

International Standard



7065/1

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Information processing — Data interchange on 200 mm (8 in) flexible disk cartridge using modified frequency modulation recording at 13 262 ftprad on two sides — Part 1: Dimensional, physical and magnetic characteristics

Traitement de l'information — Échange d'information sur cartouches à disquette de 200 mm (8 in) utilisant le mode d'enregistrement MFM à 13 262 ftprad sur deux faces — Partie 1: Caractéristiques dimensionnelles, physiques et magnétiques

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Foreword

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It has been approved by the member bodies of the following countries:

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Information processing — Data interchange on 200 mm (8 in) flexible disk cartridge using modified frequency modulation recording at 13 262 ftprad on two sides —

Part 1: Dimensional, physical and magnetic characteristics

0 Introduction

ISO 7065 specifies the characteristics of 200 mm (8 in) flexible disk cartridges recorded at 13 262 ftprad on two sides using modified frequency modulation recording.

ISO 7065/2 specifies the quality of recorded signals, the track layout, and the track format to be used on a 200 mm (8 in) flexible disk cartridge, recorded at 13 262 ftprad on two sides, using modified frequency modulation recording, which is intended for data interchange between data processing systems.

Together with the labelling scheme specified in ISO 7665 ISO 7065/1 and ISO 7065/2 provide for full data interchange between data processing systems.

1 Scope and field of application

This part of ISO 7065 specifies the dimensional, physical and magnetic characteristics of the cartridge, so as to provide physical interchangeability between data processing systems.

NOTE — Numeric values in the SI and/or Imperial measurement systems in this International Standard may have been rounded and therefore are consistent with, but not exactly equal to, each other. Either system may be used, but the two should be neither intermixed nor reconverted. The original design was made using the Imperial measurement system.

2 References

ISO 646, *Information processing — 7-bit coded character set for information interchange*.¹⁾

ISO 2022, *Information processing — ISO 7-bit and 8-bit coded character sets — Code extension techniques*.²⁾

ISO 4873, *Information processing — 8-bit coded character set for information interchange*.

ISO 7665, *Information processing — File structure and labelling of flexible disc cartridges for information interchange*.³⁾

3 Definitions

For the purpose of this International Standard the following definitions apply:

3.1 flexible disk: A flexible disk which accepts and retains on the specified side or sides magnetic signals intended for input/output and storage purposes of information data processing and associated systems.

3.2 reference flexible disk cartridge: A flexible disk cartridge arbitrarily selected for a given property for calibrating purposes.

3.3 secondary reference flexible disk cartridge: A flexible disk cartridge intended for routine calibrating purposes, the performance of which is known and stated in relation to that of the reference flexible disk cartridge.

3.4 signal amplitude reference flexible disk cartridge: A reference flexible disk cartridge selected as a standard for recording field and signal amplitude.

On side 0 of this cartridge track 00, having a radius of 91,754 mm (3.612 4 in) and track 76, having a radius of 51,537 mm (2,029 0 in) are declared as reference tracks. To provide a standard for side 1 the same surface is used by turning the disk over in the jacket. Under these conditions track 00 has now a radius of 89,637 mm (3.529 0 in) and is not a reference track. However, its correlation with the reference track having a radius of 91,754 mm (3.612 4 in) is sufficiently close for the purpose of this International Standard. Track 72 having a radius of 51,537 mm (2,029 0 in) is a reference track and is therefore used instead of track 76.

NOTE — A master standard for signal amplitudes, reference fields, overwrite and resolution characteristics has been established by the Physikalisch-Technische Bundesanstalt (PTB), Bundesallee 100 in Braunschweig, Germany. Secondary reference flexible disk cartridges can be ordered from PTB, Lab 5.11, under part number RM 5654 as long as available.

1) At present at the stage of draft. (Revision of ISO 646-1973.)

2) At present at the stage of draft. (Revision of ISO 2022-1973.)

3) At present at the stage of draft.

3.5 typical field: The minimum recording field which, when applied to a flexible disk cartridge, causes a signal output equal to 95 % of the maximum average signal amplitude when taken as a function of the recording field at the specified track and flux transition frequency of that flexible disk cartridge.

3.6 reference field: The typical field of the signal amplitude reference flexible disk cartridge.

3.7 test recording currents: The four recording currents between 147 % and 155 % of the currents which produce the reference field at 250 000 flux transitions per second (ftps) on tracks 00 and 76 of side 0 and on tracks 00 and 72 of side 1. For each side, the first of these currents shall be used for recording on tracks 00 to 43 and the second shall be used for recording on tracks 44 to 76.

3.8 standard reference amplitudes: The average signal amplitudes derived from the reference tracks of the signal amplitude reference flexible disk cartridge. SRA_{1f} is the average signal amplitude from a recording written using 250 000 ftps at a radius of 91,754 mm (3.612 4 in). SRA_{2f} is the average signal amplitude from a recording written using 500 000 ftps at a radius of 51,537 mm (2.029 0 in).

3.9 average signal amplitude: The arithmetically averaged value for a track of the output voltage measured peak-to-peak over the whole track.

3.10 in contact: An operating condition in which the magnetic surface of the disk intended for data storage is in physical contact with the magnetic head.

3.11 formatting: Writing the proper control information establishing the 77 physical cylinders and designating addresses of physical records on the flexible disk's surfaces.

3.12 initialization: Writing of the volume label, the ERMAP label, and any other information initially required to be on the flexible disk cartridge, prior to the commencement of general processing or use.

3.13 recording area: That area of each disk surface with which the head may come into contact.

4 General description

4.1 General figures

A typical flexible disk cartridge is represented in figures 1 to 3.

Figure 1 — Flexible disk cartridge, shows the cartridge seen from above, side 0 up.

Figure 2 — Section A-A, is a cross-section, along line A-A in figure 1.

Figure 3 — Protective envelope with cartridge, shows a protective envelope with cartridge, side 1 up.

4.2 Main elements

The main elements of this flexible disk cartridge are:

- the recording disk;
- the liner;
- the jacket.

The cartridge is stored in an envelope.

4.3 Description

The jacket is of a square form. It includes a central window, an index window and a head window in both sides.

The liner is fixed to the inside of the jacket. It comprises two layers of material between which the disk is held. The liner has the same openings as the jacket.

The disk has two recording sides, and has only a central hole and an index hole.

4.4 Optional features

The interchange characteristics of the jacket allow for variations of its construction. It may include flaps, (for example, three flaps as shown in the drawing, or none), and notches along the reference edge. For conditions under which a write-inhibit notch may be used, see annex D.

5 General requirements

5.1 Environment and transportation

5.1.1 Testing environment

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

- temperature: 23 ± 2 °C (73 ± 4 °F);
- relative humidity: 40 to 60 %;
- conditioning before testing: 24 h minimum.

The temperature and the relative humidity shall be measured in the air immediately surrounding the cartridge.

The stray magnetic field at any point on the disk surface, including that resulting from the concentrating effect on the recording head shall not exceed 4 000 A/m (50 Oe).

5.1.2 Operating environment

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

- temperature: 10 to 51,5 °C (50 to 125 °F);
- relative humidity: 20 to 80 %;
- wet bulb temperature: less than 29 °C (84 °F).

The temperature and the relative humidity shall be measured in the air immediately surrounding the cartridge. It is recommended that the rate of change of the temperature should not exceed 20 °C (36 °F) per hour.

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

The stray magnetic field at any point on the disk surface, including that resulting from the concentrating effect on the recording head, shall not exceed 4 000 A/m (50 Oe).

5.1.3 Storage environment

During storage it is recommended that the cartridges are kept under the following conditions:

- temperature: 4 to 51,5 °C (40 to 125 °F);
- relative humidity: 8 to 80 %.

Each cartridge shall be in an envelope and in an upright position.

The stray magnetic field shall not exceed 4 000 A/m (50 Oe).

NOTE — Cartridges which have been stored in temperatures and humidities outside the operating condition, but within the storage conditions may exhibit degraded performance characteristics. Such cartridges should be subjected to a conditioning period of not less than 24 h within the operating environment prior to use.

5.1.4 Transportation

Responsibility for ensuring that adequate precautions are taken during transportation shall be with the sender. During transportation the cartridge shall be in its envelope, and in a protective package. The latter must be free from dust or extraneous matter. It must have a clean interior and construction preventing ingress of dust and water. It is recommended that a sufficient space exists between cartridge and outer surface of the final container, so that risk of damage due to stray magnetic fields will be negligible.

It is recommended that the following conditions should not be exceeded:

- temperature: - 40 to 51,5 °C (- 40 to 125 °F);
- maximum rate of temperature change: 20 °C (36 °F) per hour;
- relative humidity: 8 to 90 %.

No moisture shall condense in or on the cartridge.

5.1.5 Handling

The cartridge shall stay out of its envelope for the shortest time possible. When handling the cartridge the operator shall not touch the exposed magnetic surfaces of the disk and shall avoid exposing the cartridge to direct sunlight, moisture and dust.

5.2 Materials

5.2.1 Jacket

The jacket may be constructed from any suitable material.

5.2.2 Liner

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

5.2.3 Disk

The disk may be constructed from any suitable material (for example, bi-axially oriented polyethylene terephthalate) coated on both sides with a strong and flexible layer of magnetic material (for example γ -Fe₂O₃).

5.2.4 Envelope

The envelope may be manufactured from any suitable material (for example, paper).

5.3 Direction of rotation

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

6 Dimensional characteristics

The dimensional characteristics listed in the following clauses are indicated in figures 4 to 7.

Figure 4 — Jacket dimensions shows the jacket.

Figure 5 — Cartridge thickness shows a partial cross-section of the jacket.

Figure 6 — Disk dimensions shows the disk.

Figure 7 — Disk thickness shows a cross-section of the disk.

All dimensions are referred to the reference edge of the cartridge (see figure 4).

6.1 Jacket

6.1.1 Form

The jacket shall have a square form with angles of $90^\circ \pm 30'$, and a side length

$$l_1 = 203,2 \pm 0,4 \text{ mm } (8.000 \pm 0.015 \text{ in})$$

6.1.2 Thickness

6.1.2.1 Jacket wall and liner

In an area defined by

$$r_1 = 60 \text{ mm } (2.36 \text{ in})$$

$$r_2 = 85 \text{ mm } (3.35 \text{ in})$$

and with a probe having a diameter of 15 mm (0.59 in) applied against the cartridge with a force of 1 N (3.6 ozf), the thickness of the jacket wall and liner shall be

$$e_1 = 0,45 \pm 0,15 \text{ mm (0.018} \pm 0.005 \text{ in)}$$

6.1.2.2 Cartridge

The overall thickness of the cartridge shall be (see 6.1.7):

$$1,2 \text{ mm (0.047 in)} < e_2 < 2,1 \text{ mm (0.083 in)} \text{ measured according to annex B.}$$

The cartridge shall fall freely through a gauge with a 2,6 mm (0.10 in) wide opening having flat and vertical walls and having a depth of 150 mm (5.9 in).

6.1.3 Central windows

The central windows shall have a diameter

$$d_1 = 58,40 \pm 0,15 \text{ mm (2.300} \pm 0.005 \text{ in)}$$

The position of their centre is defined by

$$l_2 = 101,6 \pm 0,3 \text{ mm (4.000} \pm 0.010 \text{ in)}$$

6.1.4 Index windows

6.1.4.1 Location

The centre of the index windows shall be defined by

$$l_3 = 85,09 \pm 0,25 \text{ mm (3.350} \pm 0.010 \text{ in)}$$

$$l_4 = 135,94 \pm 0,25 \text{ mm (5.352} \pm 0.010 \text{ in)}$$

6.1.4.2 Diameter

The diameter of the index windows shall be

$$d_2 = 7,7 \pm 0,1 \text{ mm (0.302} \pm 0.005 \text{ in)}$$

6.1.5 Head windows

6.1.5.1 Location

The location of the lowest point of the head windows shall be defined by

$$l_5 = 3,70 \pm 0,25 \text{ mm (0.145} \pm 0.010 \text{ in)}$$

6.1.5.2 Dimensions

The width of the head windows shall be

$$l_6 = 12,7 \pm 0,1 \text{ mm (0.500} \pm 0.005 \text{ in)}$$

The nominal radius of their ends shall be

$$r_3 = 6,35 \text{ mm (0.250 in)}$$

Their length shall be

$$l_7 = 52,60 \pm 0,25 \text{ mm (2.071} \pm 0.010 \text{ in)}$$

6.1.6 Reference edge profile

Within an area defined by

$$l_8 = 25 \text{ mm (1 in)}$$

the reference edge shall have a convex profile, for example, be rounded with one or more radii of 0,5 mm (0.020 in) minimum.

6.1.7 Construction of the jacket

If the jacket utilises flaps, their width shall be

$$l_9 = 14 \text{ mm max. (0.550 in max.)}$$

The total thickness e_2 of the cartridge with flaps shall satisfy the conditions of 6.1.2. The thickness of the flaps shall be at most 0,9 mm (0.035 in) (see annex B).

6.1.8 Notches

Two notches may be provided along the reference edge. If provided, they shall be entirely contained within areas defined by:

$$l_{10} = 81,6 \text{ mm min. (3.22 in min.)}$$

$$l_{11} = 94,6 \text{ mm max. (3.72 in max.)}$$

$$l_{12} = 108,6 \text{ mm min. (4.28 in min.)}$$

$$l_{13} = 121,6 \text{ mm max. (4.78 in max.)}$$

$$l_{14} = 2,0 \text{ mm max. (0.08 in max.)}$$

6.2 Liner

The liner shall always cover the recording area (see 6.3.4). However, no part of the liner shall protrude by more than 0,2 mm (0.008 in) into the openings of the jacket.

6.3 Disk

6.3.1 Diameters

The external diameter of the disk shall be

$$d_3 = 200,2 \pm 0,2 \text{ mm (7.882} \pm 0.008 \text{ in)}$$

The inner diameter of the disk shall be

$$d_4 = 38,100 \pm 0,025 \text{ mm (1.500} \pm 0.001 \text{ in)}$$

6.3.2 Thickness

The thickness of the disk shall be

$$e_3 = 0,080 \pm 0,010 \text{ mm (0.003 0} \pm 0.000 5 \text{ in)}$$

6.3.3 Index hole

6.3.3.1 Location

The location of the index hole shall be defined by

$$r_4 = 38,1 \pm 0,1 \text{ mm (1.500} \pm 0.004 \text{ in)}$$

6.3.3.2 Diameter

The diameter of the index hole shall be

$$d_5 = 2,54 \pm 0,10 \text{ mm } (0.100 \pm 0.005 \text{ in})$$

6.3.4 Recording area

The recording area shall be defined by

$$r_5 = 46,2 \text{ mm max. } (1.82 \text{ in max.})$$

$$r_6 = 96,6 \text{ mm min. } (3.80 \text{ in min.})$$

6.3.5 Sides

For convenience of description, the two sides are defined as side 0 and side 1; they are shown in figures 1 to 4 and figure 8.

7 Physical characteristics

7.1 Inflammability

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

7.2 Coefficient of linear thermal expansion of the disk

The coefficient of thermal expansion of the disk shall be

$$(17 \pm 8) \times 10^{-6} \text{ per degree Celsius}$$

7.3 Coefficient of linear hygroscopic expansion of the disk

The coefficient of hygroscopic expansion of the disk shall be in the range

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

7.4 Opacity

7.4.1 Opacity of the jacket

The jacket shall have a light transmittance of less than 1 % using an LED with a nominal wavelength of 900 nm as the radiation source when measured according to annex A.

7.4.2 Opacity of the disk

The disk shall have a light transmittance of less than 1 % using an LED with a nominal wavelength of 900 nm as the radiation source when measured according to annex A.

7.5 Torque

7.5.1 Starting torque

The starting torque, without head and pads loaded to the cartridge, shall not exceed 0,042 N·m. (6 ozf·in).

7.5.2 Running torque

When the disk cartridge is tested at a rotational speed of $360 \pm 7 \text{ rev/min}$, with a pressure pad of $690 \pm 10 \text{ mm}^2$ ($1.07 \pm 0.07 \text{ in}^2$) surface applied with a force of $1,50 \pm 0,05 \text{ N}$ ($5.4 \pm 0.2 \text{ ozf}$), and located parallel to the head window as defined in figure 8 by

$$l_{15} = 62,0 \text{ mm } (2.44 \text{ in})$$

$$l_{16} = 75,0 \text{ mm } (2.95 \text{ in})$$

$$l_{17} = 10,0 \text{ mm } (0.39 \text{ in})$$

$$l_{18} = 64,0 \text{ mm } (2.52 \text{ in})$$

the torque necessary to rotate the disk shall be between 0,028 N·m. (4 oz in) and 0,088 N·m. (12.46 oz in).

8 Magnetic characteristics¹⁾

8.1 Track geometry

8.1.1 Number of tracks

There shall be 77 discrete concentric tracks on each side of the disk in the recording area (see 6.3.4).

8.1.2 Width of tracks

The recorded track width on the disk surface shall be

$$0,300 \pm 0,025 \text{ mm } (0.0118 \pm 0.0010 \text{ in})$$

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

8.1.3 Track locations

8.1.3.1 Nominal locations

The nominal radii of the centrelines of all tracks shall be calculated by using the formula:

$$R_n = X + 25,4 \left(\frac{76 - n}{48} \right) \text{ mm}$$

$$\left(R_n = X + \frac{76 - n}{48} \text{ in} \right)$$

1) The peak of each voltage pulse generated at the read head defines the position of each magnetic flux transition. If two adjacent flux transitions are relatively far apart, then the two voltage signals (one positive and one negative) will not overlap. As the distance between flux transitions decreases, the two voltage signals begin to overlap and subtract from each other causing a reduction in signal amplitude and a shift in position of the voltage signal peaks. This latter phenomenon is referred to as a "peak shift". A test method for measuring that portion of the peak shift that is attributable to the flexible disk cartridge is not presently available but continues to be investigated.

$X = 51,537 \text{ mm (2.029 0 in)}$ for side 0 and

$X = 49,421 \text{ mm (1.945 7 in)}$ for side 1

n is the numeric value corresponding to the track number;
 $n = 0$ to 76

Therefore each track on side 1 is offset inwards by four track positions from the track on side 0 having the same track number.

8.1.3.2 Track location tolerance

The centrelines of tracks recorded for testing purposes shall be within $\pm 0,025 \text{ mm } (\pm 0.001 \text{ in})$ of the nominal positions, when measured in the testing environment (see 5.1.1).

8.1.4 Physical track identification

The track number shall be a two-digit decimal number (00 to 76 on each side) which identifies the tracks consecutively, starting at the outermost track (00).

8.1.5 Index

The index is the point which determines the beginning and the end of the track. At the instant of having detected the leading edge of the index hole, the index is under the read-write gap.

8.2 Functional testing

For the purposes of the following tests the same drive unit shall be used for the writing and reading operations.

8.2.1 Surface tests

The magnetic properties of the data surfaces are defined by the testing requirements given below (side 0 and side 1).

8.2.1.1 Test conditions

The disk shall be tested at $360 \pm 7 \text{ rev/min}$. The test frequencies used shall be:

$$1f = 250\,000 \pm 250 \text{ ftps}$$

$$2f = 500\,000 \pm 500 \text{ ftps}$$

and shall be used as specified for each test.

8.2.1.2 Typical field

The typical field of the disk under test shall be within $\pm 20 \%$ of the reference field. It shall be measured using $1f$

- on tracks 00 and 76 on side 0,
- on tracks 00 and 72 on side 1.

8.2.1.3 Average signal amplitude

When the disk under test has been recorded with the test recording currents, then read back and compared with the signal amplitude reference flexible disk cartridge recorded

under the same conditions and on the same system, the average signal amplitude shall be:

side 0, track 00, using $1f$, less than 130% of SRA_{1f}

side 0, track 76, using $2f$, more than 80% of SRA_{2f}

side 1, track 00, using $1f$, less than 130% of the average signal amplitude for the track with the same radius (see 3.4)

side 1, track 72, using $2f$, more than 80% of SRA_{2f}

8.2.1.4 Resolution

After recording, using the appropriate test recording current, on track 76 of side 0 on track 72 of side 1, the ratios:

$$\frac{\text{Average signal amplitude using } 2f}{\text{Average signal amplitude using } 1f}$$

shall be greater than 90% of the same ratios for the signal amplitude reference flexible disk cartridge.

8.2.1.5 Overwrite

On track 00, after recording with the appropriate test recording current, first using $1f$ and then overwriting using $2f$ for one revolution, the ratio:

$$\frac{\text{Residual average signal amplitude at } 1f \text{ after overwrite using } 2f}{\text{Average signal amplitude after first recording using } 1f}$$

shall be less than 100% of the value of the same ratio for the signal amplitude reference flexible disk cartridge. This test shall be performed with a frequency-selective voltmeter.

8.2.1.6 Modulation

Modulation shall be:

$$\left[\frac{\text{Maximum mean} - \text{Minimum mean}}{\text{Maximum mean} + \text{Minimum mean}} \right] \times 100 \%$$

The maximum mean is the average value of the amplitude-modulated output voltage in that part of the track with the maximum amplitudes, and the minimum mean is that in the respective part with the minimum amplitudes. Output voltage shall be measured peak-to-peak; averaging shall be done over about 2 000 consecutive flux transitions.

On track 00 using $1f$ and on track 76 using $2f$, modulation shall be less than 10% .

8.2.2 Track quality tests

These tests shall be carried out using $2f$ and over all 77 usable tracks at the defined positions on each side. The test recording currents shall be used.

8.2.2.1 Missing pulse

Write a track at $2f$ with the appropriate test recording current. Any playback signal, when measured base-to-peak, which is less than 40 % of half the arithmetically averaged value of the output voltages measured peak-to-peak over the preceding 2 000 consecutive flux transitions, shall be a missing pulse.

8.2.2.2 Extra pulse

Write a track at $2f$ with the appropriate test recording current and erase for one revolution with a constant direct current equivalent to the quiescent value of the test recording current.

Any playback signal, which when measured base-to-peak, including the statistical noise and the residual signal of the disk, exceeds 20 % of half the average signal amplitude of the track under test, shall be an extra pulse.

8.2.3 Rejection criteria

8.2.3.1 Defective track

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

8.2.3.2 Requirements for tracks

As initially received from the media supplier, the cartridges shall have no defective tracks.

8.2.3.3 Rejected cartridge

A cartridge which does not meet the requirements of 8.2.3.2 shall be rejected.

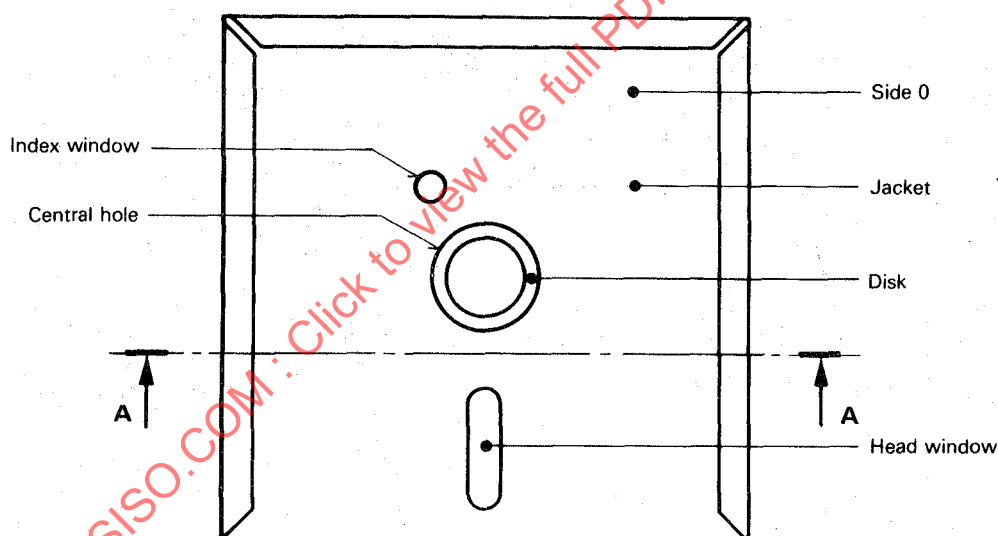


Figure 1 — Flexible disk cartridge

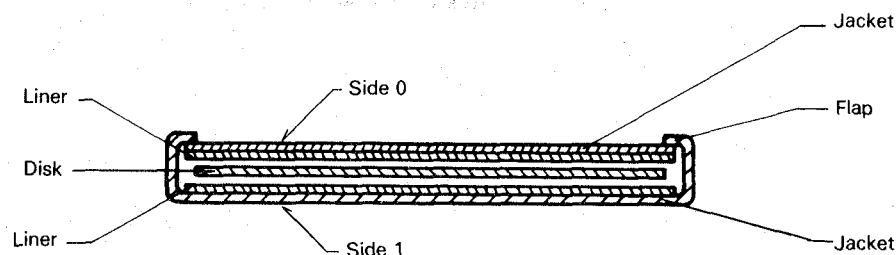


Figure 2 — Section A-A

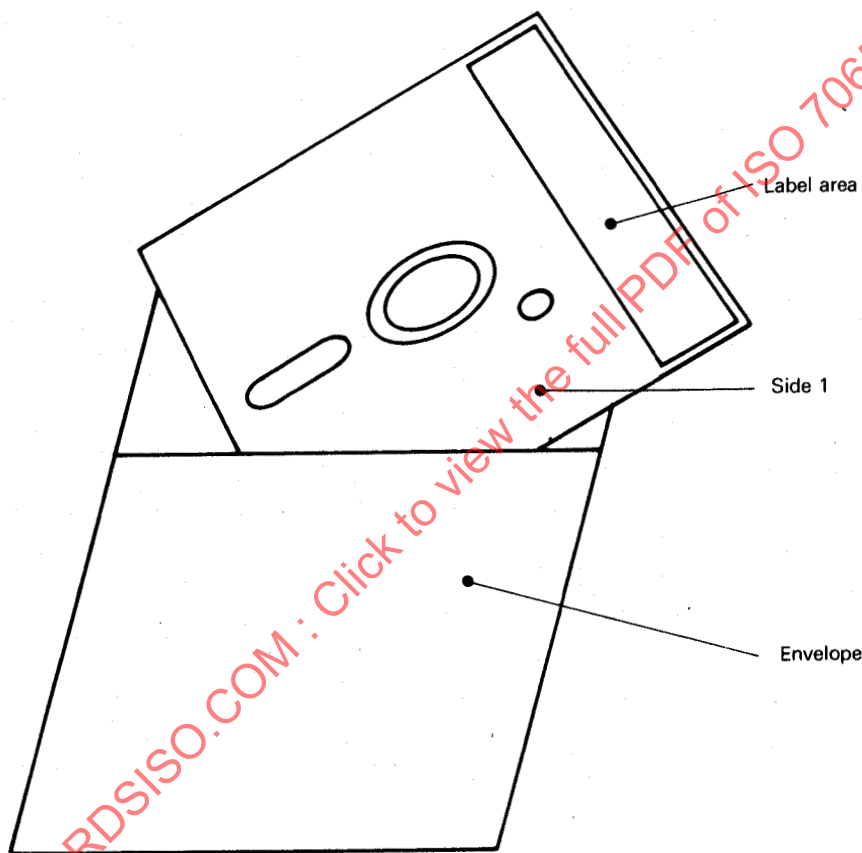


Figure 3 — Protective envelope with cartridge

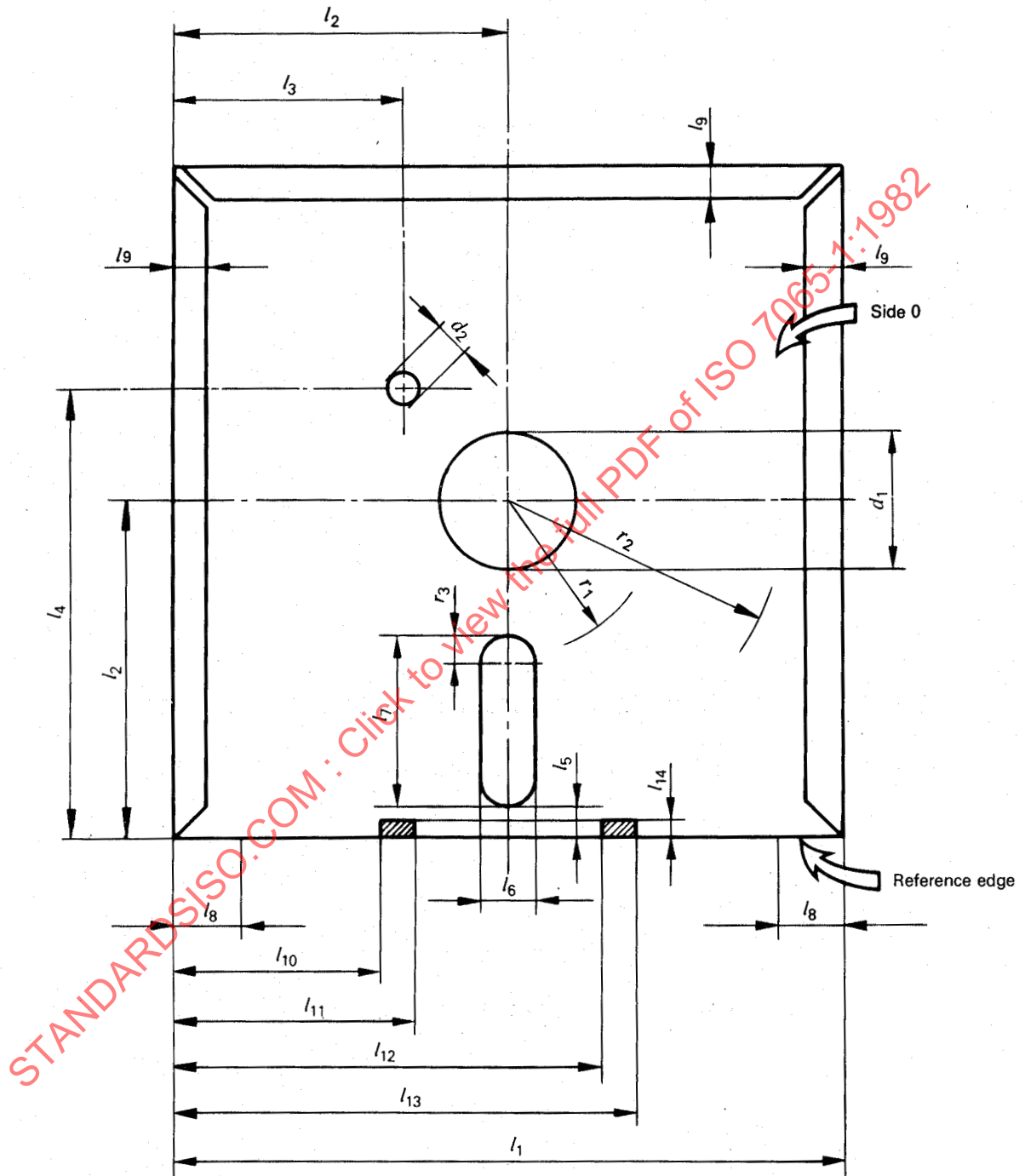
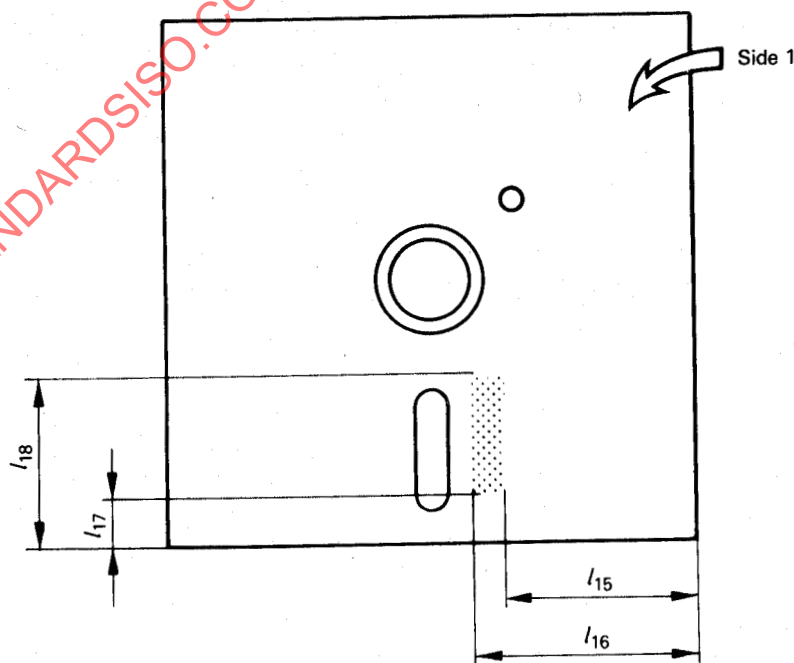
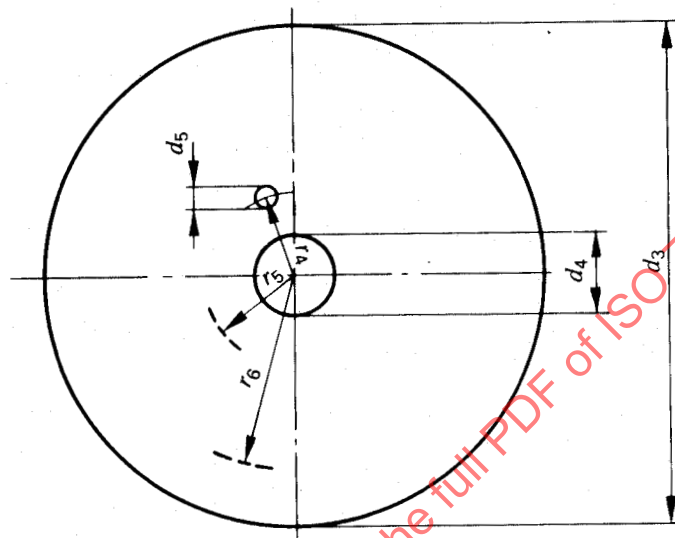
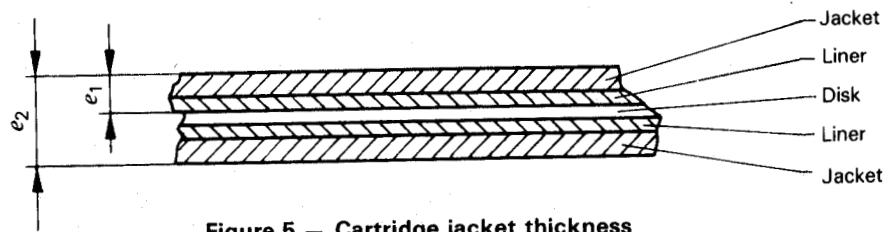


Figure 4 — Jacket dimensions



Annex A

Measurement of light transmittance

(This annex forms part of the standard.)

A.0 Introduction

The following description outlines the general principle of the measuring equipment and the measuring method to be applied when measuring the radiation (light) transmittance of the jacket and of the magnetic disk.

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

The essential elements of the measuring equipment are:

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

A.1 Description of the measuring equipment

A.1.1 Radiation source

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

Wavelength at peak emission $\lambda_{\text{peak}} = 900 \text{ nm} \pm 10 \text{ nm}$

Half-power band width $b = \pm 25 \text{ nm}$

A.1.2 Radiation receiver

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

A.1.3 Optical path (see figure 9)

The optical axis of the set up shall be perpendicular to the disk.

The distance from the emitting surface of the LED to the disk shall be

$$L_1 = \frac{d_{\text{max}}}{2 \tan \alpha}$$

where:

d_{max} is the maximum diameter of the index hole.

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

The aperture shall have a thickness of between 1,2 to 1,4 mm (0.047 to 0.055 in) and a diameter given by

$$D = (2L_2 \tan \alpha) \text{ mm}$$

$$L_2 = (L_1 + 1,5) \text{ mm}$$

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

A.1.4 Measuring circuitry

Figure 10 shows the recommended circuitry with the following components:

E: regulated power supply with variable output voltage

R: current-limiting resistor

LED: light-emitting diode

D_i : Si photo diode

A: operational amplifier

R_{f0}, R_{f1} : feedback resistors

S: gain switch

V: voltmeter

The forward current of the LED and consequently its radiation power can be varied by means of the power supply E. D_i is working in the short circuit mode. The output voltage of the operational amplifier is given by

$$V_0 = I_k \times R_f$$

and is therefore a linear function of the light intensity. I_k is the short circuit current of D_i .

R_{f0} and R_{f1} shall be low-temperature drift resistors with an accuracy of 1 %. The following ratio applies:

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

A.2 Measuring method

A.2.1 Measurement of the disk

The measurements shall be taken within an annular band whose boundaries are tangential to the index hole.

- S is set to position 0. With the index hole in front of the photo diode, the voltmeter is set to full-scale reading (100 % transmittance) by varying the output voltage of E.

— The disk is rotated until the photo diode is covered by the disk. S is set to position 1. Full deflection of the voltmeter now represents 2 % transmittance.

The disk is rotated slowly for one revolution and the readings of the voltmeter are observed.

A.2.2 Measurement of the jacket

The same procedure applies to the jacket measurement, except that the jacket without a disk shall be rotated.

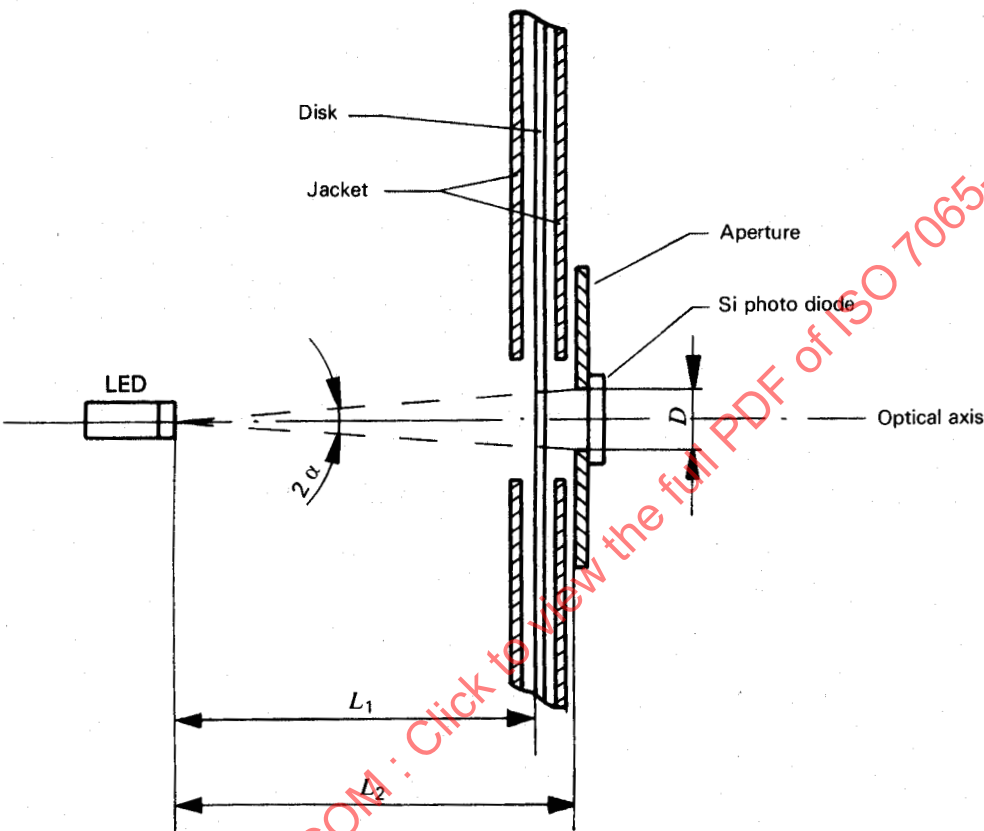


Figure 9 — Measuring device

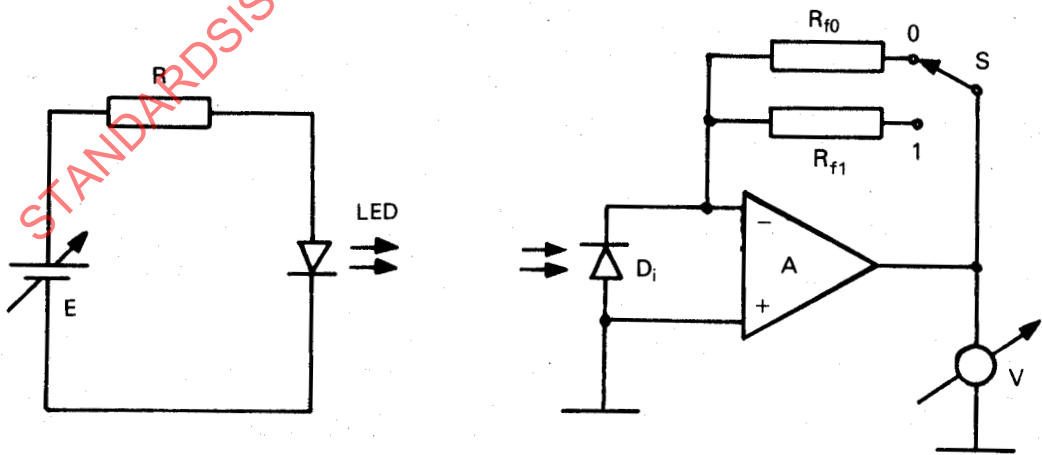


Figure 10 — Electronic circuitry