
INTERNATIONAL STANDARD



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

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FOREWORD

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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

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

4.1.2 Top cover (see figure 2)

4.1.2.1 OUTSIDE DIAMETER

The outside diameter of the top cover is

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

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

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

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

$$d_4 = 12,7 + \begin{smallmatrix} 0,8 \\ 0 \end{smallmatrix} \text{ mm (0.5} + \begin{smallmatrix} 0.03 \\ 0 \end{smallmatrix} \text{ in).}$$

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

$$d_5 = 10,97 - \begin{smallmatrix} 0 \\ 0,25 \end{smallmatrix} \text{ mm (0.432} - \begin{smallmatrix} 0 \\ 0.010 \end{smallmatrix} \text{ in).}$$

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

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

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

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

from the shoulder of the spindle lock.

The diameter with relaxed balls is

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

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

$$d_7 = 3,18 \begin{smallmatrix} 0 \\ -0,13 \end{smallmatrix} \text{ mm (0.125} \begin{smallmatrix} 0 \\ -0,005 \end{smallmatrix} \text{ in)}.$$

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

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

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

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

4.1.5.4 EDGES AND CORNERS

All edges and corners have a radius of

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

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

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

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

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

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

$$h_{15} = 12,22 \pm 0,51 \text{ mm } (0,481 \pm 0,020 \text{ in}).$$

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

$$h_{28} \leq 18,42 \text{ mm } (0,725 \text{ in})$$

in the area with a radius

$$r_4 \leq 90 \text{ mm } (3,543 \text{ in}).$$

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

$$h_{29} \geq 24,9 \text{ mm } (0,98 \text{ in})$$

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

$$h_{30} \geq 20,1 \text{ mm } (0,79 \text{ in})$$

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

$$h_{31} \leq 115,2 \text{ mm } (4,535 \text{ in}).$$

4.1.11 Hub/disks relationship

4.1.11.1 AXIAL POSITION LIMITS OF DISK SURFACES

With the disk pack revolving at $2\,400 \pm 48$ 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 $2\,400 \pm 48$ rev/min, the axial runout of the recording disks shall not exceed 0,30 mm (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 $2\,400 \pm 48$ 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/s² (5 500 in/s²). (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 $3\,000\text{ rad/s}^2$ 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 $209,8\text{ mm}$ (8.26 in) maximum to an outside diameter of $354,8\text{ mm}$ (13.97 in) minimum.

4.2 Moment of inertia

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

4.3 Balance

The disk pack shall be dynamically balanced within $100\text{ g}\cdot\text{mm}$ ($0.14\text{ oz}\cdot\text{in}$), when measured at $2\,400\text{ rev/min}$ in each of two planes parallel to the disk surface at $6,6 \pm 0,2\text{ mm}$ ($0.26 \pm 0,05\text{ in}$) 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 $2\,500\text{ rev/min}$ 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 $925 \pm 145\text{ N}$ ($206 \pm 32\text{ lbf}$), 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 $44\text{ }\mu\text{m}$ ($0.001\,73\text{ in}$). 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 $1,05\text{ mbar}$ (0.42 in of water) while passing $1,6 \pm 0,1\text{ m}^3$ ($55 \pm 3\text{ ft}^3$) 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 $2\,400 \pm 48\text{ rev/min}$ 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 $0,09\text{ }\mu\text{m}$ ($3.5\text{ }\mu\text{in}$), arithmetic average, with a maximum deviation in height of $0,76\text{ }\mu\text{m}$ ($30\text{ }\mu\text{in}$) from the average, when measured with a $2,5\text{ }\mu\text{m}$ ($0.000\,1\text{ in}$) stylus and a $750\text{ }\mu\text{m}$ (0.03 in) cut-off range.

4.10.2 Head gliding requirements

In the band defined by the diameters $209,8\text{ mm}$ (8.26 in) and $354,8\text{ mm}$ (13.97 in), see 4.1.12, there shall be no head-to-disk contacts with heads flying at $1,25\text{ }\mu\text{m}$ ($50\text{ }\mu\text{in}$) at the inner diameter and increasing linearly to $1,65\text{ }\mu\text{m}$ ($65\text{ }\mu\text{in}$) 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 :

$$0,175 - 0,025 \text{ mm } (0.0069 - 0.0010 \text{ in}).$$

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)

$$S = 0,2567 \text{ mm } (0.010106 \text{ in})$$

- magnetic gap offset distances

$$F_{ar} = 12,125 \text{ mm } (0.4774 \text{ in})$$

$$F_{br} = 10,987 \text{ mm } (0.4326 \text{ in})$$

- centreline radius of track 73

$$R_{73} = 148,057 \text{ mm } (5.8290 \text{ in})$$

- 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 $\pm 0,025 \text{ mm } (0.001 \text{ in})$ 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 $\pm 7,5 \mu\text{m } (0.0003 \text{ in})$ 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 $24 \times 10^{-6}/^{\circ}\text{C } (13.33 \times 10^{-6}/^{\circ}\text{F})$.

5.2.3.3 RECORDING OFFSET ANGLE

At the instant of writing or reading, a magnetic transition shall make an angle of $4^{\circ} 54' \pm 30'$ 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 $100 \mu\text{s}$ after index and ending not sooner than $700 \mu\text{s}$ 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 $700 \mu\text{s}$ 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 $2\,400 \pm 24$ 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 $0,026 \pm 0,001\,4$ m³/s (55 ± 3 ft³/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 agencies¹⁾ 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 1f (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 $115,087 \pm 0,254$ mm ($4.531 \pm 0.001\,0$ in) :

7,0 mV peak-to-peak

at a radius of $166,726 \pm 0,254$ 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 $0,90 \leq C_{AD} \leq 1,10$ 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 $115,087 \pm 0,254$ mm (4.531 ± 0.010 in) gives an output of

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

2,0 mV peak-to-peak if recorded at 4f (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 2f) and C_{DD4} (for 4f).

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 $0,90 \leq C_{DD} \leq 1,10$ 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 $0,90 \leq C_{AH} \leq 1,10$.

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 $1f$ (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 $0,90 \leq C_{DH} \leq 1,10$.

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 $2f$ (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 $4f$ to $2f$ average read amplitudes at the 115,087 mm (4.531 in) radius on the standard data reference surface, when measured over the same $225 \mu\text{s}$ 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 $1f$ current waveform measured at the head termination connector shall conform to figure 9, where :

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

Overshoot = 5 to 10 % of I_W .

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

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

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

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

$$|T_R - T_F| \leq 20 \text{ ns}$$

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 $7,5 \pm 0,37 \text{ k}\Omega$ in parallel with a distributed and lumped capacitance of $45 \pm 5 \text{ pF}$, 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 $2f$ write current waveform measured at the head termination connector shall conform to figure 9, where :

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

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

overshoot $\leq 8 \%$ of I_W .

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

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

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

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

$$|T_R - T_F| \leq 20 \text{ ns}$$

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

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

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

5.3.4.2.3 Read electronics

The differential input impedance of the read electronics shall be $4,20 \pm 0,21 \text{ k}\Omega$ in parallel with a distributed and lumped capacitance of $30 \pm 5 \text{ pF}$, 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

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

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

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

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 $3,43 \pm 0,10 \text{ N}$ ($350 \pm 10 \text{ gf}$), 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 $50 \mu\text{s}$ 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 $\frac{\text{amplitude at } 4f}{\text{amplitude at } 2f}$ averaged over the same $50 \mu\text{s}$ sector shall be $0,55 \pm 0,20$.

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 $50\ \mu\text{s}$ 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 $50\ \mu\text{s}$ 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 $50\ \mu\text{s}$ 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 $50\ \mu\text{s}$ 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 $50\ \mu\text{s}$ sector of the erased track shall not exceed 4 % of the highest peak-to-peak amplitude averaged over a $50\ \mu\text{s}$ 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.