ECMA

EUROPEAN COMPUTER MANUFACTURERS ASSOCIATION

STANDARD ECMA-79

DATA INTERCHANGE ON 6,30 mm MAGNETIC TAPE CARTRIDGE USING IMFM RECORDING AT 252 ftpmm

2nd Edition – September 1985

Free copies of this document are available from ECMA,
European Computer Manufacturers Association
114 Rue du Rhône – 1204 Geneva (Switzerland)

ECMA
EUROPEAN COMPUTER MANUFACTURERS ASSOCIATION

STANDARD ECMA-79

DATA INTERCHANGE ON 6,30 mm MAGNETIC TAPE CARTRIDGE USING IMFM RECORDING AT 252 ftpmm

2nd Edition – September 1985

BRIEF HISTORY

ECMA TC19 was set up by ECMA in January 1970 with aim of identifying and standardizing the physical properties and the relevant data format of a magnetic tape cassette for digital applications - below the performance range of existing magnetic tape standards - in order to ensure interchangeability.

After the issue of Standard ECMA-34 for Data Interchange on 3,81 mm Wide Magnetic Tape Cassettes Phase-Encoded at a physical recording density of 63 ftpmm and a data density of 4 cpmm per track, TC19 undertook a new project for a 6,30 mm Wide, 4-Track Magnetic Tape Cartridge Phase-Encoded at a physical recording density of 126 ftpmm and a data density of 8 cpmm per track. Standard ECMA-46 was issued in March 1976.

The final draft of the ECMA Standard was presented to ISO/TC97 as a proposed draft for an international standard. As a result, ISO 4057 was published in 1980.

Advances in magnetic recording technology have led to the use of a cartridge which has similar mechanical construction but a greatly increased performance. TC19 decided in 1980 to work on such an improved cartridge. This work led to the first issue of Standard ECMA-79 in September 1982.

This second issue incorporates extensive revisions made as the result of experience in the use of cartridge tape systems using the specified mode of recording.

The text has also been revised to include SRM 3217, now available from NBS.

Adopted as the 2nd Edition of Standard ECMA-79 by the General Assembly of June 13-14, 1985.

TABLE OF CONTENTS

Table of Contents (cont'd)

Table of Contents (cont'd)

Table of Contents (cont'd)

SECTION I

SCOPE

CONFORMANCE

DEFINITIONS

1. SCOPE AND CONFORMANCE

1.1 Scope

This Standard ECMA-79 specifies a tape cartridge, using 6,30 mm wide magnetic tape, for data interchange between data processing systems.

The mechanical, physical and magnetic properties of the unrecorded cartridge are specified, together with the quality of the recorded signals and the format for the recorded cartridge.

1.2 Conformance

A 6,30 mm wide, 4-track magnetic tape cartridge shall be in conformance with this Standard if it meets all mandatory requirements of the Standard.

2. DEFINITIONS

For the purpose of this Standard the following definitions apply:

2.1 Magnetic Tape

A tape which accepts and retains magnetic signals intended for input/output and storage purposes of information processing and associated systems.

2.2 Reference Tape Cartridge

A tape cartridge selected for a given property for calibrating purposes.

2.3 Secondary Reference Tape Cartridge

A tape cartridge intended for routine calibrating purposes, the performance of which is known and stated in relation to that of the Reference Tape Cartridge.

2.4 Typical Field

The minimum field which, when applied to the tape under test, causes a signal output equal to 95% of the maximum signal output at the specified test density.

2.5 Reference Field

The minimum field which, when applied to the Signal Amplitude Reference Tape Cartridge causes a signal output equal to 95% of the maximum signal output at the test density.

2.6 Test Recording Current

The recording current between 145% and 155% of the currents required to produce the Reference Field at 252 ftpmm.

2.7 Signal Amplitude Reference Tape Cartridge

A reference tape cartridge selected as a standard for signal amplitude.

NOTE 1:

A Master Standard (Computer Amplitude Reference) Cartridge has been selected by the US National Bureau of Standards (NBS) to establish the reference level for average peak-to-peak signal amplitudes when recorded at:

252 ftpmm
394 ftpmm

Secondary Standard Amplitude Reference Tape Cartridges are available from NBS under Part Number SRM 3217.

(NBS, Office of Standard Reference Materials, Room 311, Chemistry Building, Gaithersburg, Md. 20899, USA)

2.8 Average Signal Amplitude

The average peak-to-peak value of the signal output measured over at least 4000 flux transitions.

2.9 Standard Reference Amplitude

The Standard Reference Amplitudes are the average signal amplitudes of the Signal Amplitude Tape Cartridge.

SRA_{252} is the average peak-to-peak signal amplitude when recording at 252 ftpmm using the appropriate Test Recording Current.

2.10 In Contact

An operating condition in which the magnetic surface of a tape is in physical contact with a magnetic head.

2.11 Track

A longitudinal area of the tape along which a series of magnetic signals may be recorded.

2.12 Physical Recording Density

The number of recorded flux transitions per unit length of track (ftpmm).

2.13 Data Density

The number of data characters stored per unit length of tape (cpmm).

2.14 Position of Flux Transitions

The position of a flux transition is that which exhibits the maximum free space flux density normal to the tape surface.

2.15 Erasing Field

A unidirectional field of sufficient strength to remove the signals from the tape.

2.16 Recording Area

That part of the tape satisfying the requirements for magnetic properties.

SECTION II

ENVIRONMENT

TRANSPORTATION

FLAMMABILITY

TOXICITY

3. ENVIRONMENT AND TRANSPORTATION

3.1 Testing Environment

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

Temperature	:	(23 ± 2) °C
RH	:	40% to 60%
Wet bulb temp.	:	18 °C maximum
Conditioning before testing	:	24 hours minimum

3.2 Operating Environment

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

Temperature	:	5 °C to 45 °C
RH	:	20% to 80%
Wet bulb temperature	:	26 °C maximum

The temperature is to be measured in the air immediately surrounding the cartridge. Rapid temperature variations should be avoided. There shall be no deposit of moisture on or in the cartridge.

3.3 Storage Environment

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

Temperature	:	5 °C to 45 °C
RH	:	20% to 80%
Wet bulb temperature	:	26 °C maximum

3.4 Transportation

3.4.1 Transportation environment

During transportation, the cartridge may have been exposed to conditions outside the operating environment. The recommended limits are:

Temperature	:	-40 °C to 45 °C
RH	:	20% to 80%
Wet bulb temperature	:	26 °C maximum

3.4.2 Transportation procedures

Responsibility for ensuring that adequate precautions are taken during shipment shall be with the sender. For transportation a rigid container free from dust or extraneous matter shall be used. The final package must have a clean interior and a contruction preventing ingress of dust or 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.

3.5 Conditioning of the Cartridge

Before use the cartridge shall be conditioned by exposure to the operating environment for a time at least equal to the period during which it has been out of the operating environment (up to a maximum of 8 hours). The cartridge shall also be conditioned by running the tape one complete end-to-end pass in any of the following cases:

i) Each time that it is inserted in a drive
ii) After prolonged operation over a limited area
iii) When the temperature change to which the cartridge has been exposed is greater than 17 °C.

3.6 Flammability

Tape or cartridge components which will ignite from a match flame, and, when so ignited, will continue to burn in a still carbon dioxide atmosphere, shall not be used.

3.7 Toxicity

Tape or cartridge components which may cause bodily harm by contact, inhalation or ingestion during normal use of the cartridge shall not be used.

SECTION III

CHARACTERISTICS OF THE TAPE

4. CHARACTERISTICS OF THE TAPE

4.1 Mechanical Properties

4.1.1 Tape width

The width of the tape shall be:

$$6{,}30 \text{ mm} \begin{matrix} + 0{,}00 \text{ mm} \\ - 0{,}06 \text{ mm} \end{matrix}$$

4.1.2 Tape length

The length of the tape between the LP and the EW markers (see 4.1.4) shall be:

$$137{,}0 \text{ m} \begin{matrix} + 4{,}6 \text{ m} \\ - 0{,}0 \text{ m} \end{matrix}$$

4.1.3 Tape thickness

The thickness of the tape and of its coating shall be:

Overall thickness	Coating thickness
19 um nominal	6,6 um max.

4.1.4 Markers

In the tape there shall be a number of markers, the relative positions of which are shown in Fig. 1.

4.1.4.1 Beginning-of-Tape (BOT)

4.1.4.1.1 Definition and use

A BOT marker shall be a pair of holes punched in the tape. There shall be three such markers, the innermost of which is used for the purpose of identifying the storage position for the cartridge. In the storage position, all of the recording area shall be wound on the supply hub and shall be protected by at least one layer of tape. The two other markers shall be used to ensure reliability of detection.

4.1.4.1.2 Dimension

The diameter of the BOT holes shall be:

$$1{,}17 \text{ mm} \pm 0{,}05 \text{ mm}$$

4.1.4.2 End-of-Tape (EOT)

4.1.4.2.1 Definition and use

An EOT marker shall be a single hole punched in the tape. There shall be three such markers along a single line. The first to pass the photo sensor during forward operation shall indicate that the recording area has been exceeded. The two other markers shall be used to ensure reliability of detection.

4.1.4.2.2 Dimension

The diameter of the EOT holes shall be:

1,17 mm ± 0,05 mm

4.1.4.3 Load-Point (LP)

4.1.4.3.1 Definition and use

The LP marker shall be a single hole punched in the tape to indicate the beginning of the recording area in the forward direction.

4.1.4.3.2 Dimension

The diameter of the LP hole shall be:

1,17 mm ± 0,05 mm

4.1.4.4 Early-Warning (EW)

4.1.4.4.1 Definition and use

The EW marker shall be a single hole punched in the tape for the purpose of indicating the approaching end of the recording area in the forward direction. Recording shall stop before the EOT marker is sensed.

4.1.4.4.2 Dimension

The diameter of the EW marker shall be:

1,17 mm ± 0,05 mm

4.1.5 Light transmittance

The tape shall have a light transmittance of less than 0,5% measured according to Appendix A.

4.1.6 Elastoplastic properties

4.1.6.1 Tensile yield force

The tensile yield force of the tape - defined as the force required to elongate a sample by 3% - shall be:

6,7 N minimum

This elongation shall be measured with a static weighing tester with a constant rate of grip separation. A specimen of tape of at least 178 mm shall be clamped with an initial separation of 102 mm between the jaws. This specimen shall be elongated with a rate of 51 mm per minute until an elongation of at least 10% is reached. The tensile yield force is the force required to produce the elongation of 3%.

4.1.7 Layer-to-layer adhesion

Layer-to-layer adhesion shall be sufficiently low to meet the test of Appendix B.

4.1.8 Cupping

Cupping, i.e. the departure across a tape (transversely to the tape motion) from a flat surface, shall be:

0,38 mm maximum

A length of tape of 6,30 mm shall be cut and placed concave side down on a flat surface. Measurement shall be made at least one hour after cutting.

4.1.9 Leaders and splices

The cartridge shall contain no splices or spliced-in leaders.

4.1.10 Tape wind

The tape shall be wound on the hubs with the magnetic coating out, and in such a way that during forward read/write operations the tape is unwound in a counter-clockwise direction viewed from above as shown in Fig. 2.

4.2 Electrical Surface Resistance

The electrical surface resistance of the magnetic surface of any square sample of the tape shall be between:

5.10^5 Ohm and 10^9 Ohm

measured between electrodes placed on two opposite sides of the square , using a voltage of 500 V ± 10 V.

4.3 Magnetic Properties

The magnetic properties of the tape are defined by the testing requirements given in this section. When performing the tests, the output or resultant signal shall be measured on the same relative pass for both the Signal Amplitude Reference Tape Cartridge and the tape under test (read-whilst-write, or on equipment without read-whilst-write capability on the first forward-read-pass) on the same equipment.

The in-contact condition shall be used for all tests.

4.3.1 Test density

The test density shall be 252 ftpmm nominal.

4.3.2 Test tracks

Testing shall be carried out on four tracks numbered 1 to 4. Track designation, location and width are specified in Section V.

4.3.3 Typical field

The typical field of the tape under test shall be within ± 20% of the Reference Field.

4.3.4 Average Signal Amplitude

When a tape has been recorded with the appropriate Test Recording Current, then played back on a system which has been calibrated by means of a Signal Amplitude Reference Tape Cartridge recorded under the same conditions, the Average Signal Amplitude of the tape under test shall be within +25% and -25% of SRA_{252}.

4.3.5 Ease of Erasure

When a tape has been recorded at 63 ftpmm with a recording current equal to 150% at the Test Recoding Current and then passed through a longitudinal steady erasing field of 79600 A/m, any remaining signal shall not exceed 3% of the Standard Reference Amplitude SRA_{252}. The erasing field shall be reasonably uniform, e.g. the field in the middle of a solenoid. This measurement shall be made with a band pass filter passing at least the first three harmonics.

4.3.6 Test for missing pulses

These tests shall be carried out on the test tracks in the in-contact condition and over the recording area (see 4.3.8) using the Test Recording Current.

Any playback signal, when measured base-to-peak, which is less than 40% of half SRA_{252} shall be a missing pulse.

NOTE 2:

This standard does not specify a test for extra pulses as it has no relevance to the recording method (IMFM) specified in Section VI.

4.3.7 Rejected regions

A rejected region shall be an area of tape which exhibits missing pulses. The acceptable number of rejected regions is a matter of agreement between the parties concerned (See Appendix F).

4.3.8 Recording Area

The Recording Area shall be that part of the tape tested according to 4.3.1 to 4.3.6. In the forward direction, it begins at least 686 mm before the LP marker and ends at least 991 mm after the EW marker (see Fig. 1).

SECTION IV

CHARACTERISTICS OF THE CARTRIDGE

5. CHARACTERISTICS OF THE CARTRIDGE

5.1 General Description

The cartridge shall be of a compact coplanar design with the tape and hubs completely enclosed by the casing, except for belt capstan and head openings. The drive shall be by means of a tensioned belt which is driven by the internal belt capstan which in turn receives motion from an external motor (see Fig. 2). Tape guides shall be located inside the cartridge. A clear plastic top shall allow visual monitoring of the tape and shall not extend beyond the base except at the notches.

5.1.1 Dimension

The dimensions of the cartridge shall be as shown in Fig. 3.

5.1.2 Cartridge positioning planes

The cartridge shall be referenced to the drive only in the cross-hatched areas shown in Fig. 4. The application of forces suggested in Fig. 4 is one method of assuring conformance of the cartridge to the positioning plane of the drive.

5.1.3 Attachment

The ends of the tape shall not be attached to the hubs.

5.1.4 Mounting position

It shall be possible to mount the cartridge in the read/write device in one position only; to ensure this, the cartridge shall have the following asymmetrical features (see Fig. 3):

i) a projection in one guide slot,

ii) the guide slots shall be accessible on the head opening edge only.

5.1.5 Light sensing

The cartridge shall contain optical elements to permit photo-electric detection of the tape markers (see Fig. 5). The total light transmittance of both cover windows, including the effects of reflection from the mirror surface sensed by a silicon photo-transistor shall be at least 50%.

This requirement shall be satisfied for both:

- a 2000K ± 200K incandescent light source
- and a 940nm ± 50nm LED light source

5.1.6 Cartridge-in-position sensing

The cartridge shall have a solid area on the front surface, which shall be dimensioned as shown in Fig. 6, to be used for mechanically sensing that the cartridge is in position for writing and reading.

5.1.7 Cartridge door

The cartridge shall have a door for protection of the tape during storage and transport. Requirements for opening the door are shown in Fig. 7.

5.2 File Protection

The cartridge shall have a rotatable plug to prevent writing or erasing the tape. See Fig. 6 for the file-protect plug location.

5.3 Physical Labels

5.3.1 Location and size

The rear surface of the cartridge, opposite the exposed tape, and a portion of the top side of the cartridge shall allow the use of labels. The rear surface area allows the label to be read when in a stacked or inserted position. The position and size of the label shall be within the provided depression of the label area as shown in Fig. 8.

5.3.2 Interchange

Labels shall be used for marking contents of cartridges. The use of pencil or erasable material is not allowed.

5.4 Tape Guides

The tape shall be guided by two tape guides contained within the cartridge (see Fig. 9). The drive shall not contain any elements to restrict the tape path in the transverse direction.

5.5 Speed

The cartridge shall be capable of being used at any nominal tape speed in the range 0,76 m/s to 2,29 m/s.

NOTE 3:

When using the higher speeds reliable data transfer is specially dependent on careful design of the head-to-tape contact.

5.6 Instantaneous Speed Variation (ISV)

An instantaneous speed variation event is said to have occured when the Residual Time Displacement Error (TDE) exceeds 156 ns when measured at 0,76 m/s and 252 ftpmm. The number of ISV events shall be a matter of agreement between the parties concerned.

See Appendix C for definitions and test method.

5.7 Acceleration

The cartridge shall be capable of withstanding any acceleration and deceleration of the linear tape motion up to a maximum of 50,8 m/s^2.

5.8 Driving Force

The tangential force required at the external driving surface of the belt capstan to maintain a constant operating speed shall be 1,0 N ± 0,3 N. The external radial load applied to the belt capstan when making this measurement shall be 5,6 N ± 0,6 N.

5.9 Total Inertia

The total equivalent mass of all moving cartridge elements, when measured at the external driving surface of the capstan, shall be 0,022 kg maximum.

5.10 Dynamic Response

5.10.1 Definition

The speed response of tape motion to a step driving function applied to the belt capstan.

5.10.2 Requirement

The natural resonant frequency shall be at least 60 Hz.

5.10.3 Procedure

A drive capable of producing a pronounced overshoot of the tape speed should be used. The drive servo should be critically damped so that the overshoot observed is not that of the drive. The reciprocal of the time measured between the first two over-speed peaks is the natural resonant frequency.

5.11 Tape Tension

5.11.1 Definitions

5.11.1.1 Tape tension

Tape tension is the resultant force in the longitudinal direction of the tape on a cross-section of the tape taken through the tape perpendicular to the longitudinal direction.

5.11.1.2 Instantaneous tension

Instantaneous tension is the tape tension as measured at the cross-section of the tape located at the head position of the free tape path and average over 10 ms.

5.11.1.3 Average tension

Average tension at a point along the length of the tape is the average value of the instantaneous tension measured over 1 m of tape symmetrically located around that point.

5.11.1.4 Dynamic tape tension

Dynamic tension at a point along the length of the tape is the maximum variation of instantaneous tension over the 1 m of tape symmetrically located around that point.

5.11.1.5 Transverse tape tension variation

Transverse tape tension variation is that variation of average tension across the tape produced by the difference in free tape path length between the two edges of the tape.

5.11.2 Procedures

For test procedures see Appendix D.

5.11.3 Requirements

5.11.3.1 Value of instantaneous tension

5.11.3.1.1 In the Testing Environment the Instantaneous Tension at any point along the length of the tape between LP and EW shall be between 0,28 N and 0,98 N.

5.11.3.1.2 In the Operating Environment the Instantaneous Tension shall be between 0,14 N and 1,12 N. When the temperature is brought back to that of the Testing Environment the requirements of 7.11.3.1.1 shall be met.

5.11.3.2 Value of dynamic tension

The dynamic tension at any point along the length of the tape between LP and EW shall not exceed 0,21 N.

5.11.3.3 Requirement for Transverse Tension Variation

The test rod shall not deviate from the horizontal by more than 4^{o} at any point along the length of the tape from LP to EW.

5.12 Drive Ratio

The ratio of the tape speed to the surface speed of the external driving surface of the belt capstan shall be 0,76 ± 0,02.

5.13 Tape Path Length

The cartridge shall be used with drives causing an increase of the tape path length in the range 0,38 mm to 1,40 mm.

NOTE 4:

The length of the tape path is the length of the straight tangent common to the tape guides when the cartridge is not mounted in the drive. It is measured between the two contact points of the tape with the guides. When the cartridge is mounted in the drive, the head and/or other parts of the drive provoke an increase of this tape path length which affects the initial tape tension.

5.14 Electrical Resistance of the Belt Capstan

The electrical resistance of the belt capstan shall not exceed 1 MOhm when measured using the test equipment and test procedures described in Appendix E.

SECTION V

LAYOUT OF TRACKS AND DATA REPRESENTATION

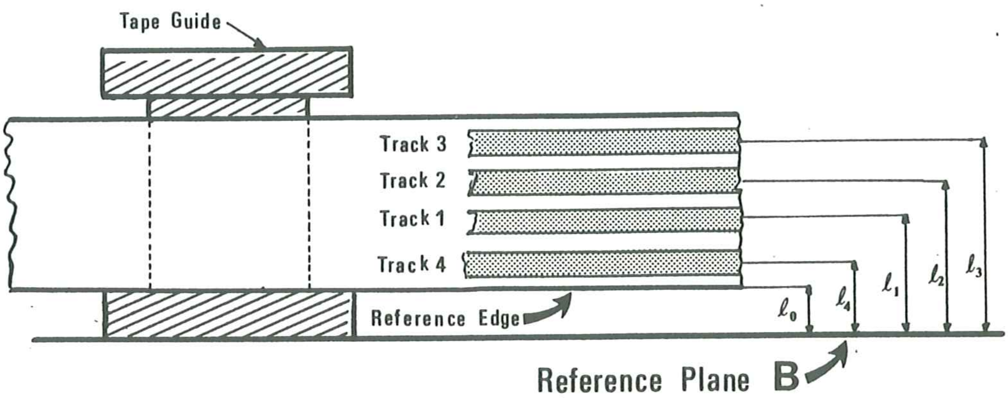
6. LAYOUT OF TRACKS

6.1. Reference Plane B and Reference Edge

All positioning requirements shall be referred to the top of the base plate and the cartridge, which is Reference Plane B. The Reference Edge shall be the edge of the tape positioned at a distance:

$$\ell_0 = 1{,}78 \text{ mm} \pm 0{,}01 \text{ mm}$$

from Reference Plane B.



6.2 Number of Tracks

There shall be four parallel tracks numbered track 4, track 1, track 2, and track 3. Track 4 is the track nearest to the Reference Edge, track 3 being the track farthest from the Reference Edge.

6.3 Track Centreline Location

The track centreline locations shall be:

For track 1 : ℓ_1 = 4,11 mm ± 0,20 mm

For track 2 : ℓ_2 = 5,74 mm ± 0,20 mm

For track 3 : ℓ_3 = 7,37 mm ± 0,20 mm

For track 4 : ℓ_4 = 2,48 mm ± 0,20 mm

6.4 Track Width

The track width shall be 0,914 mm ± 0,050 mm

7. DATA REPRESENTATION

Characters shall be represented by means of the 7-bit Coded Character Set (Standard ECMA-6) and, where required, by its 7-bit or 8-bit extensions (Standard ECMA-35) or by means of the 8-bit Coded Character Set (Standard ECMA-43).

7.1 Recording of 7-bit Coded Characters

Each 7-bit coded character shall be recorded in bit positions B_1 to B_7 of an 8-bit byte; bit-position B_8 shall always be recorded with ZERO. The relationship shall be as follows:

Bits of the 7-bit combination	0	b_7	b_6	b_5	b_4	b_3	b_2	b_1
Bit-positions in the byte	B_8	B_7	B_6	B_5	B_4	B_3	B_2	B_1

7.2 Recording of 8-bit Coded Characters

Each 8-bit coded character shall be recorded in bit positions B_1 to B_8 of an 8-bit byte. The relationship shall be as follows:

Bits of the 8-bit combination	b_8	b_7	b_6	b_5	b_4	b_3	b_2	b_1
Bit-positions in the byte	B_8	B_7	B_6	B_5	B_4	B_3	B_2	B_1

SECTION VI

METHOD OF RECORDING AND TRACK LAYOUT

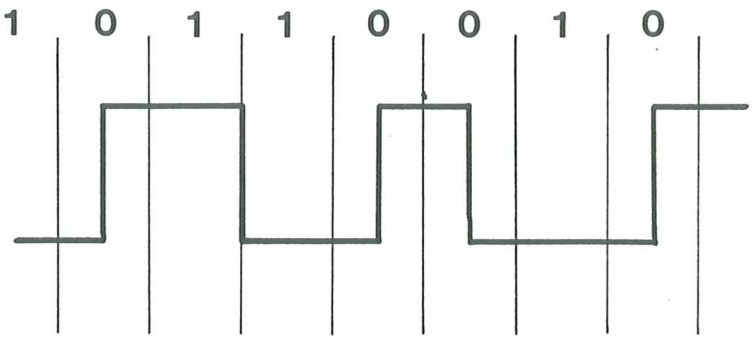
8. RECORDING

8.1 Method of Recording

The recording method shall be Inverted Modified Frequency Modulation (IMFM) for which the conditions shall be:

i) a flux transition shall be written at the centre of a bit cell containing a ZERO,

ii) a flux transition shall be written at the cell boundary between consecutive bit cells containing ONEs.



8.2 Measurement

All signal measurements shall be made at the point in the read chain where the amplitude is proportional to the rate of change of flux in the read head. The ratio of tape speed to the surface speed of the belt capstan shall be assumed to be exactly 0,76.

8.3 Density of Recording

8.3.1 The nominal recording density shall be 252 ftpmm. The nominal bit cell length shall be 3,97 um.

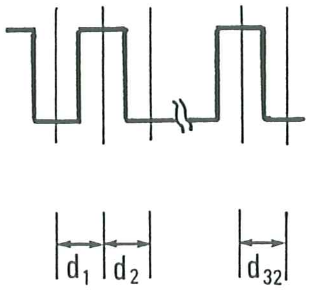
8.3.2 The long-term average bit cell length shall be the average bit cell length measured over at least 500 000 flux transitions. It shall be within ± 3% of the nominal bit cell length.

8.3.3 The short-term average bit cell length, referred to a particular bit cell, shall be the average of the lengths of the preceding four bit cells. It shall be within ± 7% of the long-term average bit cell length and shall be within ± 2% of the average bit cell length of any string of 128 consecutive bit cells containing the said particular bit cell.

8.4. Flux Transition Spacing

8.4.1 Effect of asymmetry

At nominal recording density the average variation of spacing between consecutive flux transitions, taken over 32 flux transition spacings, shall not be greater than 2%.

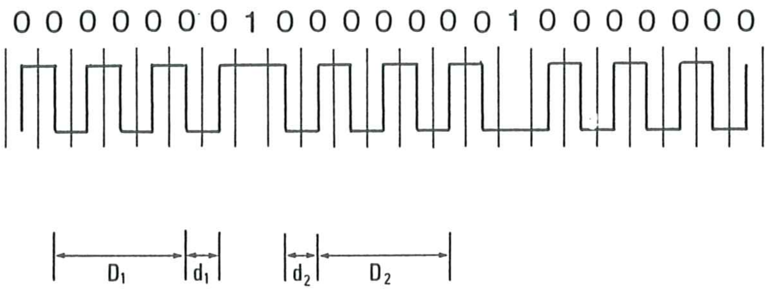


$$\frac{1}{31}\sum_{1}^{31}\frac{|d_i - d_{i+1}|}{\frac{d_i + d_{i+1}}{2}} \leqslant 0{,}02$$

8.4.2 Effect of Data Patterns

In each of the two possible sequences of flux transitions defined by bit pattern 000000010000000010000000 the spacing d_1 between the two ZERO flux transitions preceding the ONE bit cell shall not exceed the average of the four earlier flux transition spacings by more than 12%.

Similarly, the spacing d_2 between the two ZERO flux transitions following the ONE bit cell shall not exceed the average of the four subsequent flux transition spacings by more than 12%.



$$\frac{|d_1 - 0{,}25\,D_1|}{0{,}25\,D_1} \leqslant 0{,}12 \geqslant \frac{|d_2 - 0{,}25\,D_2|}{0{,}25\,D_2}$$

8.5 Signal Amplitude of the Interchanged Cartridge

8.5.1 The average peak-to-peak signal amplitude at 252 ftpmm shall not deviate by more than +50%, -35% from SRA_{252}.

Averaging shall be done over a minimum of 6400 flux transitions, which may be segmented into blocks.

8.5.2 No peak-to-peak signal amplitude at 126 ftpmm shall be more than 3 times SRA_{252}.

8.6 Minimum Signal Amplitude

No cartridge when interchanged shall contain flux transitions the base-to-peak amplitudes of which are less than 35% of half SRA_{252}.

8.7 Erasure

After erasure any signal amplitude shall be less than 3% of the SRA_{252}.

8.8 Recording Offset Angle

On any track the angle that a flux transition across the track makes with a line perpendicular to Reference Plane B shall not exceed 9 minutes of arc.

9. TRACK FORMAT

9.1 Use of Tracks

Each track shall be a data track and shall be written serially in the direction from the BOT marker to the EOT marker. No data for interchange shall be written between the BOT marker and the LP marker. Data for interchange shall be written after sensing the LP marker and may continue to be written after sensing the EW marker.

9.2 Location of Characters on the Tracks

Each character shall be located in a byte of eight bit positions along the track numbered from 1 to 8 in order of recording.

9.3 Sequence of Recording

The least significant bit shall be recorded first. The information to be interchanged shall be recorded serially by bit and by character.

Bit-positions : ...4321|87654321|8765432...

Forward tape motion : →

Resulting recording direction : ←

9.4 Data Block

A data block shall consist of a preamble, a data portion, a CRC character and a postamble.

PREAMBLE	DATA	CRC	POSTAMBLE
000....001	8-bit bytes	one 16-bit byte	100....000
min. 39 ZEROs max. 47 ZEROs	min. 12 bytes max. 8196 bytes		min. 39 ZEROs max. 47 ZEROs

9.4.1 Preamble

Immediately preceding data in each data block the preamble, consisting of at least 39 ZEROs and at most 47 ZEROs followed by a single ONE, shall be written.

9.4.2 Data portion

The data portion of a data block shall contain a minimum of 12 data bytes and a maximum of 8192 data bytes.

9.4.3 Cyclic Redundancy Check (CRC)

The 16 bits following the data portion of a data block shall be a Cyclic Redundancy Check (CRC) character. This 16-bit character shall be written in each data block following the data portion and immediately preceding the postamble, the least significant bit being recorded first. The polynomial generating the CRC shall be:

$$x^{16} + x^{15} + x^2 + 1$$

9.4.4 Postamble

Immediately following the CRC in each data block the postamble, consisting of a ONE followed by at least 39 ZEROs and at most 47 ZEROs, shall be written.

9.5 Control Block

A control block shall consist of a preamble, two bytes of eight ZEROs, and a postamble.

9.6 Gaps

9.6.1 Integrity of gaps

The gaps shall be erased.

9.6.2 Initial gap

The gap between the LP marker and the first data block shall be 152,4 mm minimum and 1,2 m maximum.

9.6.3 Interblock gaps

The interblock gap shall have a minimum length of 31 mm and a maximum length of 1,2 m. Any gap in excess of 1,2 m shall be considered end of data on this track.

NOTE 5:

The ability to start or stop within a gap of a given length is dependent on the tape speed selected from the range specified in 5.5 and the acceleration specified in 5.7.

SECTION VII

DRAWINGS

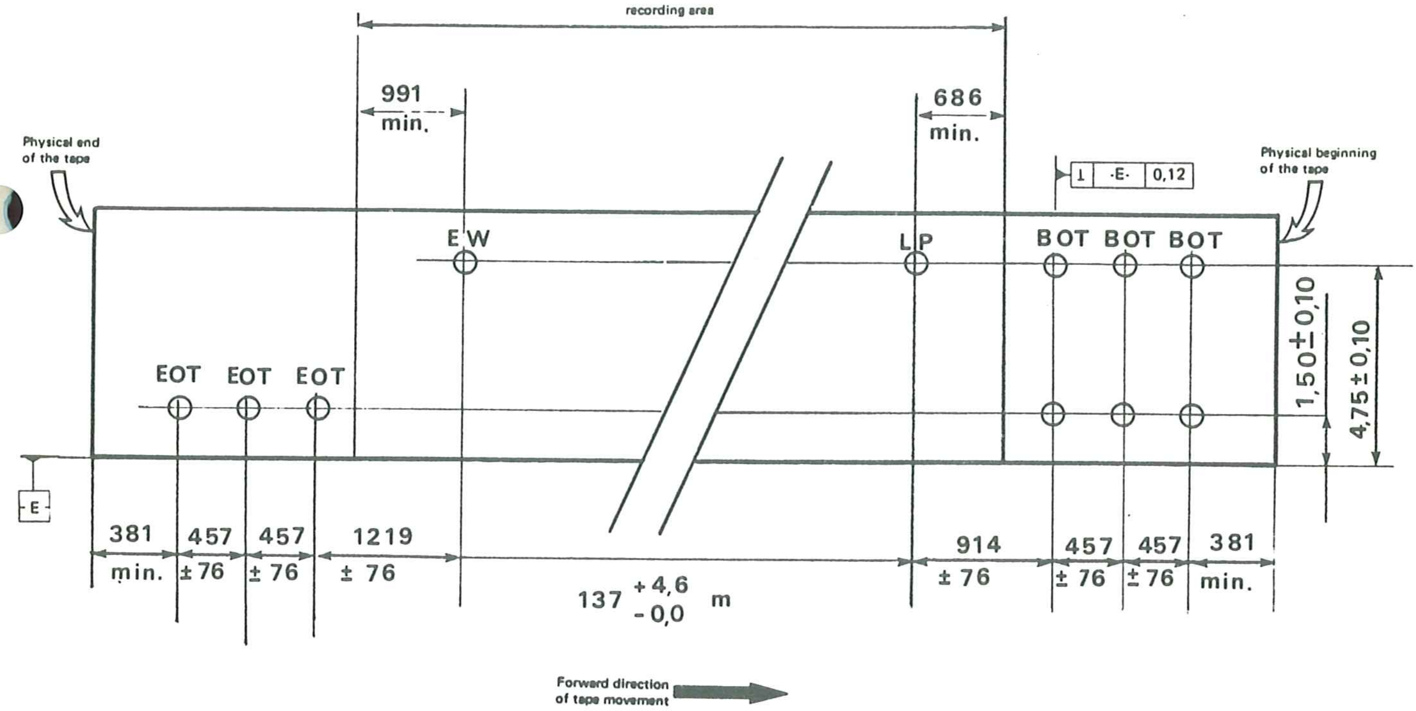


Fig. 1 - Position of the markers and recording areas
(magnetic surface shown)

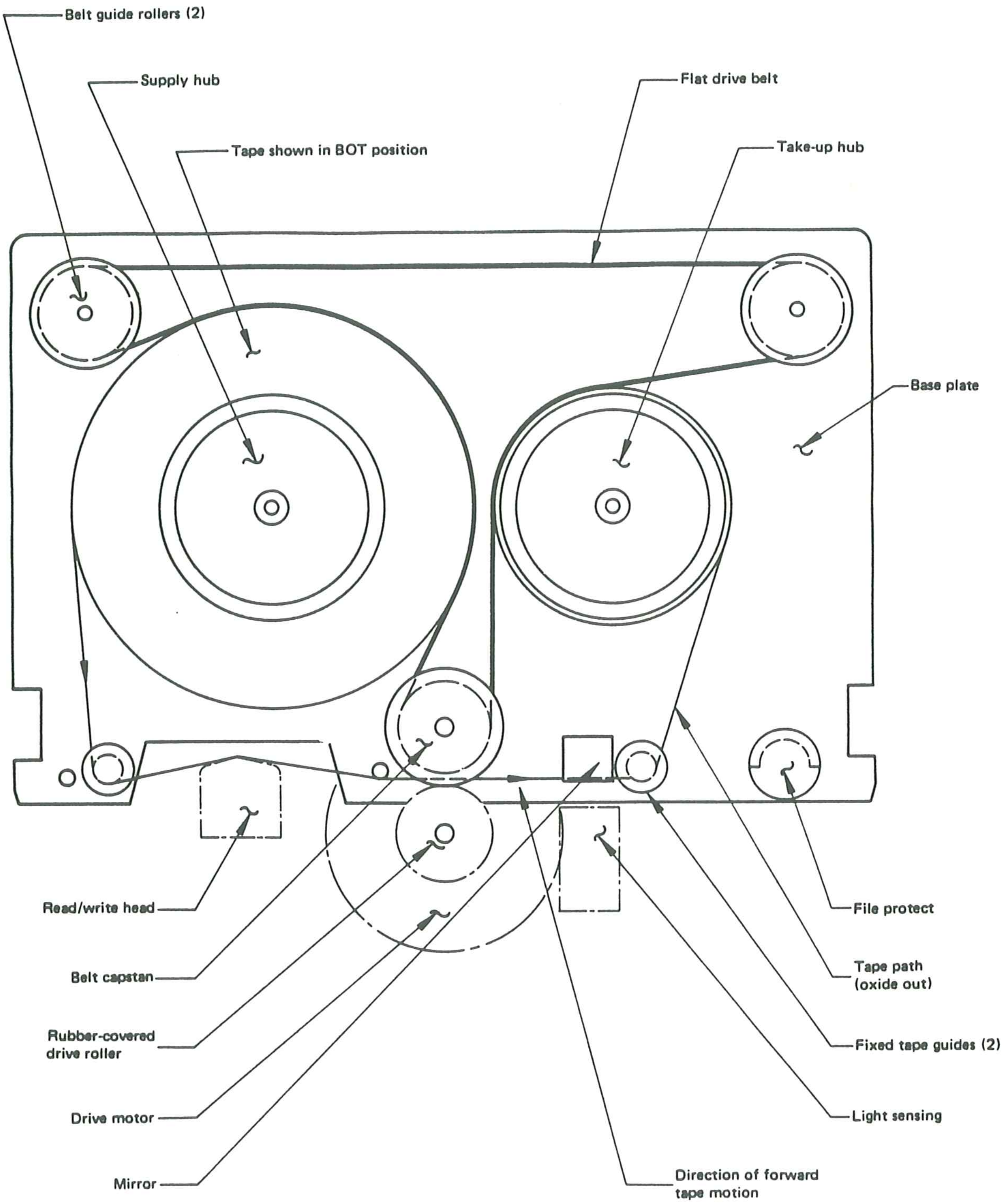


Fig. 2 - Cartridge diagram

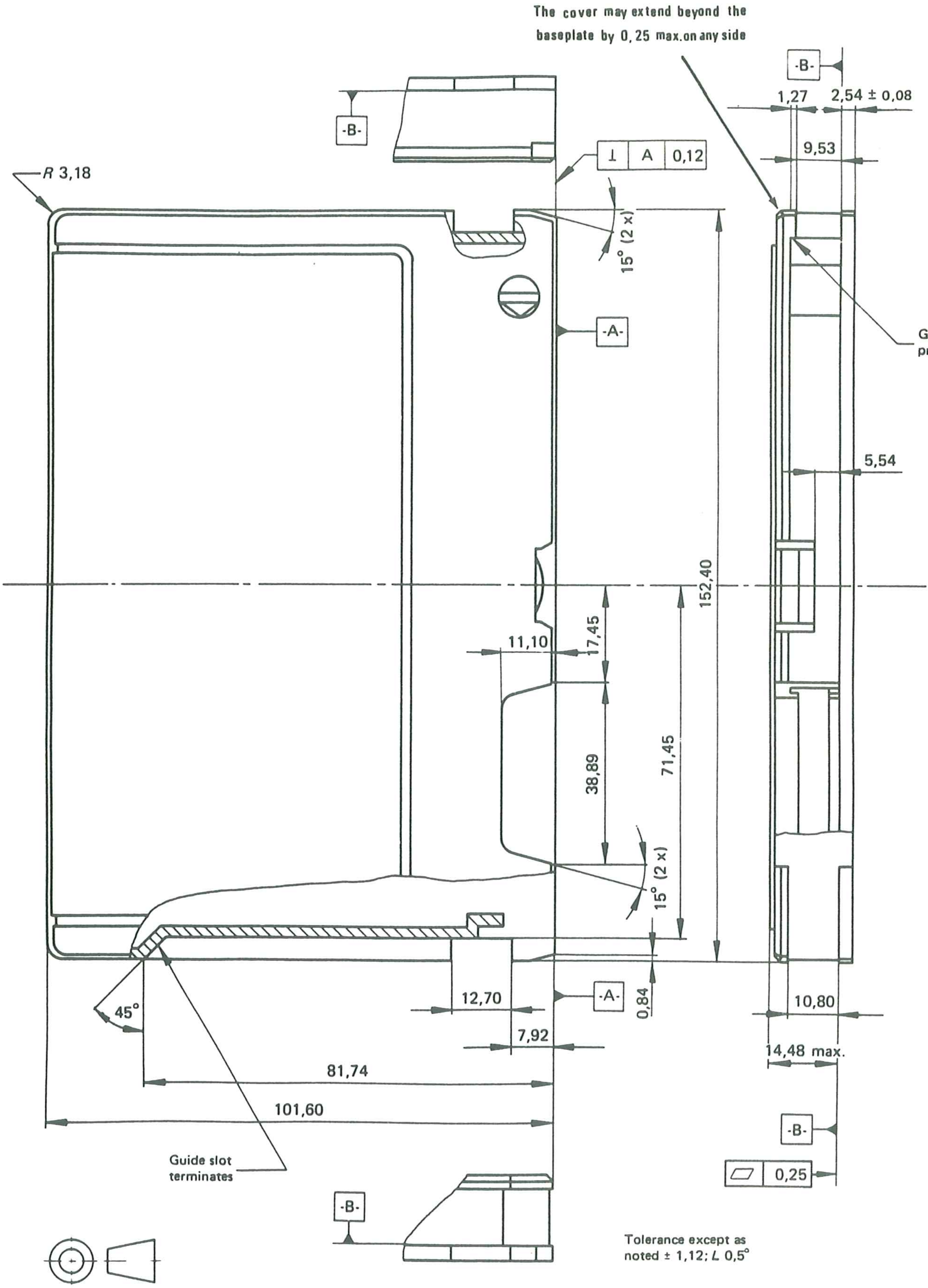


Fig. 3 - Cartridge dimensions

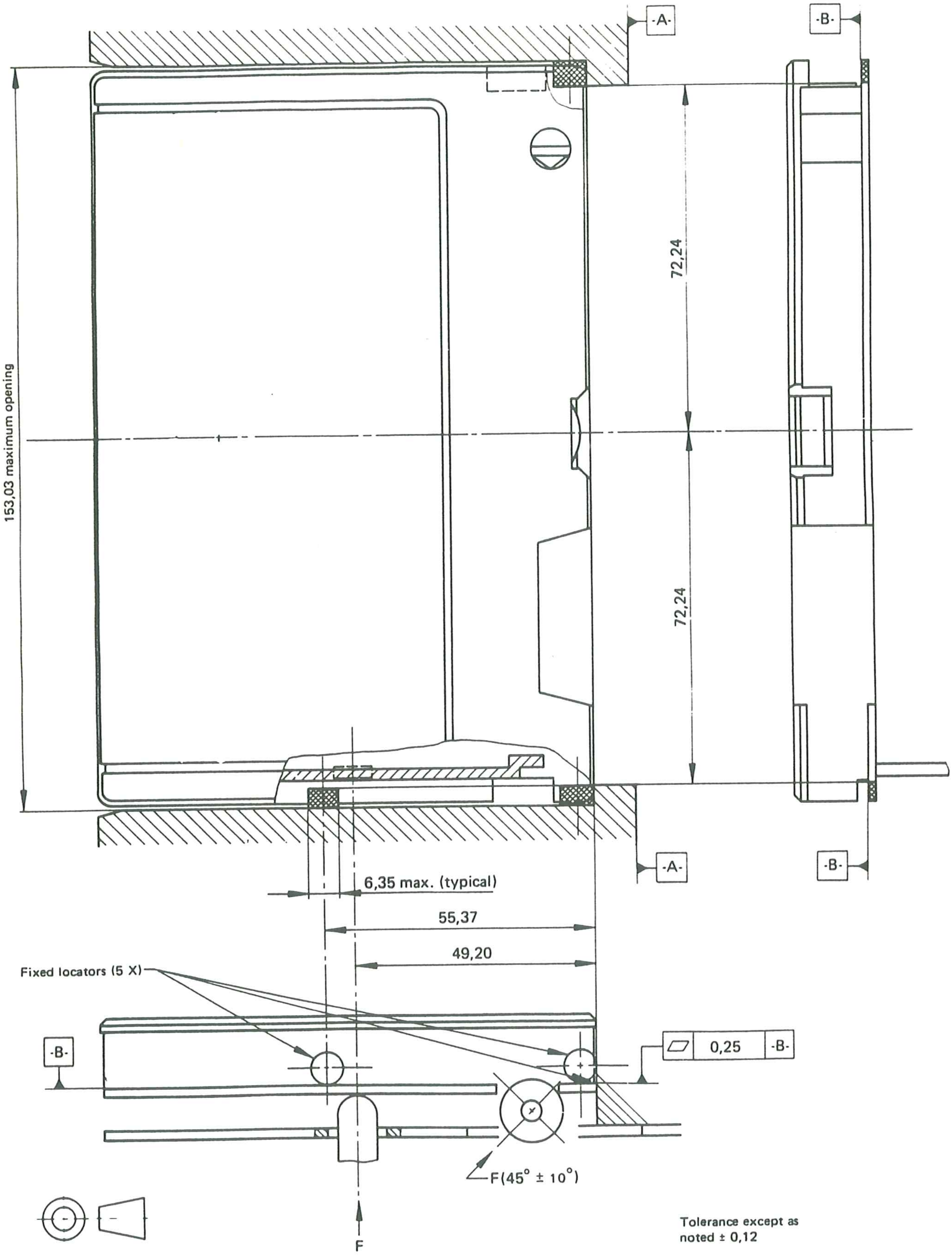


Fig. 4 - Cartridge locating planes

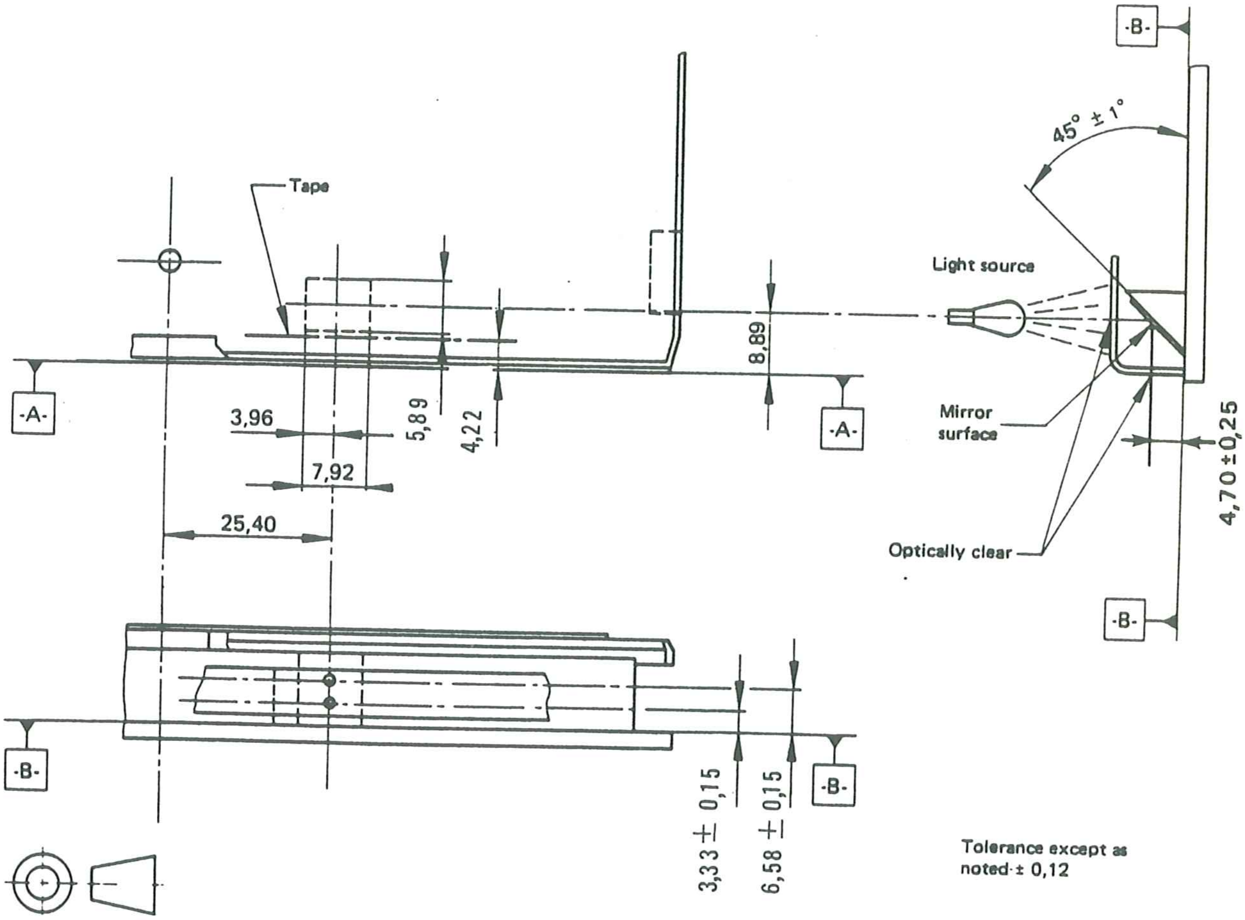


Fig. 5 - Light sensing

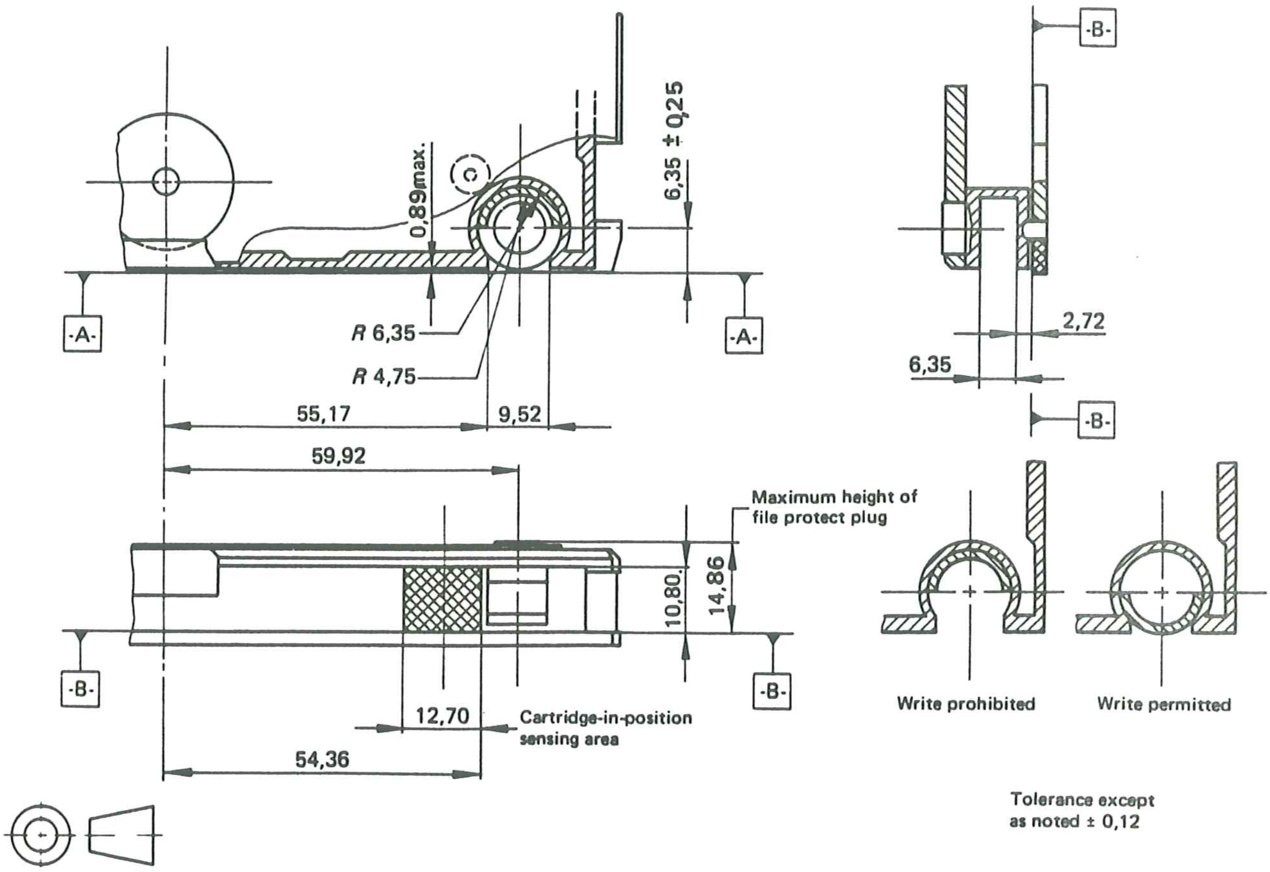


Fig. 6 - File protect and cartridge-in-position sensing

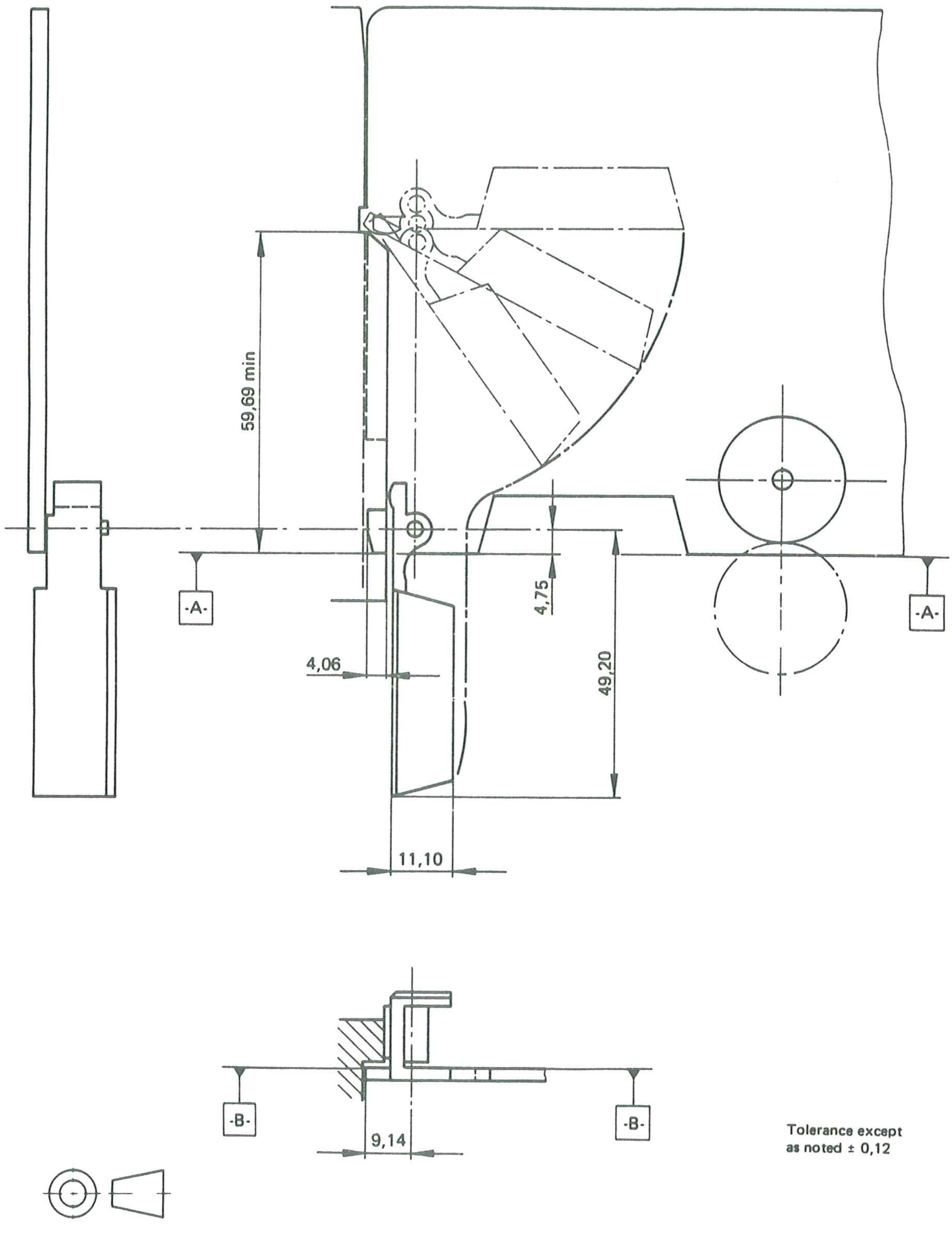


Fig. 7 - Cartridge door profile

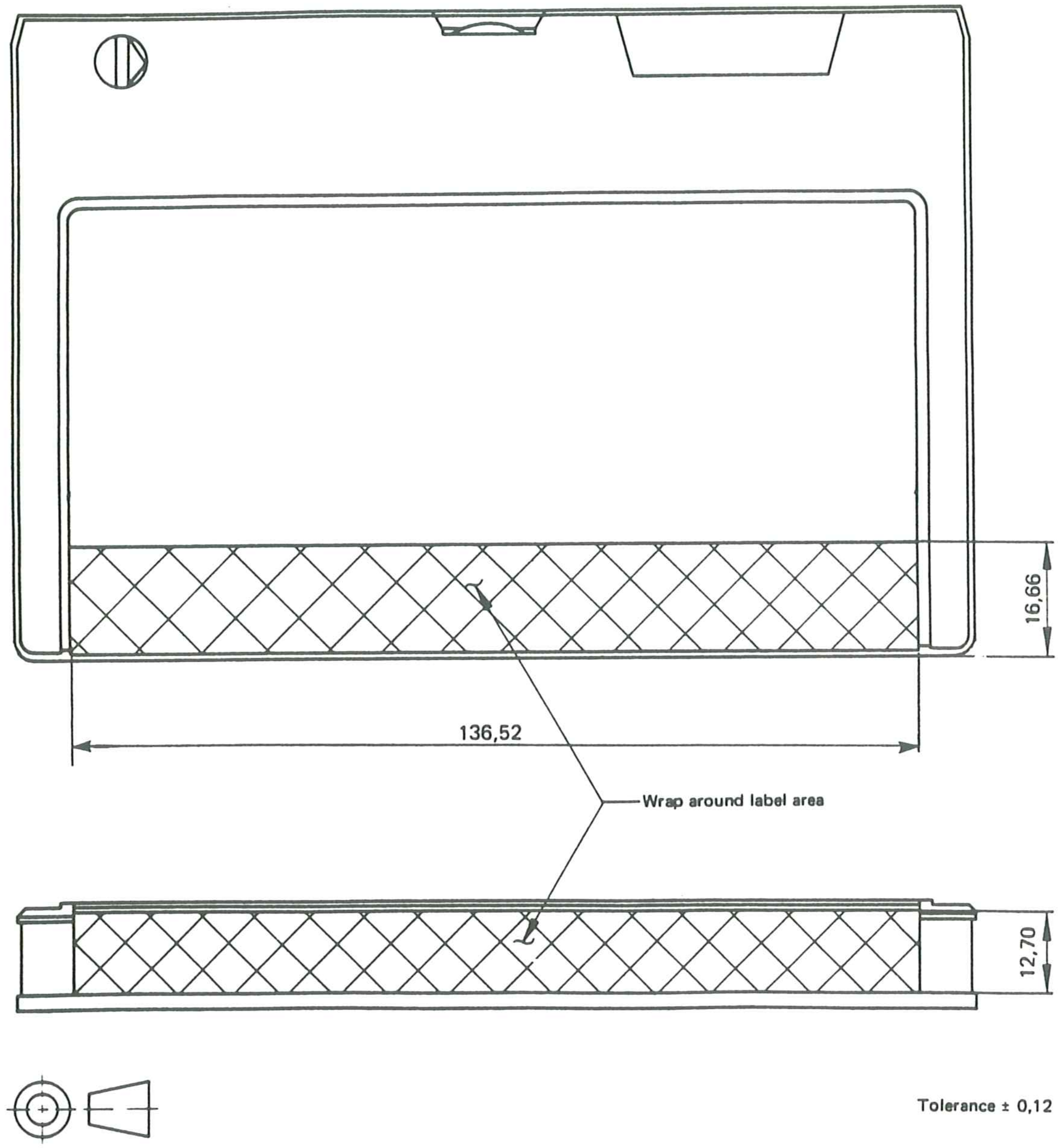


Fig. 8 - Label area

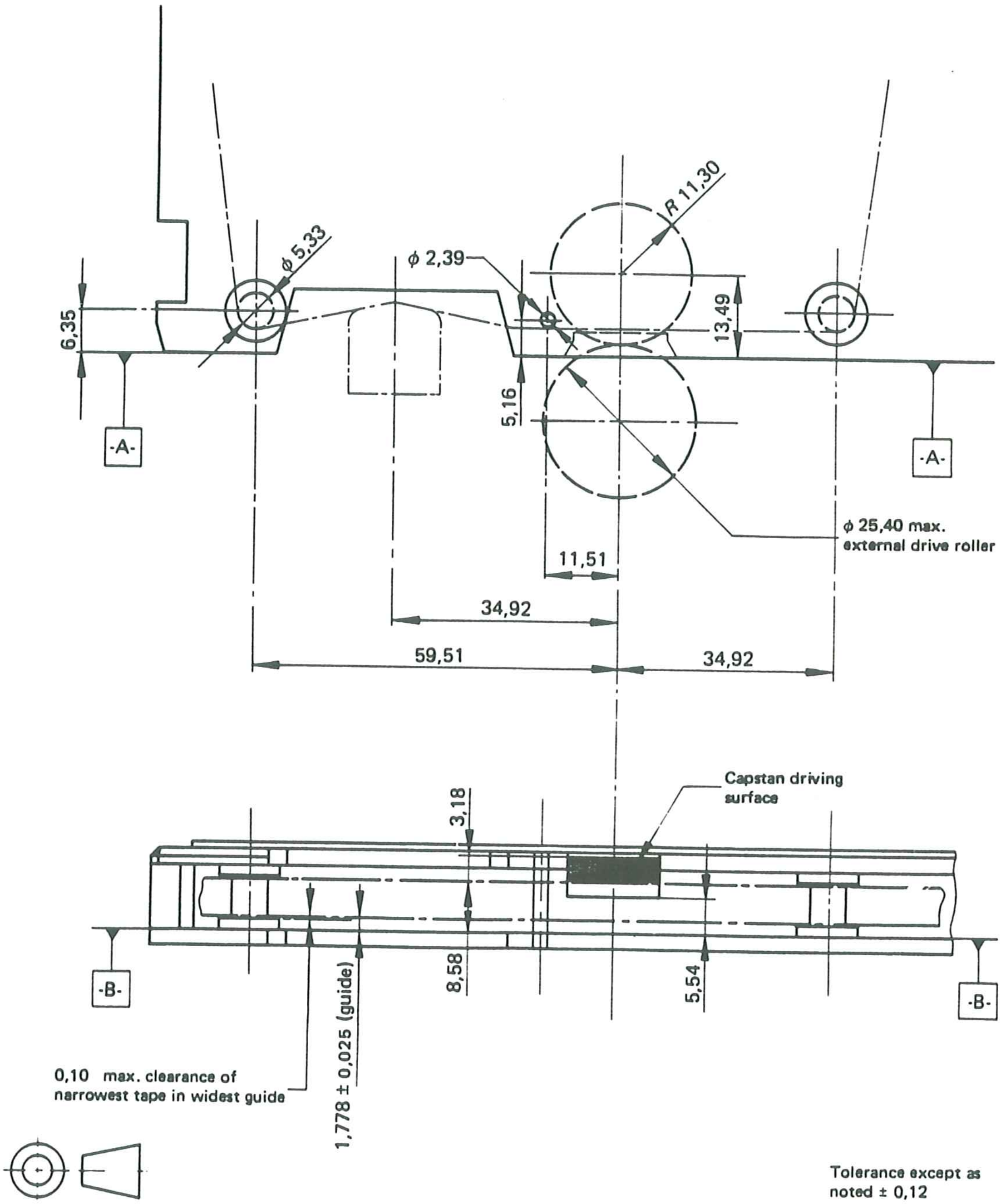


Fig. 9 - Tape path and drive dimensions

SECTION VIII

APPENDICES

APPENDIX A

MEASUREMENT OF LIGHT TRANSMITTANCE

A.1 INTRODUCTION

The description in the following paragraphs outlines the general principle of a test device and the test method to be employed when measuring the radiation (light) transmittance of magnetic tape for each of two radiation sources.

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 tape 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 test device are:

- the radiation sources
- the optical path
- the measuring mask
- the photocell
- the measuring equipment

A.2 DESCRIPTION OF THE TEST DEVICE

A.2.1 Radiation Sources

A tungsten lamp is used as one radiation (light) source and should be operated in an under-run state.

The colour temperature should be 2000 K ± 200 K and a resulting illumination at the surface of the tape sample of about 5000 lux is recommended. A light emitting diode is used as the second radiation source. The output wavelength shall be 940 nm ± 50 nm.

A.2.2 Optical Path

The radiation should be perpendicular to the tape sample and be of substantially uniform intensity. Typically the tape sample should be separated from the source by a distance of 150 mm.

A diaphragm of the form shown in Fig. A 1 is recommended in order to sensibly ensure that scattered radiation does not enter the mask area.

A.2.3 Measuring Mask Geometry

The measuring mask shall be constructed in one piece according to the drawing shown in Fig. A 2. A good matt black finish capable of absorbing infra-red radiation is necessary.

Special care must be taken to ensure that the tape sample to be measured is maintained flat in contact with the inner face of the mask.

A.2.4 Photocell

A flat silicon photocell should be used. Its dimensions must be such that the active area of the photocell exceeds the diameter of the mask orifice. It should be mounted parallel and in close proximity to the outer face of the mask.

A.2.5 Measuring Equipment

The measuring equipment should be connected directly across the photocell to measure the output current. In order to be able to set the measuring equipment to full scale deflection (100%) a shunt potentiometer in the circuit must be provided or a fine adjustment of the lamp power supply voltage is required.

The load impedance across the photocell should be as low as possible and must not exceed 500 Ohm. The instrument should have a nominal accuracy of ± 0,05%.

A.3 TEST PROCEDURE

A.3.1 For the purpose of the test a sample strip of tape not shorter than 250 mm (10 in) is used.

- The measuring equipment is set to full scale reading representing (100%).
- The sample strip is inserted and 45 observations on different points along the sample are recorded.
- The sample strip is then withdrawn and full scale deflection (100%) is re-checked. If the reading lies outside the range of 99% to 101% the equipment is reset to 100% and a new set of 45 observations is recorded.

A.3.2 A statistical maximum value of light transmittance shall be determined according to the following formula:

$$\boxed{T = \bar{x} + K \cdot \sigma}$$

where x = mean value of n observations,
σ = accurate estimate of the lot standard deviation,
K = constant specified by the selected plan of inspection,
n = number of observations on the sample specified by the selected plan of inspection.

The T value so calculated is for use where inspection of lots of tape is by variables. Lot quality is judged in terms of percent defective and acceptance is lot by lot.

The plan is based upon single sampling (with σ known) and gives an

Acceptable Quality Level (AQL) of 0,5% defective

and a

Lot Tolerance Percent Defective (LTPD) of 1,26%.

The selected plan has a sample size letter of 0 and gives the values for:

$\kappa = 2{,}33$ and

$n = 45$ *

If $T \leqslant T_{max}$, the lot is accepted.
If $T > T_{max}$, the lot is rejected.

where T_{max} = maximum value of transmittance permitted.

A.4 GUIDANCE ON CONSTRUCTION

A.4.1 Experience has shown that a projector lamp is most suited as the tungsten source. When selecting a lamp, care must be taken to avoid a lamp with optical inhomogenities in the glass envelope. Also, if mirrors or lenses are used in the optical path, they must be placed such that no filament image occurs in the proximity of the mask and photocell area. It is necessary to operate the radiation sources from a stabilized, regulared power supply.

A.4.2 Special attention must be paid to all surfaces parallel to the optical path and in close proximity to the mask and photocell to avoid reflection of light. Similarly, the method of inserting the tape must ensure that no ambient light leaks through any slot arrangement.

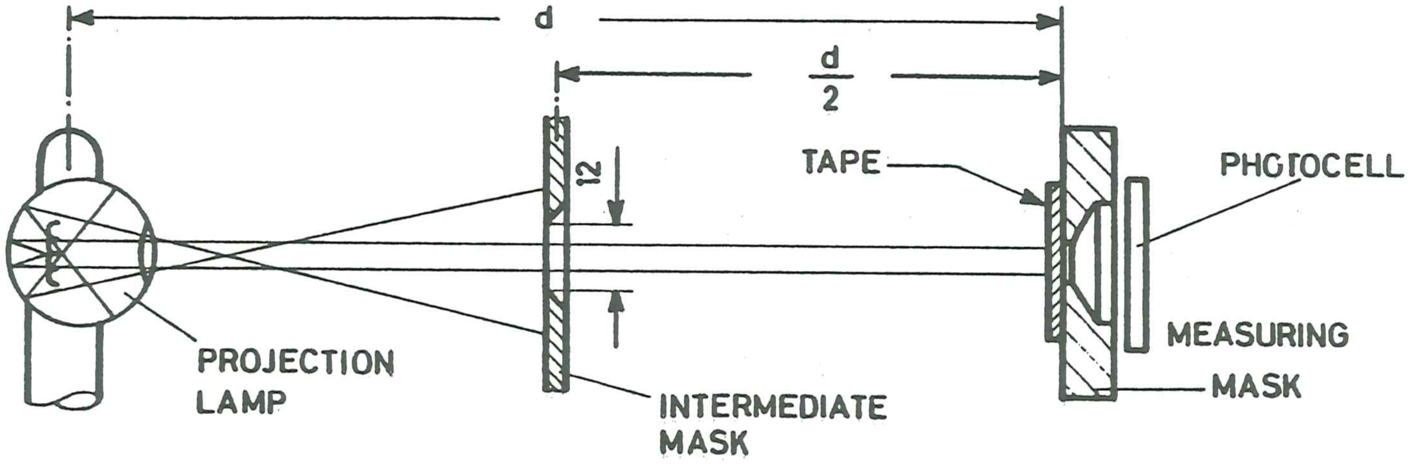
A.4.3 The accuracy of the measurement is dependent not only on attaining the dimensional tolerances shown in Fig. A 2, but also on the subsequent coating of the surfaces with a high quality optical matt black paint. The mask should be checked after coating to ensure that the small hole remains in tolerance. The method of holding the sample must be such that the tape is maintained flat in contact with the face of the mask. However, it must allow the sample to be moved without physical damage or distortion.

A.4.4 The photocell must be mounted with care, taking special precaution that the photocell leads do not interfere with the mounting arrangement. It is advisable that the face of the photocell presses slightly on the outer face of the mask.

A.4.5 An effective means of providing periodical calibration should be incorporated by inserting an opaque object for 0% light transmittance and a filter glass for 75% light transmittance.

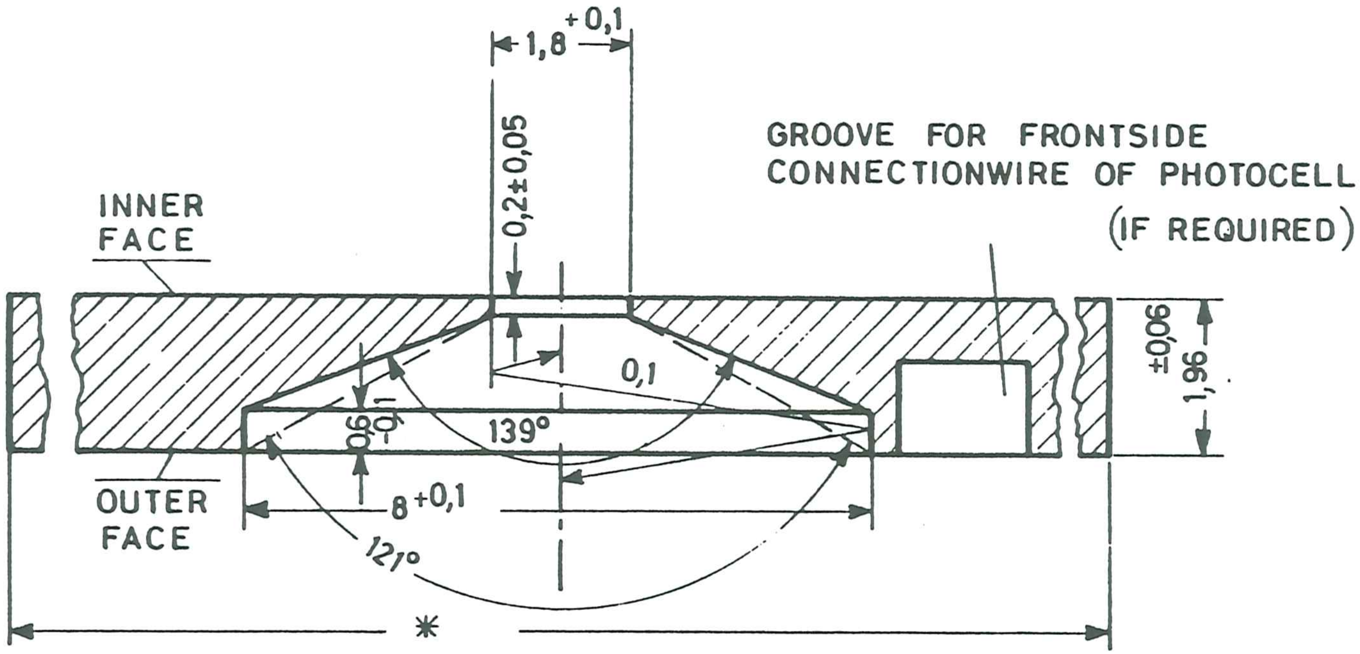
A.4.6 The test device should be cleaned periodically.

* *References: A.H. Bowker*
H.P. Goode
"Sampling Inspection by Variables"
McGraw-Hill 1952



d = approx. 150 mm

FIGURE A1 MEASURING DEVICE (DIAGRAM)



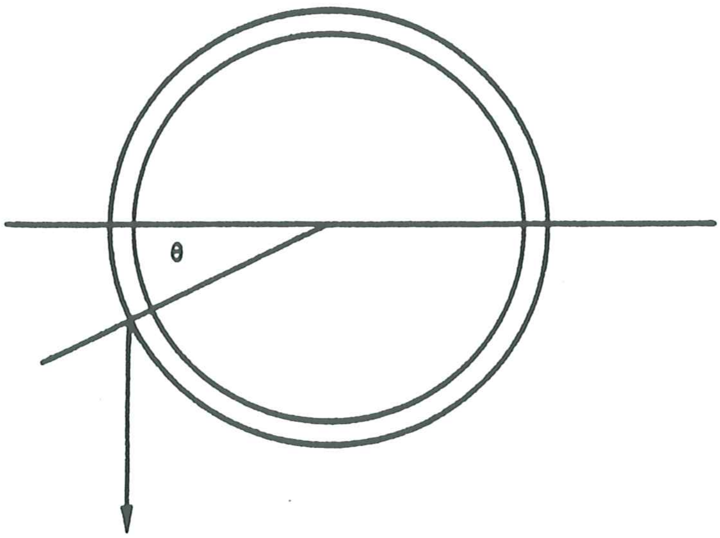
* DETERMINED BY USER

FIGURE A2 MEASURING MASK

APPENDIX B

LAYER-TO-LAYER ADHESION

A piece of the tape to be tested, about 1 m in length, shall be wound around a glass pipe, 36 mm in diameter, with a tension of 3 N, and fixed at the end. This shall be stored for 24 hours at a temperature of (45 ± 3) ^{o}C, and at 80% RH. After this period it shall be stored for another 24 hours in the testing environment specified in Section 3. The tape shall then be unwound with a mass of 8,3 g at the end of tape as shown below, and the angle (Θ) shall be smaller than 45^{o}.



APPENDIX C

INSTANTANEOUS SPEED VARIATION

C.1 GENERAL

When a tape is recorded at constant frequency, F_0, and played back, the frequency of the recovered signal will not be constant but will in general be $F_0 \pm \Delta F$.

$\Delta F/F_0$ is defined as Instantaneous Speed Variation (ISV) and can be resolved into a series of frequency components f_1, f_2, ... f_K, each of magnitude α_1, α_2, ... α_K, i.e.:

$$\sum_{i=1}^{K} \alpha_i \sin 2\pi f_i t$$

Due to this ISV, any flux transition will not be in its expected time location, but will exhibit a shift (Δt). This shift is defined as Time Displacement Error (TDE). It can be shown that, for any given component of ISV, the resultant TDE is:

$$\frac{\alpha_i}{2\pi f_i} \sin 2\pi f_i t$$

with a peak value of:

$$\frac{\alpha_i}{2\pi f_i}$$

A data separator phase-locked loop will normally follow the TDE and reduce it to some residual value (Residual TDE). The degree of reduction (suppression) is equal to (1+G), where G is the open-loop gain at the frequency of interest.

Hence, residual TDE for a given frequency is:

$$TDE_R = \frac{\alpha_i}{2\pi f_i} \frac{1}{1+G_i}$$

For the purpose of defining allowable TDE for interchange, a standard phase-locked loop gain of the form:

$$G = \left(\frac{f_n}{jf}\right)^2 \left(1 + j\sqrt{2}\ \frac{f}{f_n}\right)$$

is established, leading to a suppression function of:

$$\frac{1}{1+G} = \frac{\left(\frac{jf}{f_n}\right)^2}{1 + j\sqrt{2}\ \frac{f}{f_n} + \left(\frac{jf}{f_n}\right)^2}$$

The magnitude of the suppression function is:

$$\frac{1}{1+G} = \frac{\left(\frac{f}{f_n}\right)^2}{\sqrt{\left(1 - \left(\frac{f}{f_n}\right)^2\right)^2 + 2\left(\frac{f}{f_n}\right)^2}}$$

This is shown as a function of frequency in Figure 14.

$f_n = F_0/17$

NOTE C.1

For tape speeds other than 0,76 m/s, the natural frequency of the loop may be scaled linearly.

NOTE C.2

The maximum allowable single-frequency ISV which would result in a value of TDE within the specification is shown in Figure C.3).

C.2 TEST CIRCUIT

The standard loop (Fig. C.1) shall be designed as detailed below.

$$\frac{K_1 K_2}{C\ R_1} = \left(2\pi f_n\right)^2 = 1,25 \cdot 10^9$$

$$CR_2 = \frac{1}{2\pi \cdot 4 \cdot 10^3}$$

$$TDE_{OUT} = \frac{1}{K_1 F_0} \quad s/V$$

$$F_0 = 96 \text{ kHz}$$

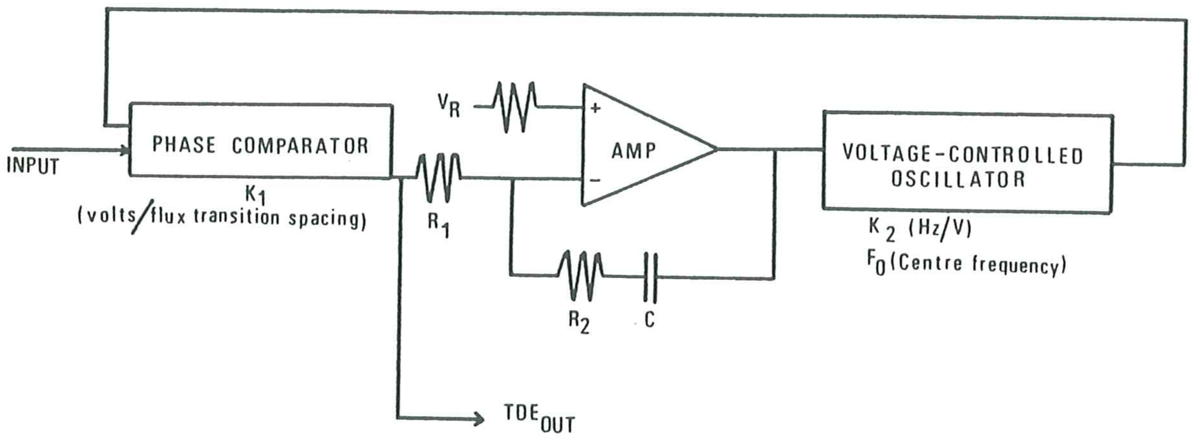


Fig. C1 STANDARD LOOP

C.3 TEST METHOD

C.3.1 Record the tape with a constant recording density of 252 ftpmm full length, two tracks.

C.3.2 Read the tape signals at 0,76 m/s, using the square wave output from the read channel connected to the input of the standard loop.

C.3.3 Count the TDE events which exceed 156 ns (3% of the nominal cell time at 252 ftpmm.

C.3.4 TDE events within 12,7 mm shall be considered as a single event. TDE events caused by missing pulses shall be ignored.

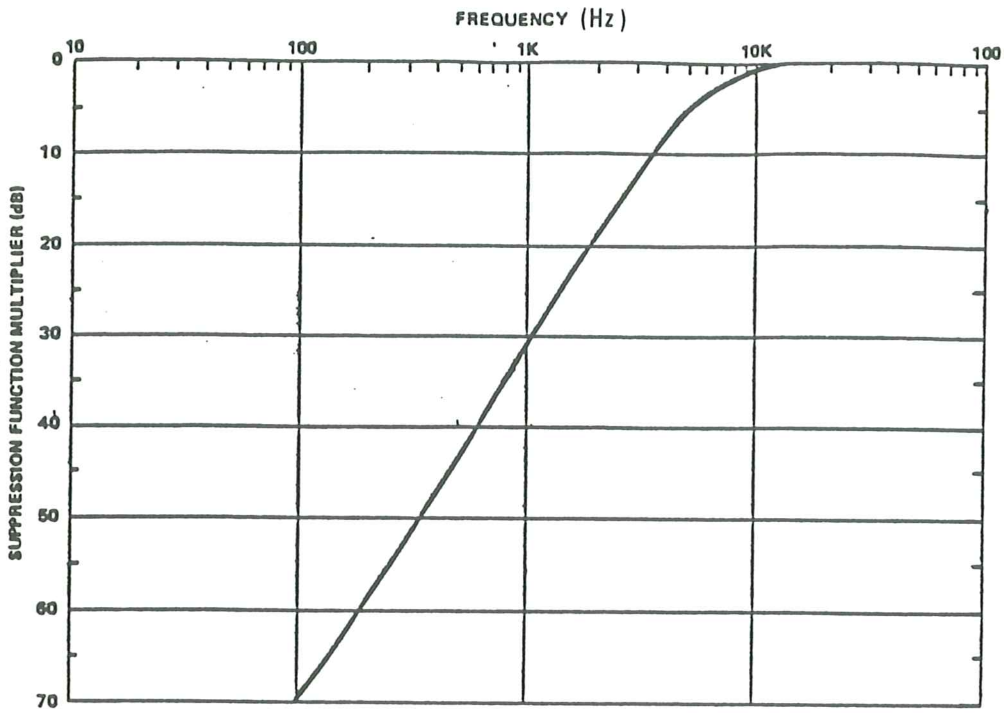


Fig. C2 Suppression Function

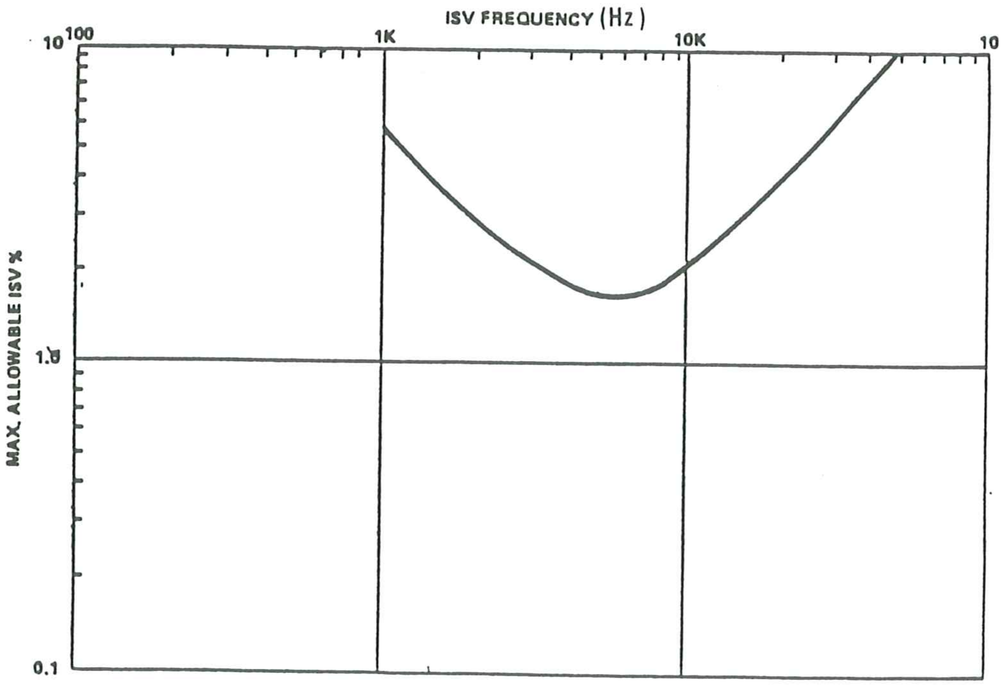


Fig. C3 Maximum Allowable ISV

APPENDIX D

TAPE TENSION

D.1 TEST PROCEDURE FOR MEASURING INSTANTANEOUS TENSION

D.1.1 Conditioning

Condition the tape before testing by winding at 2,29 m/s from BOT to EOT, and back to BOT.

D.1.2. Tape Speed

The tape speed during testing shall be 0,76 m/s.

D.1.3 Position of the Measuring Transducer

D.1.3.1 The measuring transducer shall be positioned at the point along the free tape path at which the head would be located if the cartridge were mounted in a drive.

D.1.3.2 When inserted in the tape path it shall cause an increase in the tape path length within the limits of 5.13.

D.1.3.3 It shall be perpendicular to the Reference Plane B $\pm$ 1^{o}.

D.1.4 Characteristics of the Measuring Transducer

D.1.4.1 The coefficient of friction of the bearing surface shall be less than 0,1.

D.1.4.2 The upper limit of its frequency response shall be at least 100 Hz.

D.1.4.3 The width of the bearing surface shall be sufficient for it to be in contact with the whole width of the tape.

D.2 TEST PROCEDURE FOR MEASURING TRANSVERSE TAPE TENSION VARIATION

D.2.1 Conditioning

Condition the tape before testing by winding at 2,29 m/s from BOT to EOT, and back to BOT.

D.2.2 Position of Tape for Measurement

D.2.2.1 The cartridge shall be held with Reference Plane B vertical, and the cartridge door on top and in the open position.

D.2.2.2 The tape shall remain stationary at the selected point.

D.2.3 Characteristics of the Test Rod

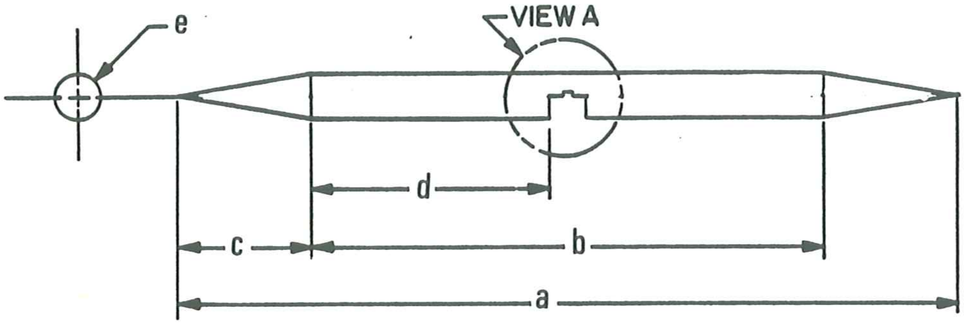
D.2.3.1 The form and dimensions of the test rod are given in Fig. D.1.

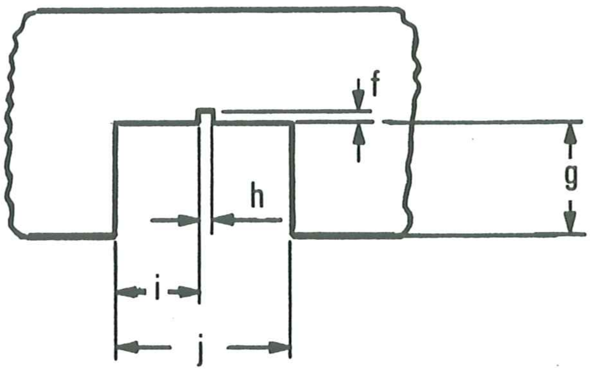
D.2.3.2 The mass of the test rod shall be 14 g ; suitable material is aluminium.

D.2.3.3 The centre of gravity shall be within 0,13 mm of a vertical line through the centre of the notch.

D.2.4 Position of the Test Rod

The slot of the test rod shall be centred over the point along the free tape path at which the head would be located if the cartridge were mounted in a drive.





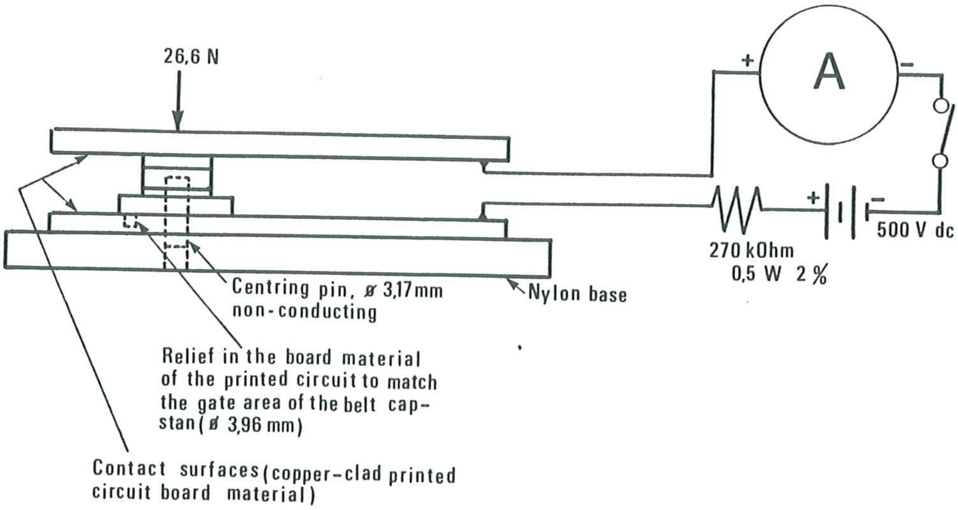
VIEW A

Dimension of the Rod

a	138,43	
b	90,78	
c	23.82	
d	42,21	± 0,13
e	7,92	
f	0,25	
g	3,96	
h	0,279	
i	3,025	± 0,025
j	6,325	

APPENDIX E

ELECTRICAL RESISTANCE OF THE BELT CAPSTAN



E.1 PROCEDURE

E.1.1 Ensure that the contact surfaces of the belt capstan and test fixture are clean and free from oil, grease, tarnish or other contaminants before making the rest.

E.1.2 Place the belt capstan on the centring pin of the bottom contact surface, with the gate area over the relief.

E.1.3 Place the upper contact surface on top of the belt capstan and apply a force of 26,6 N centrally over the capstan.

E.1.4 Measure the current flowing in the circuit when potential of 500 V ± 5 V is applied.

E.2 TEST RESULT

The current shall be 0,40 mA minimum.

APPENDIX F

DEFECT DENSITY

F.1 INTRODUCTION

To assess the number of rejected regions to be expected in any application for this cartridge, the concept of defect density has been introduced. With the concept of defect density and using a representative test for missing pulses and manufacturing data, the maximum number of rejected regions may be predicted for the cartridges in a given production lot. From these data the acceptability of these cartridges may be determined for use in accordance with this standard.

F.2 DEFINITIONS

F.2.1 Rejected region

A rejected region is a length of track of 25,0 mm in which one or more missing pulses have been detected.

F.2.2 Track width (TW)

The TW is the width of the recorded signal sensed by the read head.

F.2.3 Tested surface area

The tested surface area is that surface containing recorded signals, exclusive of erased gans or other non-used recording areas where missing pulses are not detectable. This tested surface area is the product of TW and the total length of track tested.

F.2.4 Defect density

The number of rejected regions, divided by the tested surface area, is the defect density and is expressed as defects per square millimeter (D/mm^2).

F.2.5 Threshold level (TL)

The TL is measured relative to the standard reference amplitude (SRA_{252}) and is expressed as a percentage.

F.2.6 Effective defect diameter (EDD)

The EDD is computed as follows:

$$EDD = (1 - \frac{TL}{100}) \times TW$$

F.3 PROCEDURE

The test is performed in-contact over the tested surface area.

F.4 REQUIREMENTS

The cartridge shall meet the following requirements:

Defect Density $\leqslant$ 0,0341 $e^{-19,3\ EDD}$ (D/mm^2)

F.5 EXAMPLE

F.5.1 Given:

Read track width	0,46 mm
Threshold level	40%
Number of tracks	4
Tested track length	138836 mm

F.5.2 Calculate:

EDD = 0,46 $(1 - \frac{40}{100})$ = 0,276 mm

Defect Density $\leqslant$ 0,00017 D/mm^2

Tested surface area = 138836 x 0,46 x 4 = 255458 mm^2

Maximum number of rejected regions = 0,00017 x 255458
= 44

F.5.3 Conclusion

The result in F.5.2 indicates that the maximum number of rejected regions is 44 for a cartridge operated under a given conditions. Cartridges with more than this number shall not be used for interchange.