	6.494 30	58	5.930 11	5.980 17
8	6.483 99	6.484 22	59	5.970 04	5.970 09
9	6.473 91	6 474 13	60	5.959 96	5.960 01
10	6.463 83	6.464 05	61	5.949 89	5.949 94
11	6.453 75	6.453 97	62	5.939 81	5.939 86
12	6.443 67	6.443 89	63	5.929 74	5.929 78
13	6.433 59	6.433 80	64	5.919 67	5.919 80
14	6.423 51	6.423 72	65	5.909 59	5.909 62
15	6.413 43	6.413 64	66	5.899 52	5.899 54
16	6.403 35	6.403 56	67	5.889 44	5.889 47
17	6.393 27	6.393 47	68	5.879 37	5.879 39
18	6.383 19	6.383 39	69	5.869 30	5.869 31
19	6.373 12	6.373 31	70	5.859 22	5.859 23
20	6 363 04	6.363 23	71	5.849 15	5.849 16
21	6.352 96	6.353 15	72	5.839 07	5.839 08
22	6.342 88	6.343 06	*73	5.829 00	5.829 00
23	6.332 80	6.332 98	74	5.818 93	5.818 92
24	6.322 72	6.322 90	75	5.808 85	5.808 85
25	6.312 64	6.312 82	76	5.798 78	5.798 77
26	6.302 57	6.302 74	77	5.788 71	5.788 69
27	6.292 49	6.292 66	78	5.778 63	5.778 62
28	6.282 41	6.282 57	79	5.768 56	5.768 54
29	6 272 33	6.272 49	80	5.758 49	5.758 46
30	6.262 25	6.262 41	81	5.748 42	5.748 39
31	6.252 18	6.252 33	82	5.738 34	5.738 31
32	6.242 10	6.242 25	83	5.728 27	5.728 23
33	6.232 02	6.232 17	84	5.718 20	5.718 16
34	6.221 94	6.222 09	85	5.708 13	5.708 08
35	6.211 87	6.212 01	86	5.698 06	5.698 00
36	6.201 79	6.201 93	87	5.687 98	5.687 93
37	6.191 71	6.191 85	88	5.677 91	5.677 85
38	6.181 64	6.181 76	89	5.667 84	5.667 78
39	6.171 56	6.171 68	90	5.657 77	5.657 70
40	6.161 48	6.161 60	91	5.647 70	5.647 63
41	6.151 40	6.151 52	92	5.637 63	5.637 55
42	6.141 33	6.141 44	93	5.627 56	5.627 47
43	6.131 25	6.131 36	94	5.617 49	5.617 40
44	6.121 17	6.121 28	95	5.607 41	5.607 32
45	6.111 10	6.111 20	96	5.597 34	5.597 25
46	6.101 02	6.101 12	97	5.587 27	5.587 17
47	6.090 95	6.091 04	98	5.577 20	5.577 10
48	6.080 87	6.080 96	99	5.567 13	5.567 03
49	6.070 79	6.070 88	100	5.557 06	5.556 95
50	6.060 72	6.060 80	101	5.546 99	5.546 88

TABLE 1 b) (*concluded*)

Values in inches

Track No.	A Head track radius	B Head track radius	Track No.	A Head track radius	B Head track radius
102	5.536 92	5.536 80	153	5.023 55	5.023 19
103	5.526 85	5.526 73	154	5.013 49	5.013 12
104	5.516 78	5.516 65	155	5.003 43	5.003 05
105	5.506 71	5.506 58	156	4.993 36	4.992 99
106	5.496 64	5.496 51	157	4.983 30	4.982 92
107	5.486 57	5.486 43	158	4.973 24	4.972 85
108	5.476 51	5.476 36	159	4.963 18	4.962 79
109	5.466 44	5.466 29	160	4.953 12	4.952 72
110	5.456 37	5.456 21	161	4.943 06	4.942 65
111	5.446 30	5.446 14	162	4.933 00	4.932 59
112	5.436 23	5.436 07	163	4.922 94	4.922 52
113	5.426 16	5.425 99	164	4.912 88	4.912 46
114	5.416 09	5.415 92	165	4.902 82	4.902 39
115	5.406 03	5.405 85	166	4.892 76	4.892 33
116	5.395 96	5.395 78	167	4.882 70	4.882 26
117	5.385 89	5.385 70	168	4.872 64	4.872 20
118	5.375 82	5.375 63	169	4.862 58	4.862 13
119	5.365 75	5.365 56	170	4.852 52	4.852 07
120	5.355 69	5.355 49	171	4.842 46	4.842 00
121	5.345 62	5.345 41	172	4.832 41	4.831 94
122	5.335 55	5.335 34	173	4.822 35	4.821 87
123	5.325 49	5.323 27	174	4.812 29	4.811 81
124	5.315 42	5.315 20	175	4.802 23	4.801 75
125	5.305 35	5.305 13	176	4.792 17	4.791 68
126	5.295 29	5.295 06	177	4.782 12	4.781 62
127	5.285 22	5.284 96	178	4.772 06	4.771 56
128	5.275 15	5.274 92	179	4.762 00	4.761 49
129	6.265 09	5.264 84	180	4.751 94	4.751 43
130	5.255 02	5.254 77	181	4.741 89	4.741 37
131	5.244 96	5.244 70	182	4.731 83	4.731 30
132	5.234 89	5.234 63	183	4.721 77	4.721 24
133	5.224 82	5.224 56	184	4.711 72	4.711 18
134	5.214 76	5.214 49	185	4.701 66	4.701 12
135	5.204 69	5.204 42	186	4.691 61	4.691 06
136	5.194 63	5.194 35	187	4.681 55	4.681 00
137	5.184 56	5.184 28	188	4.671 50	4.670 93
138	5.174 50	5.174 21	189	4.661 44	4.660 87
139	5.164 44	5.164 14	190	4.651 39	4.650 81
140	5.154 37	5.154 07	191	4.641 33	4.640 75
141	5.144 31	5.144 00	192	4.631 28	4.630 69
142	5.134 24	5.133 94	193	4.621 28	4.620 63
143	5.124 17	5.123 87	194	4.611 17	4.610 57
144	5.144 12	5.113 80	195	4,601 12	4.600 51
145	5.104 05	5.103 73	196	4.591 06	4.590 45
146	5.093 98	5.093 66	197	4.581 01	4.580 39
147	5.083 93	5.083 59	198	4.570 96	4.570 33
148	5.073 86	5.073 52	199	4.560 90	4.560 27
149	5.063 80	5.063 46	200	4.550 85	4.550 21
150	5.053 74	5.053 39	201	4.540 80	4.540 16
151	5.043 67	5.043 32	202	4.530 75	4.530 10
152	5.033 61	5.033 25			

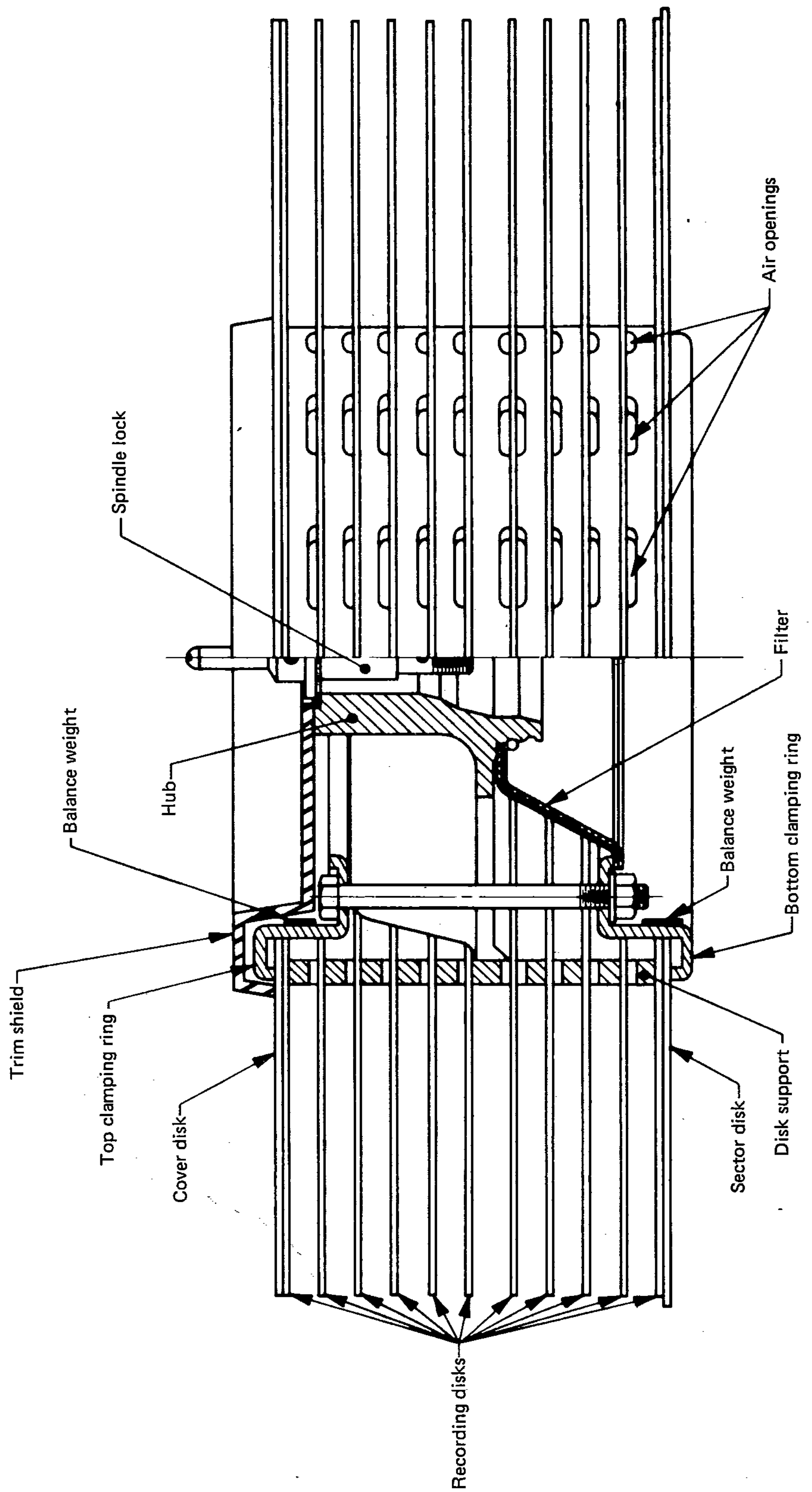


FIGURE 1 — Disk pack without covers, partially in vertical cross-section

3564-76 4851903 0026410 8

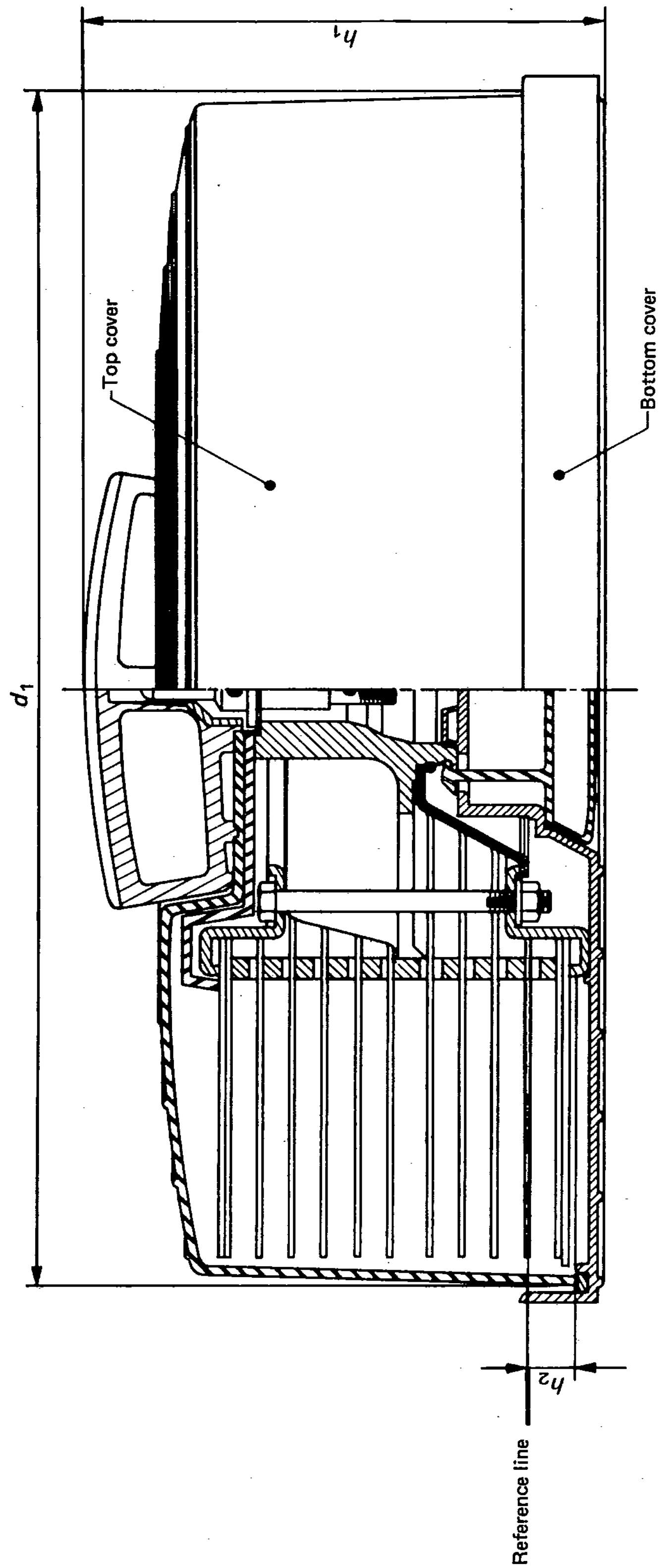
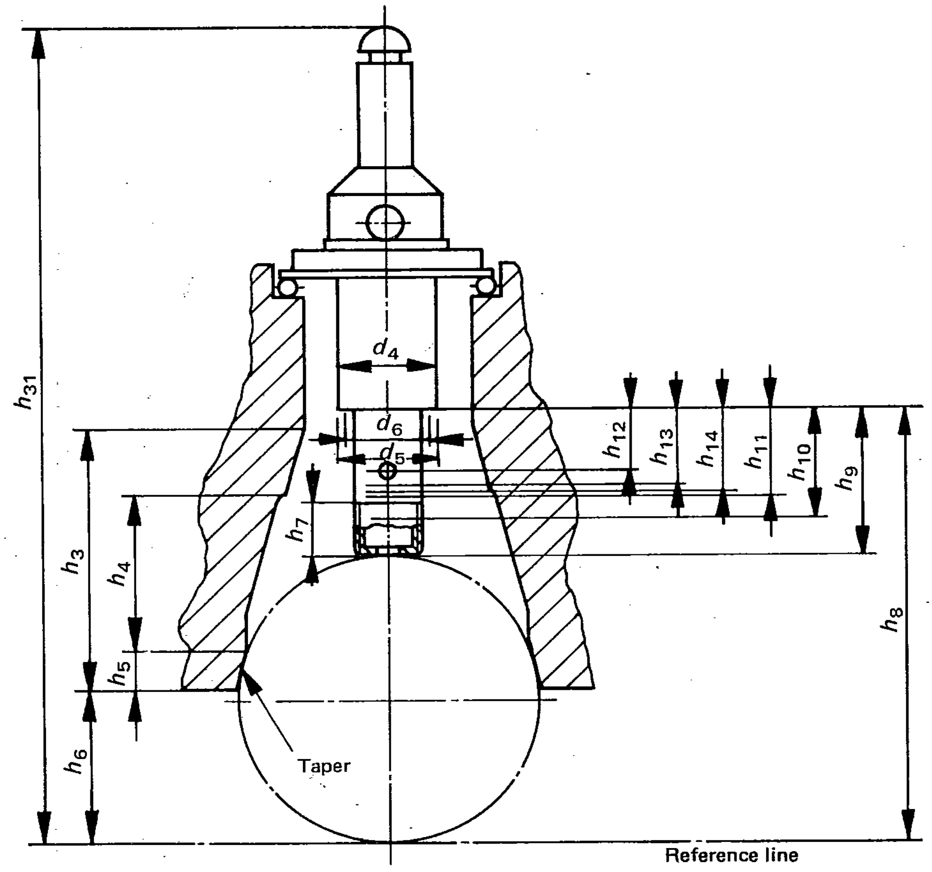


FIGURE 2 – Disk pack with top and bottom cover, partially in vertical cross-section



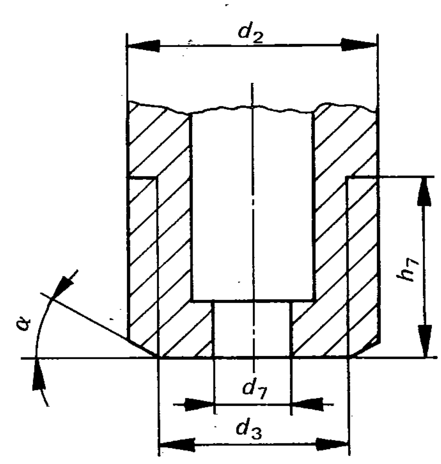


FIGURE 3 — **Simplified cross-section of the hub**

3564-76 4851903 0026412 1

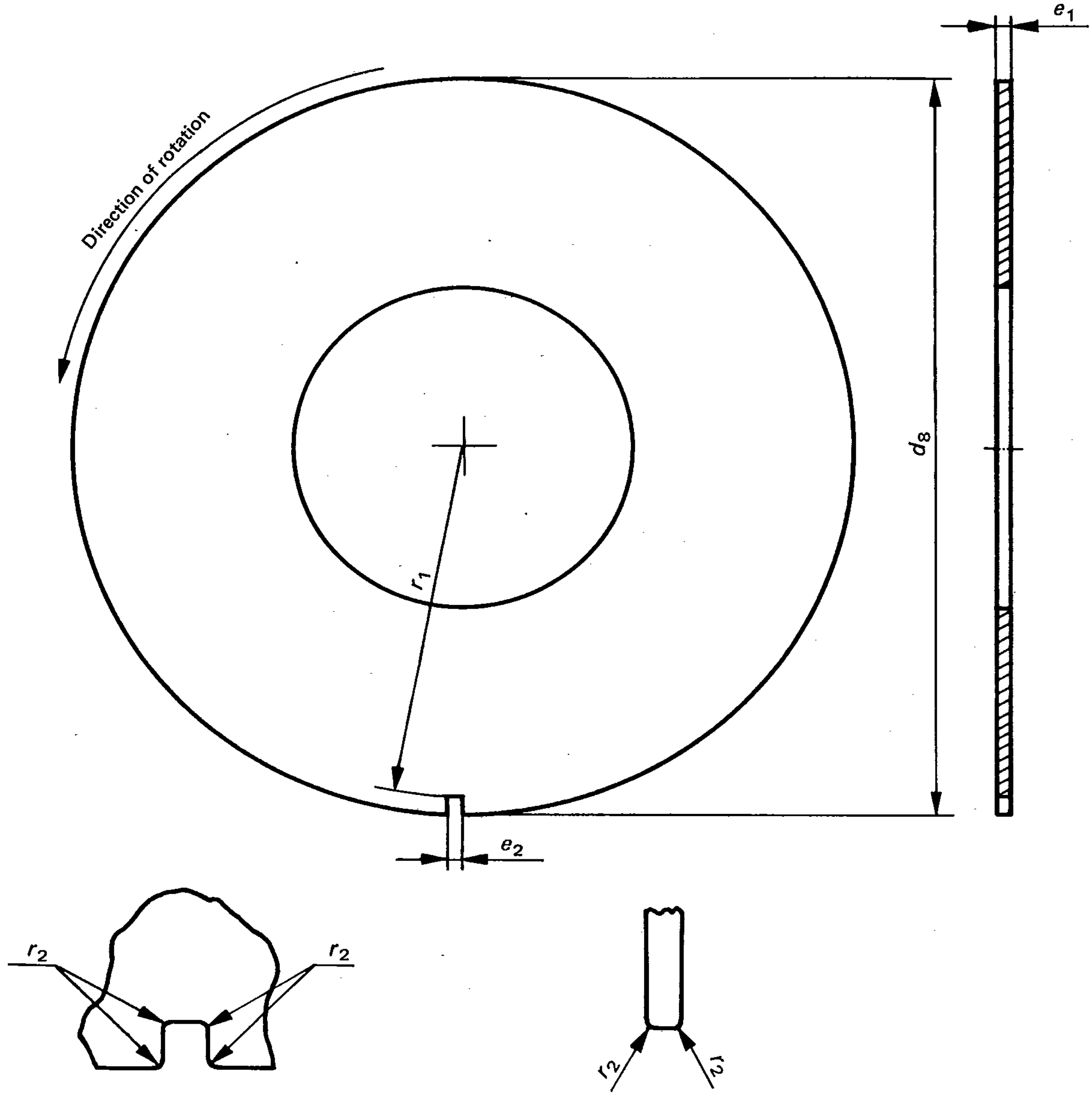


FIGURE 4 — Index disk (top view)

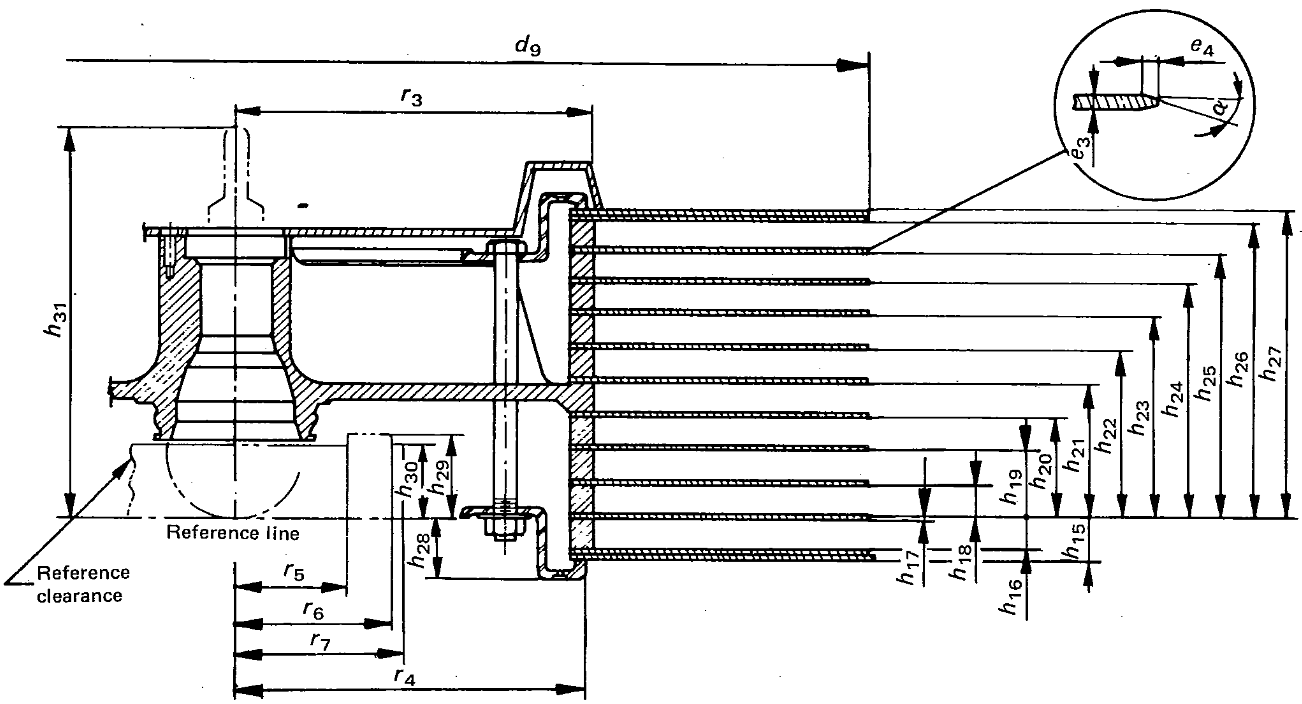


FIGURE 5 — **Enlarged, partial and simplified cross-section of the disk pack**

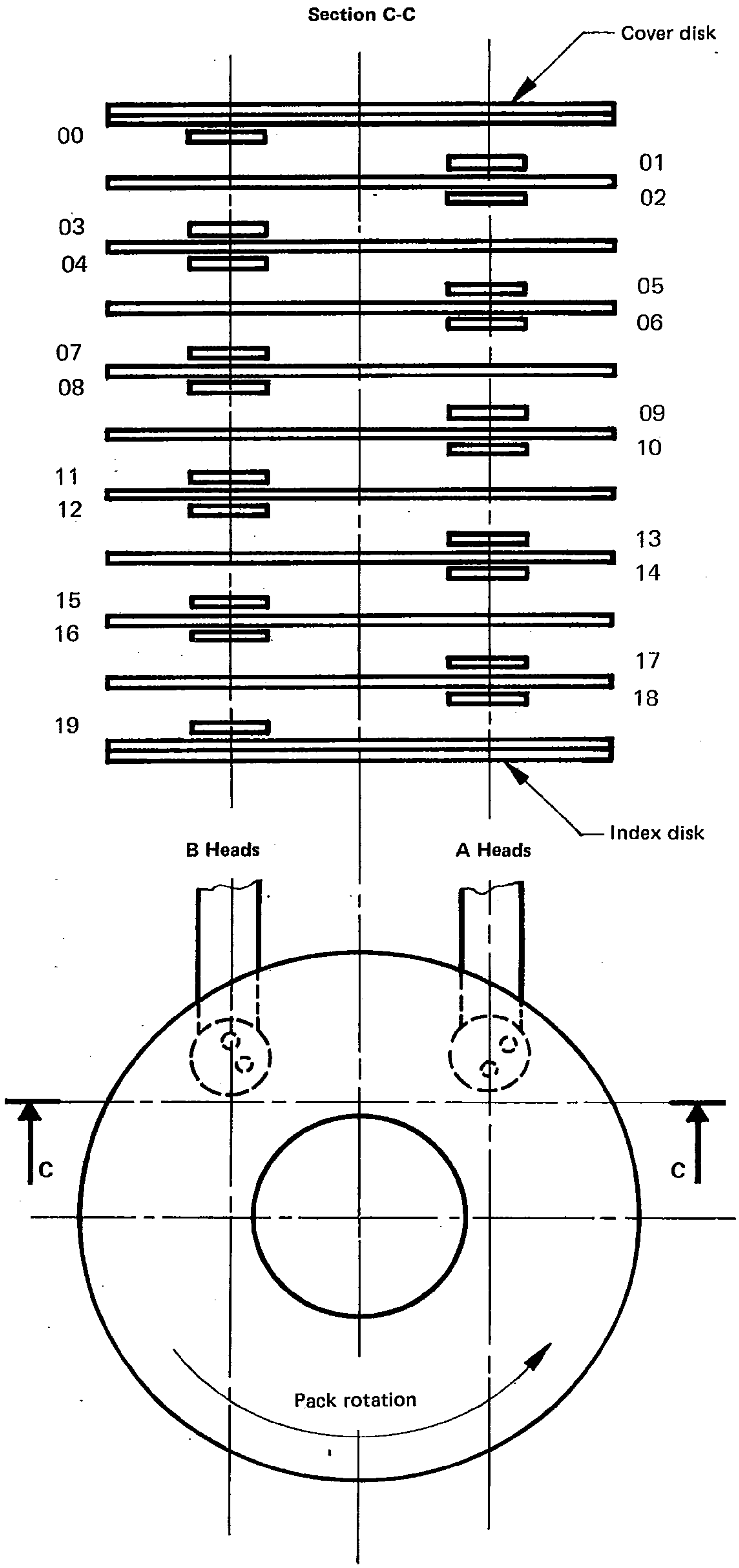


FIGURE 6 — Disk rotation and designations of disk surfaces and heads

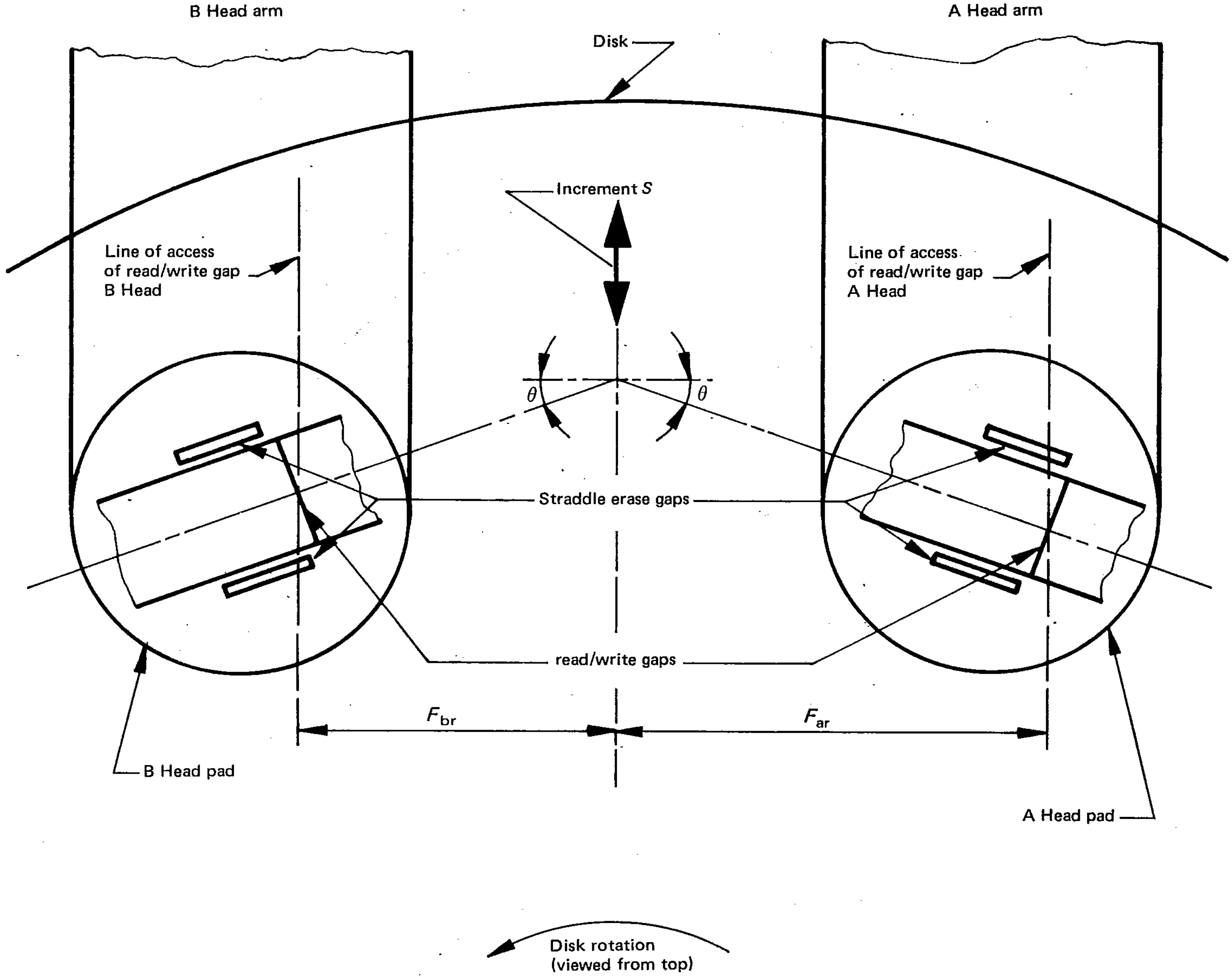


FIGURE 7 — **Geometry of head disk system**

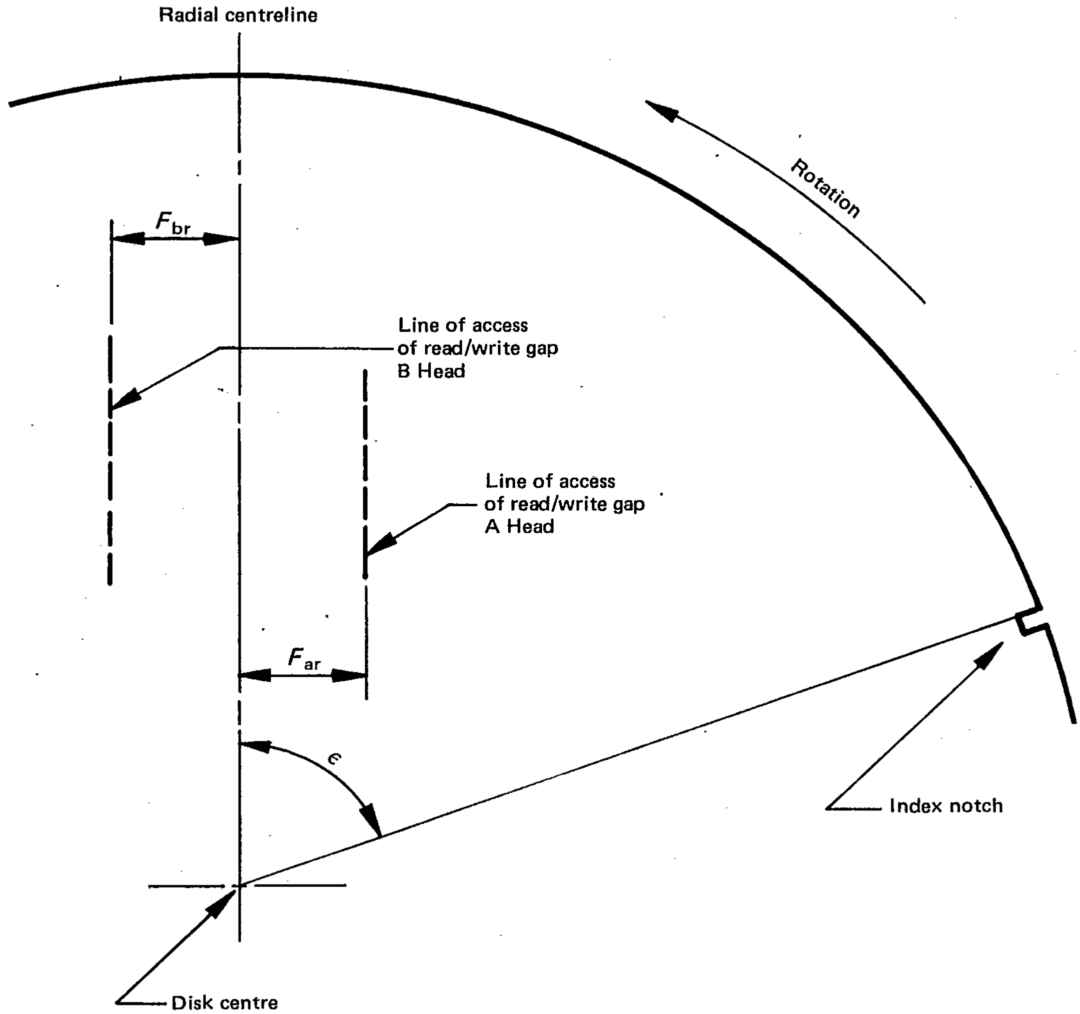


FIGURE 8 – **Top view on the index disk**

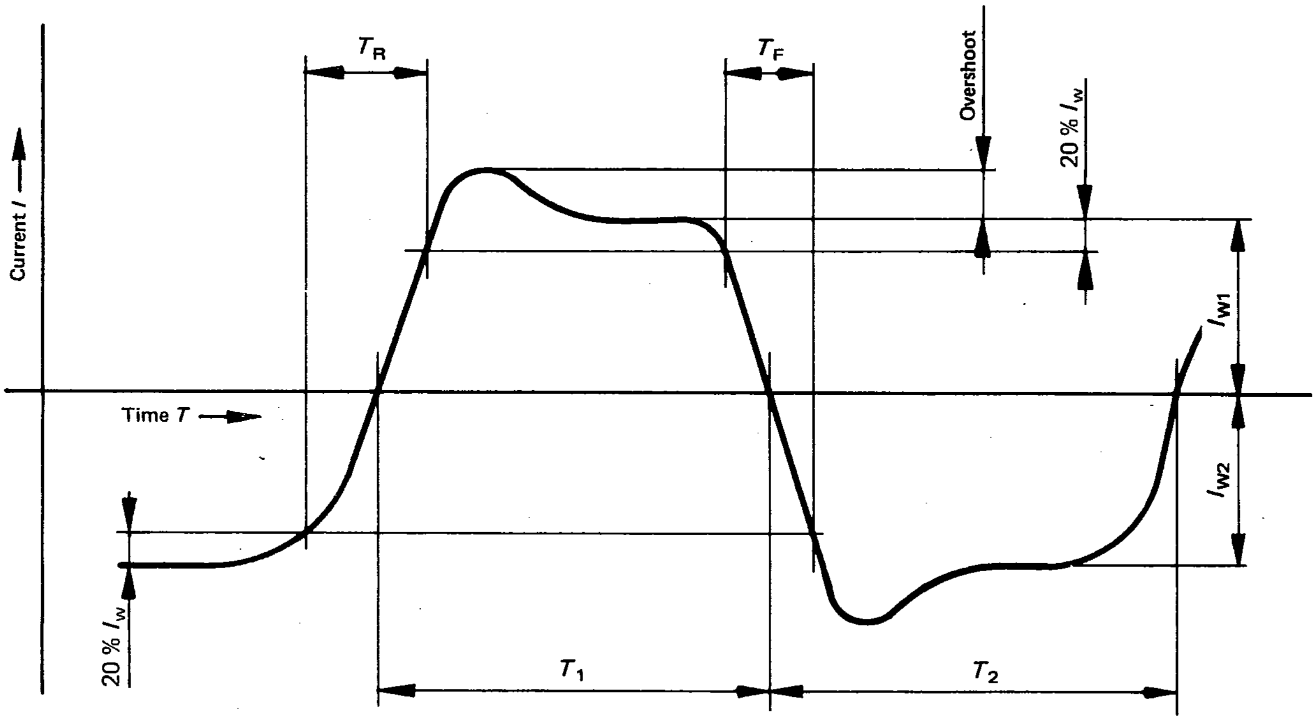


FIGURE 9 — Write current waveform

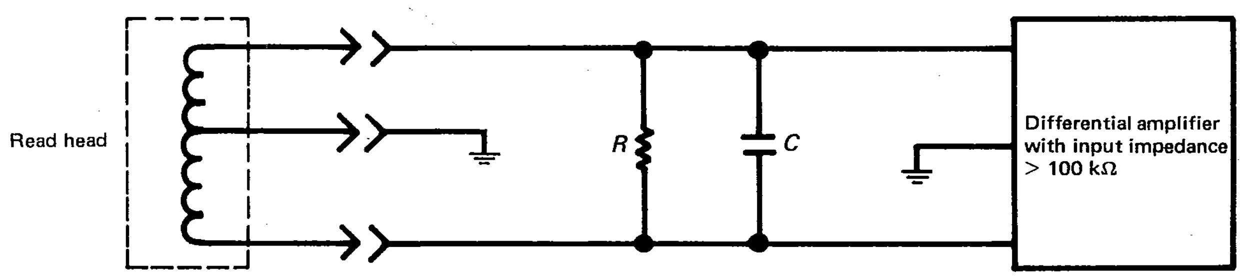


FIGURE 10 — Read circuit

ANNEX A

(Not part of the standard)

ACCELERATED STORAGE LIFE TEST[1]

The disk pack shall be magnetically recorded on all track locations. The disk pack shall then be placed in a temperature- and humidity-controlled chamber, with covers removed, and subjected to a cyclic test where the temperature is varied from − 40 °C to + 65 °C (− 40 °F to + 150 °F) and where the relative humidity does not exceed 80 % at any point. The rate of change of the temperature shall not exceed 15 °C/h (27 °F/h) with a 4 h holding period at each temperature extreme.

One full cycle to be completed every 24 h time period. On the completion of five cycles the disk pack shall be removed from the chamber, then conditioned in the testing environment for 24 h, following which the recorded data will be read back. All recorded data shall be successfully recovered.

NOTE — Distilled water or mineral- and chlorine-free water should be used in the humidifier of the temperature- and humidity-controlled chamber.

ANNEX B

(Not part of the standard)

VIBRATION AND SHOCK[2]

B.1 VIBRATION – METHOD 1

The disk pack with covers shall be attached to the vibrating table with two tie-down straps, each 10 mm (0.375 in) diameter shock cord or suitable equivalent. The straps shall pass through the disk pack handle and the attachment of the four strap ends to the vibrating table shall be from a 87 cm^2 (13.5 in^2) pattern. The resulting total tie-down force (perpendicular to the disk surfaces) shall be 200 ± 20 N (45 ± 5 lbf). The assembly shall be subjected to simple harmonic motion having a constant peak-to-peak displacement of 2,5 mm (0.1 in) ± 10 % in the frequency range from 5 to 20 Hz, and a constant peak acceleration amplitude of twice the acceleration of free fall ± 10 % in the frequency range from 20 to 1 000 Hz. The frequency shall be varied cyclically at a logarithmic rate and the entire frequency range of 5 to 1 000 Hz being traversed in 5 min ± 10 %. Testing shall continue for 2 h with direction of motion perpendicular to the disk surfaces and for an additional 2 h with direction of motion parallel to the disk surfaces.

B.2 VIBRATION – METHOD 2

The disk pack with covers shall be subjected to simple harmonic motion having a constant amplitude (zero-to-peak displacement) of 0,15 mm (0.06 in) ± 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 from 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 h with direction of motion perpendicular to the surfaces and for an additional 2 h with direction of motion parallel to the disk surfaces.

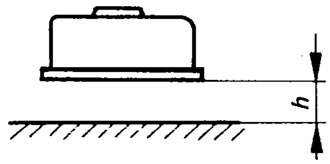
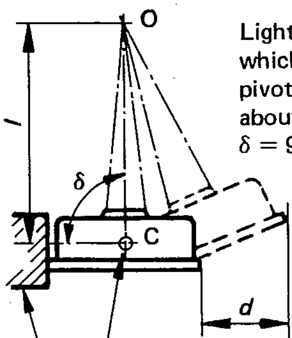
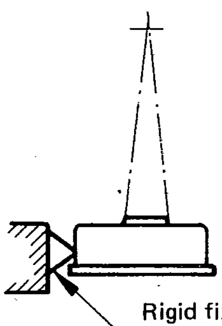
For test method see IEC Publication 80-2-6, *Basic environmental testing procedures for electronic components and electronic equipment, Part 2 : Tests — Test F : Vibration.*

B.3 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).

1) See 3.1.2.2.

2) See 3.2.

Test	Schematic	With top and bottom covers on 1)	With bottom cover removed 1)
a) Free fall	 Hard smooth rigid surface (such as concrete floor)	h = 100 mm (4 in)	h = 60 mm (2.5 in)
b) Side impact (flat surface)	 Lightweight rigid suspension which rotates freely about pivot O but prevents rotation about axis O-C and maintains $\delta = 90°$ Pack centre of gravity Fixed rigid flat impact surface 2)	l = 760 mm (30 in) d = 200 mm (8 in)	d = 150 mm (6 in)
c) Side impact (sharp corner)	 Same test set up as above Rigid fixed square-based pyramid having 90° apex with a radius of 1,6 ± 0,1 mm 2) (0.062 5 ± 0.004 in)	d = 150 mm (6 in) Impact against edge of 7th data disk from top (i.e. data surfaces 11 and 12)	d = 125 mm (5 in) Impact against edge of bottom index disk

1) Tolerance on dimensions is ± 3 mm (0.125 in).

2) Use of massive steel or aluminium impact elements is recommended.

ANNEX C

(Not part of the standard)

DYNAMIC DIMENSIONAL DISK CHARACTERISTICS AND MOMENT OF INERTIA[1)]

C.1 INTRODUCTION

The purpose of this International Standard is to provide the minimum requirements to achieve the interchangeability of unrecorded eleven-disk packs among information processing systems utilizing similar type disk drives, and provide the basis to support data interchange among such systems. This does not imply that all disk packs to be used for data interchange must be individually tested for compliance with each individual requirement prior to use. It is the responsibility of the manufacturer of the disk packs and subsequently of the users to determine the extent and frequency of testing necessary to ensure compliance with this International Standard.

C.2 MEASUREMENT

C.2.1 Dynamic dimensional disk characteristics

The disk axial dynamic deflection signal used for determining dynamic dimensional disk characteristics shall be developed using non-contact dimensional gauging probes or systems having a bandwidth at least five times cut-off frequency for the acceleration tests (i.e. 1,5 kHz). The basic not-contact measurement system, working over a displacement range of plus and minus 0,5 mm (0.02 in) (corresponding to the maximum allowable deviation from datum due to stacking and dynamic deflection surface errors) shall be capable of being operated in a manner such that the error of the system does not exceed ± 0,2 % of this full deviation over the whole 1 mm (0.04 in) operating range. Further, the equipment used shall not be significantly affected by normal differences in disk alloy, hardness, or grain direction. The equipment used should look substantially at the surface of the coating on the disk, and should have an active area of not more than 1/3 the slider diameter.

C.2.1.1 *Position limits of disk surfaces*

A recommended test arrangement for determining the position limits of disk surfaces is shown in figure 11. The non-contact probe system used for measuring dynamic characteristics is first zeroed on the datum reference stack (position A) and the probe then inserted into the pack to survey that surface. The positive and negative peak deviations from the zero established when the probe is looking at the datum reference stack surface are now measured and determined to be less than the tolerance on deviation from stacking dimension for the disk surface being tested. (See dimensions h_{15} to h_{27}, figure 5.)

C.2.1.2 *Axial runout of disks*

This measurement should be made with the same basic arrangement shown in figure 11. In this case however, the TIR should be measured. Refer to figure 12. The TIR is shown in the upper (displacement) curve. The TIR is the peak-to-peak displacement for a complete disk revolution.

C.2.1.3 *Acceleration (second derivation) of axial runout*

The arrangement of figure 11 should again be used for developing the displacement signal from which the acceleration measurement is derived. A suggested circuit arrangement for deriving the acceleration from the displacement signal is shown in figure 13. The bandwidth of the signal processing electronics between the actual measuring probe and the input to the active filter which conditions the acceleration to derive a signal representative of the head-to-disk spacing change should be at least five times the active filter cut-off frequency. The low frequency cut-off frequency for this system should be at no higher than 400 Hz with attenuation below this frequency no greater than 10 dB/octave.

Referring to figure 12, the lower (acceleration) curve, interpretation of the acceleration specification is that both the positive and negative peak values of acceleration shall be as specified in B.1. These measurements are as shown in figure 12, that is they are peak values from the base line or zero acceleration level, determined when the probe is measuring a surface which is experiencing no acceleration (as when the disk is at rest).

1) See 4.1.11.1, 4.1.11.2, 4.1.11.3 and 4.2.

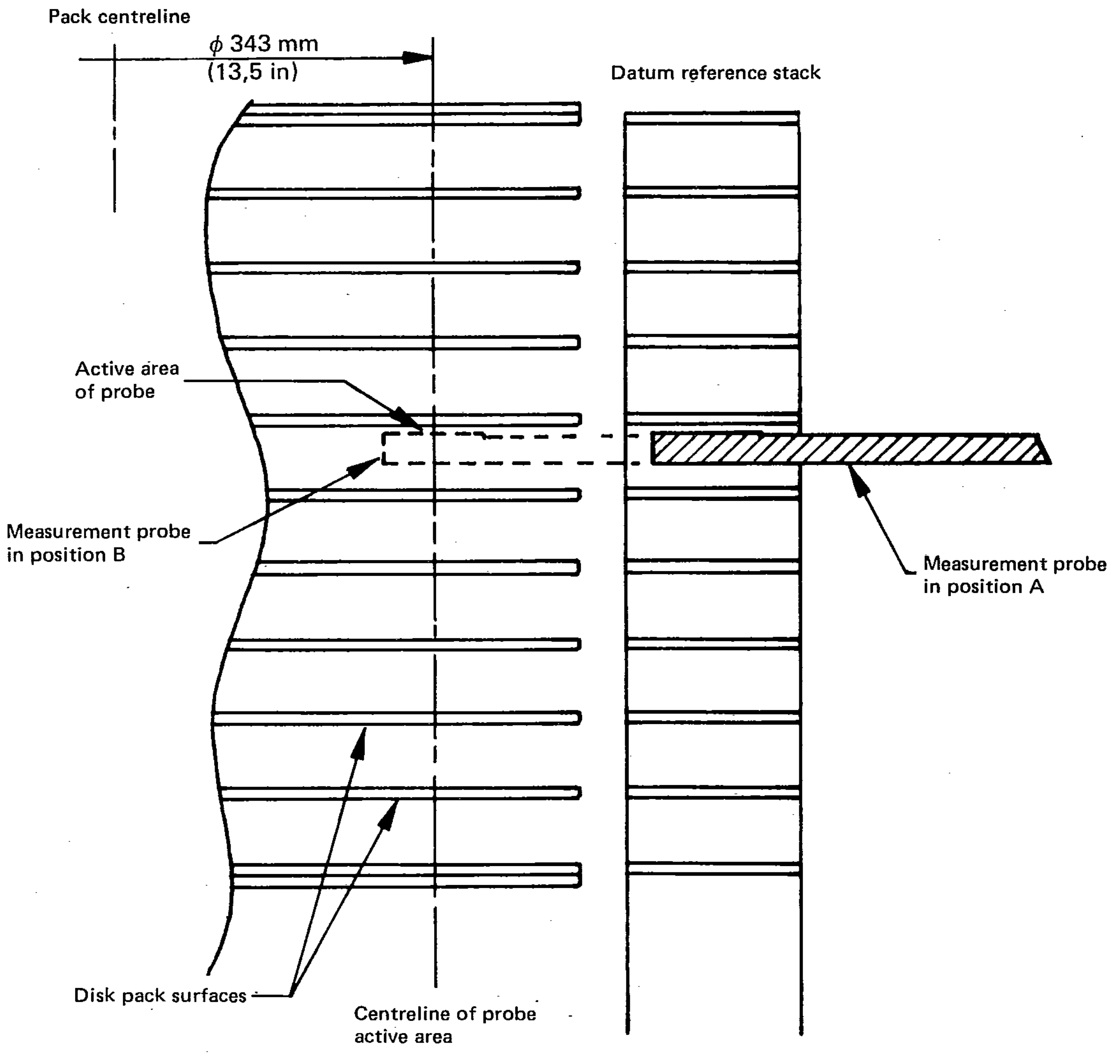


FIGURE 11 — **Position limits of disk surfaces**

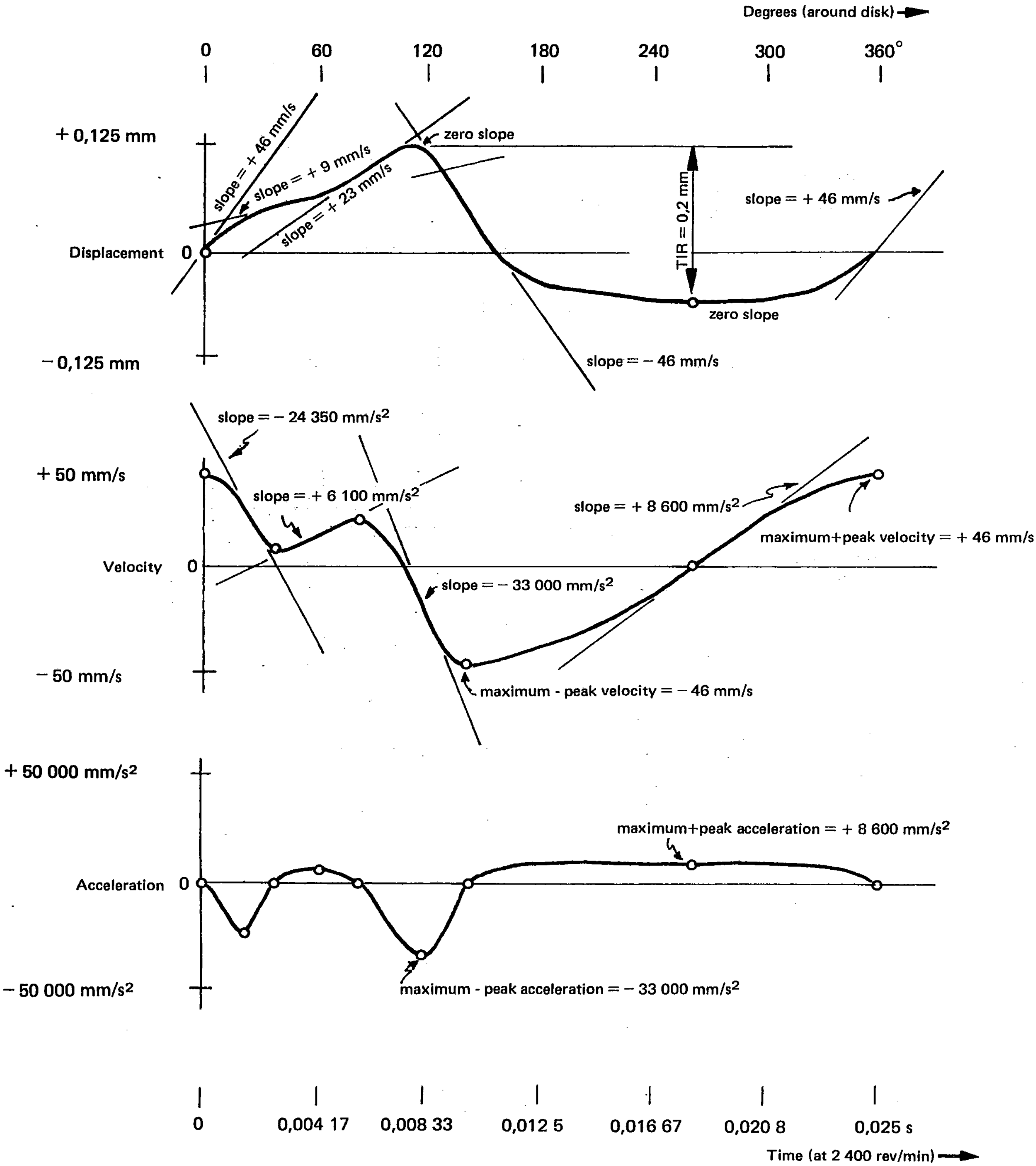


FIGURE 24 — **Displacement, velocity, acceleration** (millimetre values)

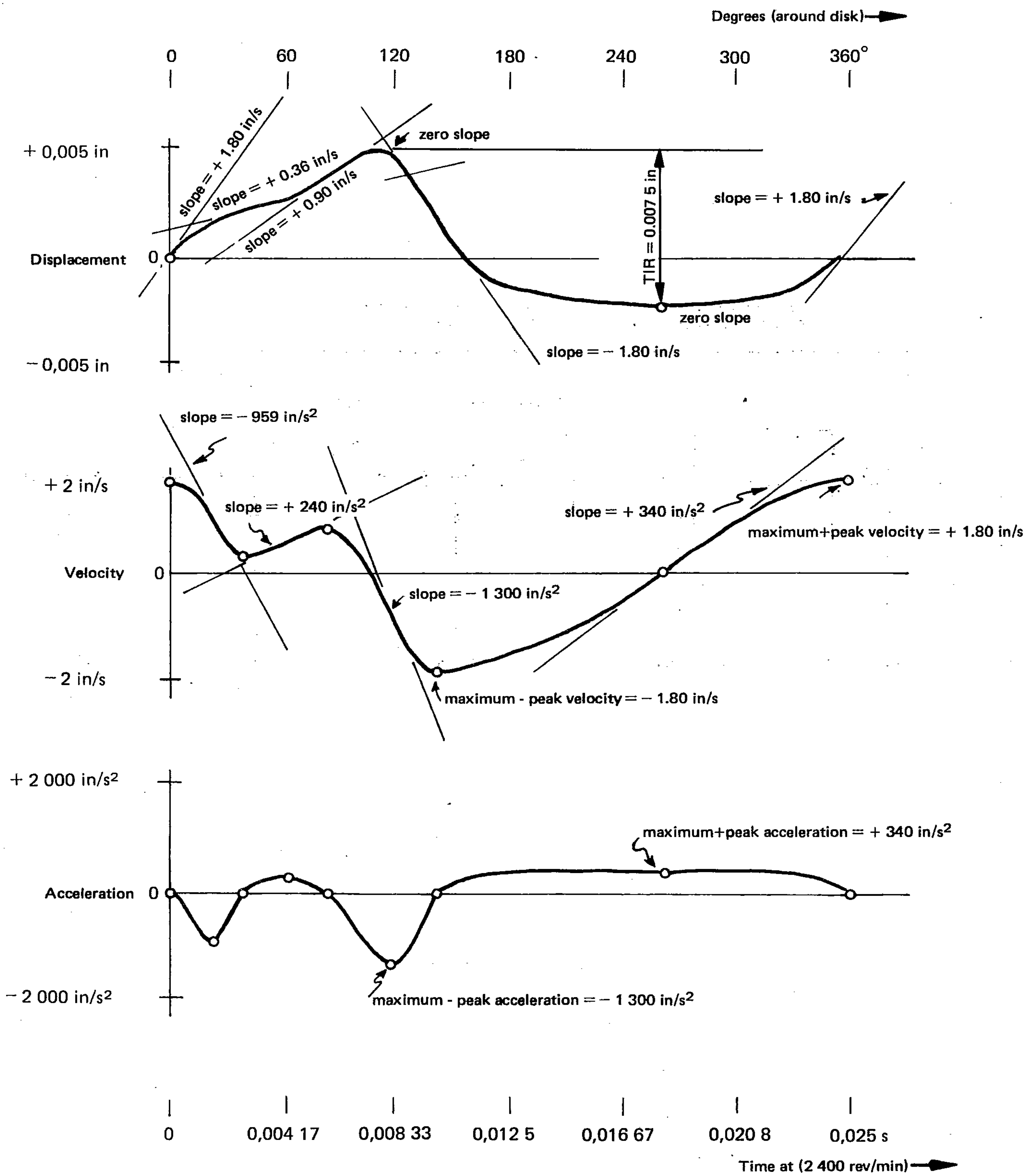


FIGURE 12b — **Displacement, velocity, acceleration** (inch values)

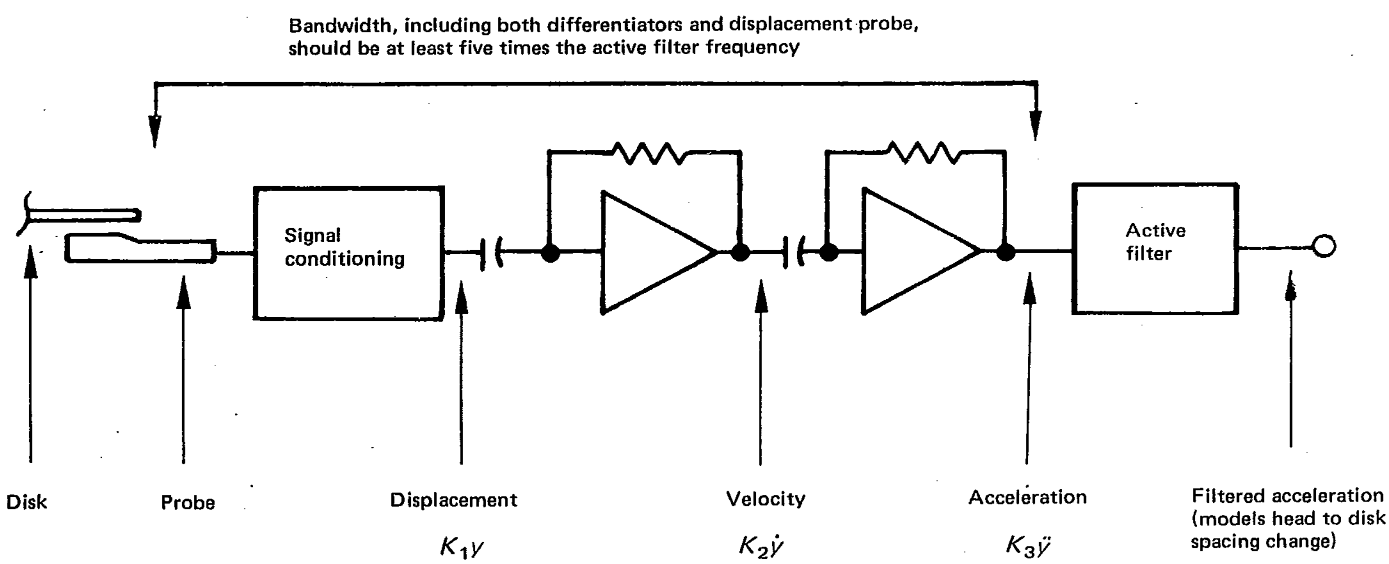


FIGURE 13 — **Circuit arrangement**

C.2.2 Moment of inertia

The disk pack, without covers, is suspended by two cords as shown in figure 14, oscillation is started by rotating the pack not more than 45° from the rest position. At a convenient point during the oscillation, begin timing until 100 oscillations have been completed.

One oscillation is defined as the time required for the pack to rotate one complete cycle from the starting point until it reaches the starting point again while rotating in the same direction. The moment of inertia is then determined from the following expression :

$$J = \frac{mgD^2T^2}{16\pi^2 L}$$

where

- J is the moment of inertia ($kg \cdot m^2$ or $lb \cdot in^2$);
- m is the mass (kg or lb);
- g is the acceleration of free fall (m/s^2 or in/s^2);
- D is the distance between cords (m or in);
- T is the time for one complete oscillation (s);
- L is the length of the cords (m or in) ($L \geqslant 3\,D$).

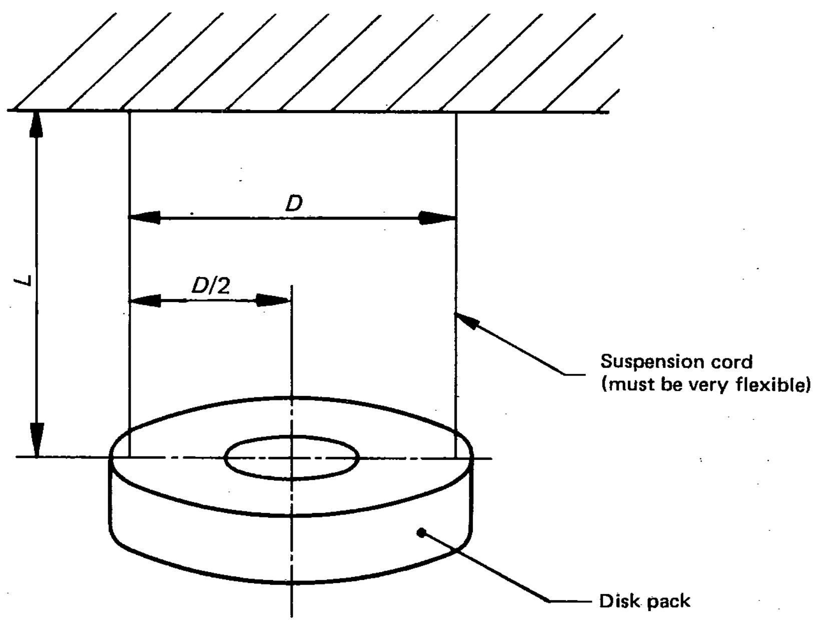


FIGURE 14 — **Moment of inertia measurement**

ANNEX D

(Not part of the standard)

COATING ADHESION AND ABRASIVE WEAR RESISTANCE[1)]

D.1 COATING ADHESION

The adhesion of the magnetic coating to the applicable disk substrates shall be maintained as determined by either of the following tests and associated requirements.

D.1.1 Test of aluminium substrates

D.1.1.1 *Criterion*

The adhesion of the coating to the substrate should be maintained following bending around the 25,4 ± 3,2 mm (1.0 ± 0.125 in) 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.

D.1.1.2 *Equipment and materials*

a) Conical mandrel tester (ASTM D 522-60).

b) Number 1 brown kraft wrapping paper, substance 30, lubricated with talc (see ASTM D 522-60).

c) Pressure-sensitive tape (3 M Company No. 202 masking tape or equivalent).

D.1.1.3 *Test sample*

The test sample shall be as shown in figure 15;

$$a = 119{,}4 \pm 5{,}1 \text{ mm } (4.7 \pm 0.2 \text{ in}).$$

D.1.1.4 *Procedure*

a) Clean the sample with isopropyl alcohol.

b) Mount the sample in the conical mandrel tester as shown in figure 15;

$$b = 25 \pm 2{,}5 \text{ mm } (1 \pm 0.1 \text{ in}).$$

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

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

e) Wipe the 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 (0.25 in) wide strip of pressure-sensitive tape to the upper surface as shown in figure 15.

g) Peel the tape at an angle of 90° and a rate of approximately 25 mm/s (1 in/s). The peel force should be 3,0 ± 0,5 N (300 ± 50 gf) on unbent samples if the tape was properly applied.

h) Examine for coating removal.

1) See 4.10.3.2 and 4.10.3.3.

D.1.2 Test of glass substrates

D.1.2.1 *Criterion*

The adhesion of the magnetic coating to glass substrate shall be determined by measuring the removal force with a knife edge. The instrument which shall be used for this measurement is the Hesiometer[1], or an equivalent knife cutting instrument. The adhesion of the coating is adequate if the removal force exceeds 5,5 N (560 gf) for a 5 μm (200 μin) thick coating and 8,3 N (850 gf) for a 7,5 μm (300 μin) thick coating.

For coatings of other thicknesses, the minimum acceptable removal force shall be determined by linear interpolation or extrapolation from the two given points.

D.1.2.2 *Equipment and materials*

Hesiometer, equipped with a knife 7,9 mm (0.312 in) long with radius of curvature at the cutting edge of less than 1 μm (40 μin). The cutting edge shall form a straight line, with the deviations from this line not to exceed 1 μm (40 μin).

D.1.2.3 *Procedure*

The test procedure shall follow the manufacturer's manual for using the Hesiometer.

a) Clean the disk surface with isopropyl alcohol as described in 4.10.2.1.

b) Record the steady state value of the coating removal over a minimum of 25 mm (1 in).

c) Determine the thickness of the coating in the test area with the minimum accuracy of ± 10 %.

D.2 ABRASIVE WEAR RESISTANCE

D.2.1 Criterion

Coating wear in the modified Taber Abraser[2] test shall be less than 0,000 6 mm^2 (10^{-6} in^2) of cross-sectional area in a test performed with the equivalent of a 6 μm silicon carbide abrasive.

D.2.2 Equipment and materials

a) Taber Abraser[2] wear tester, model 503 or equivalent. Abrasive mounting wheel positioned to provide a 66,55 mm (2.62 in) diameter wear scar (see figure 16).

b) Thin double-backed tape (Scotch[3] double-stick tape, 3M Company catalog No. 136 or equivalent).

c) Silicon carbide-coated abrasives of approximately 3 and 8 μm particle size (Charles Pfizer Company silicon carbide Ultralap[4] abrasive on 0,073 mm (0.003 in) polyester backing or equivalent).

d) Acrylic plastic sheet of 1,27 mm (0.05 in) thickness (Rohm and Haas Company grade G Plexiglas[5] or equivalent).

e) Profilometer having a 0,002 5 mm (0.000 1 in) radius stylus.

D.2.3 Test sample

The test sample shall be as shown in figure 16.

1) Manufactured by Gardner Laboratory (Bethesda, Maryland, U.S.A.).

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

3) Trademark of 3M Company, 3M Center, St. Paul, Minn.

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

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

D.2.4 Procedure

a) Fasten a strip of new abrasive to the periphery of the mounting wheel with double-backed tape. The strip should be 3,2 to 4,8 mm (1/8 to 3/16 in) wide and firmly attached with a minimum amount of tension. The ends must not overlap but should have less than 0,8 mm (1/32 in) 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.

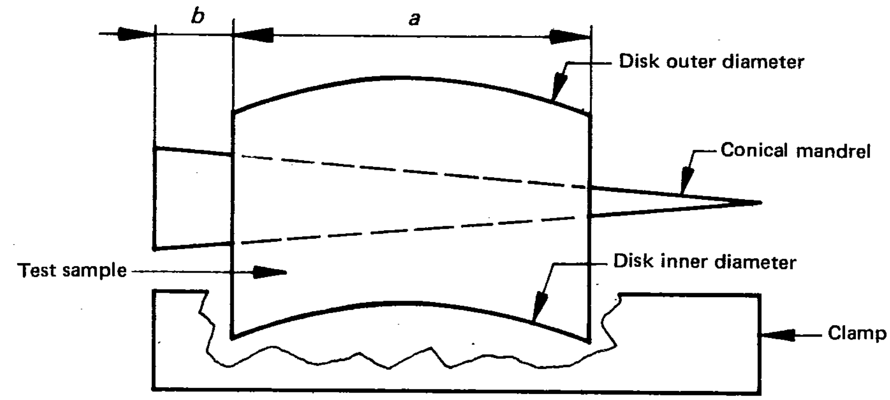
c) Abrade samples with the nominal 3 and 8 μm silicon carbide abrasives. The test should be performed using a 440 g total load (wheel plus arm) and 50 revolutions of the sample.

d) Record the profile of the wear scar at the eight locations shown in figure 16. The cross-sectional area of the profilometer trace of the wear scar may be determined after drawing a straight line representing the unworn surface.

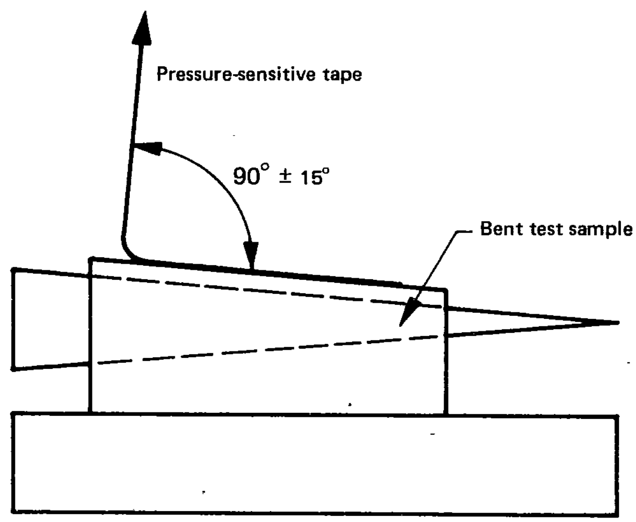
The nominal 3 and 8 μm abrasives will be calibrated by means of tests employing acrylic plastic samples. The measured wear values will be used to determine the equivalent standard particle size by referring to the calibration curve in figure 17. (An example is also shown in the figure.) In subsequent tests of actual coatings the wear values are then plotted versus the standard particle size. The wear value for a 6 μm abrasive is obtained by drawing a straight line between wear values obtained with abrasives both coarser and finer than 6 μm.

D.3 DYNAMIC WEAR

Disk packs should provide recovery of previously recorded data after 4 000 normal head loadings when tested on an operating system.



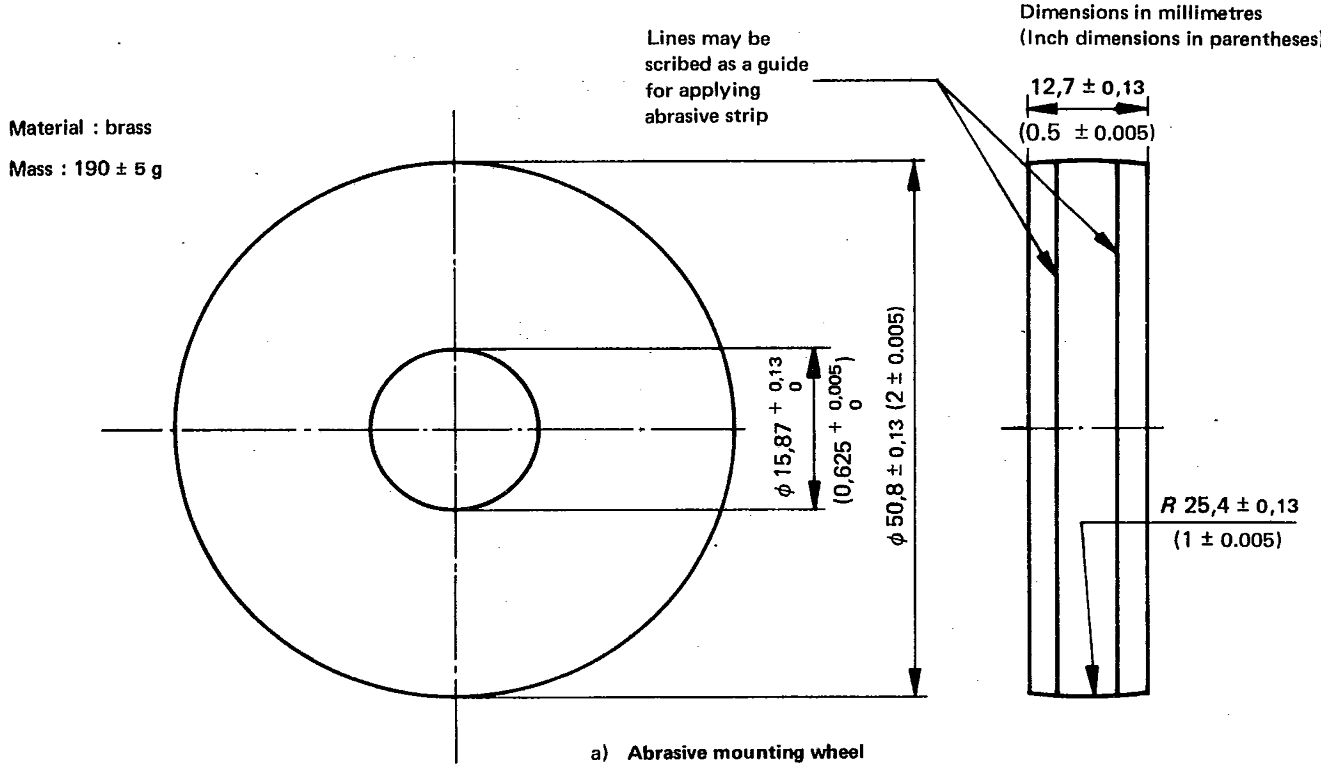
a) **Sample configuration and mounting location**



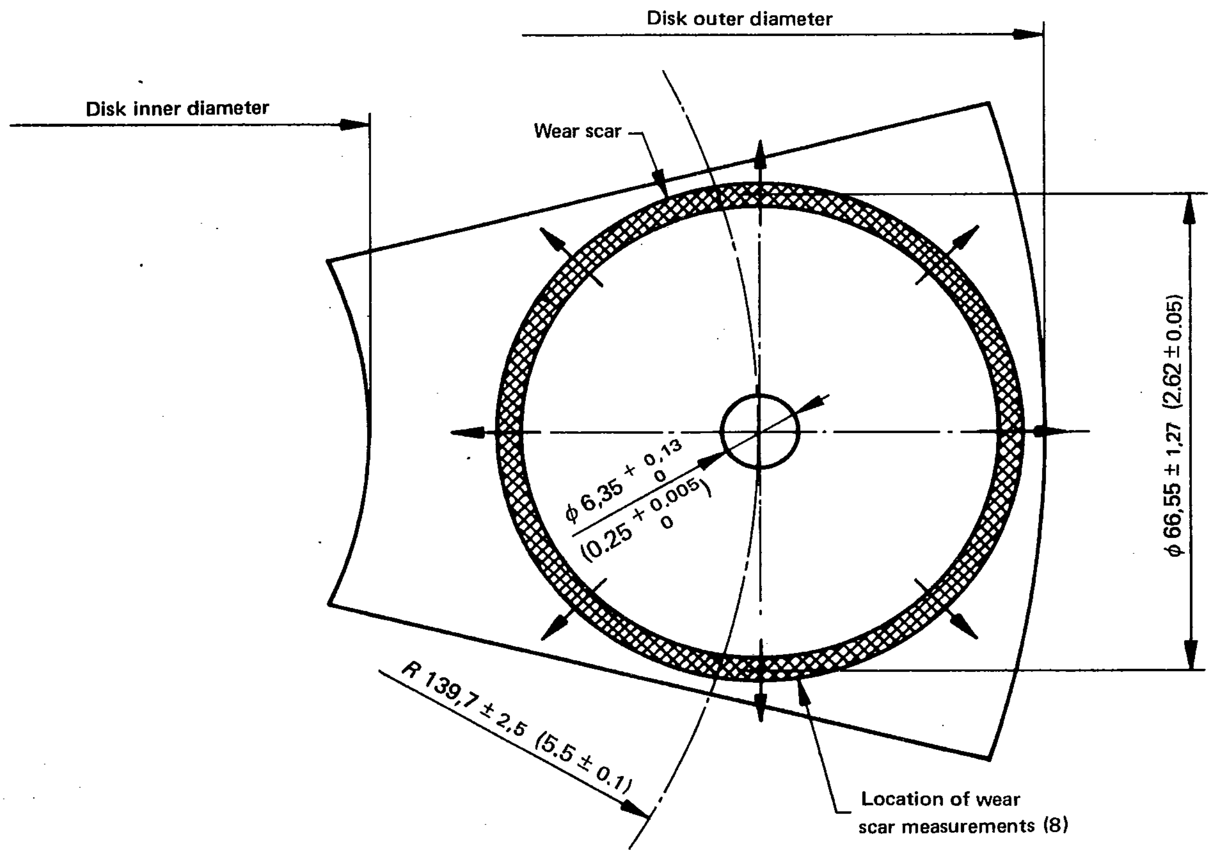
b) **Fastening and removal of pressure-sensitive tape**

FIGURE 15 — **Adhesion test**

Dimensions in millimetres
(Inch dimensions in parentheses)

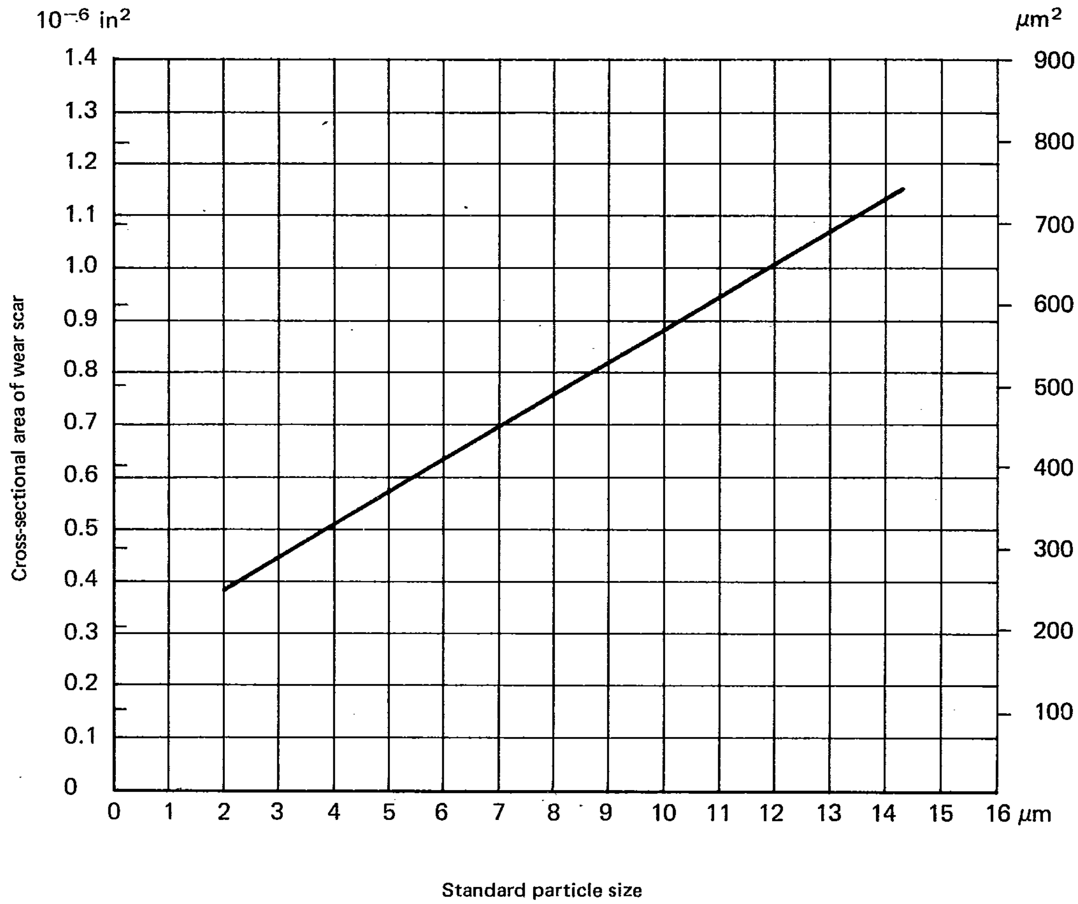


a) Abrasive mounting wheel



b) Wear test sample

FIGURE 16 — Abrasive wear-resistance test



Example

Wear of an acrylic plastic sample with a nominal 8 μm abrasive is 650 μm^2 (10^{-6} in^2). The standard particle size for this abrasive is 11,9 μm.

FIGURE 17 — **Calibration curve for silicon carbide abrasives with acrylic plastic test samples**

ANNEX E

(Not par of the standard)

MEASURING EFFECTIVE TRACK WIDTH

DC erase a seven track wide band with track location 199 in the centre of the band and record with straddle erase a *2f* frequency pattern in track location 199 using a data test head. The read-back signal amplitude in this position is called 100 %. Then move the head radially over the disk in increments not greater than 0,01 mm (0.000 4 in) to the left or to the right of track 199 until the read-back signal becomes zero. Determine the read-back signal amplitude at each incremental move and plot amplitude (*y*-axis) versus displacement (*x*-axis).

See figure 18 for reading track width.

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

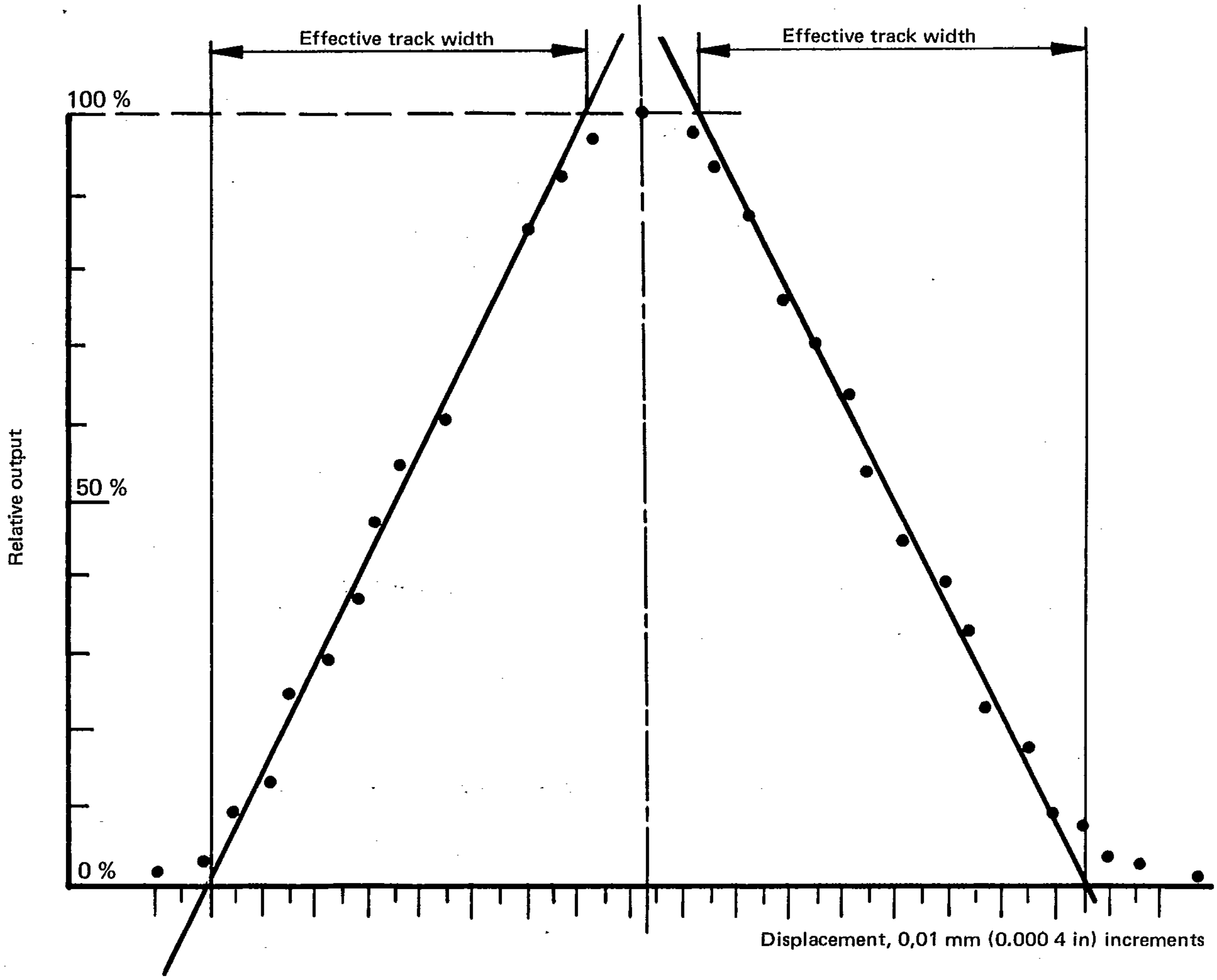


FIGURE 18 — **Track width diagram**