# ECMA

EUROPEAN COMPUTER MANUFACTURERS ASSOCIATION

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## STANDARD ECMA-98

# DATA INTERCHANGE ON 6,30 mm MAGNETIC TAPE CARTRIDGE USING NRZ1 RECORDING AT 394 ftpmm STREAMING MODE

September 1985

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# BRIEF HISTORY

In the past decade ECMA TC19 has produced several standards for 6,30 mm Wide Magnetic Tape Cartridges.

Standard ECMA-46 specifies such a cartridge for a 4-track format at a physical density of 126 ftpmm using phase encoding with a data density of 8 cpmm per track.

Standard ECMA-79, first published in 1982, has now been revised, it specifies a 4-track format for start/stop mode at a physical density of 252 ftpmm using inversed modified frequency modulation (IMFM) with a nominal data density of 41 cpmm per track.

The present Standard ECMA-98 specifies a cartridge for use in streaming mode using NRZ1 at a physical density of 394 ftpmm. It specifies two alternative track formats of 4 and 9 tracks, respectively.

These last two ECMA standards have formed the basis for the corresponding International Standards ISO 8063 and ISO 8462, respectively.

This Standard has been accepted by the General Assembly of ECMA on June 13-14, 1985.

TABLE OF CONTENTS


| | Page |
|---|---|
| SECTION I - SCOPE AND CONFORMANCE, GENERAL DESCRIPTION, DEFINITIONS | |
| 1. SCOPE AND CONFORMANCE | 1 |
| 1.1 Scope | |
| 1.2 Conformance | 1 |
| 2. DEFINITIONS | 1 |
| 2.1 Magnetic Tape | 1 |
| 2.2 Reference Tape Cartridge | 1 |
| 2.3 Secondary Reference Tape Cartridge | 1 |
| 2.4 Typical Field | 2 |
| 2.5 Reference Field | 2 |
| 2.6 Test Recording Currents | 2 |
| 2.7 Signal Amplitude Reference Tape Cartridge | 2 |
| 2.8 Standard Reference Amplitude | 2 |
| 2.9 Average Signal Amplitude | 2 |
| 2.10 In-Contact | 2 |
| 2.11 Track | 3 |
| 2.12 Physical Recording Density | 3 |
| 2.13 Data Density | 3 |
| 2.14 Position of Flux Transitions | 3 |
| 2.15 Reference Alignment Tape Cartridge | 3 |
| 2.16 Recording Area | 3 |
| 2.17 Erasing Field | 3 |
| SECTION II - MECHANICAL AND PHYSICAL CHARACTERISTICS | |
| 3. ENVIRONMENT AND TRANSPORTATION | 4 |
| 3.1 Testing Environment | 4 |
| 3.2 Operating Environment | 4 |
| 3.3 Storage Environment | 4 |
| 3.4 Transportation | 4 |
| 3.4.1 Transportation environment | 4 |
| 3.4.2 Transportation procedures | 5 |
| 3.5 Conditioning of the Cartridge | 5 |
| 3.6 Flammability | 5 |
| 3.7 Toxicity | 5 |
| 4. CHARACTERISTICS OF THE TAPE | 5 |
| 4.1 Mechanical Properties | 5 |
| 4.1.1 Tape width | 5 |
| 4.1.2 Tape length | 5 |
| 4.1.3 Tape thickness | 6 |
| 4.1.4 Markers | 6 |
| 4.1.5 Light transmittance | 7 |
| 4.1.6 Tensile yield force | 7 |
| 4.1.7 Layer-to-layer adhesion | 7 |
| 4.1.8 Cupping | 7 |
| 4.1.9 Leaders and splices | 7 |

TABLE OF CONTENTS (cont'd)


| | Page |
|---|---|
| 4.1.10 Tape wind | 7 |
| 4.2 Electrical Surface Resistance | 8 |
| SECTION III - MAGNETIC CHARACTERISTICS OF THE UNRECORDED FLEXIBLE DISK CARTRIDGE | |
| 5. MAGNETIC PROPERTIES | 8 |
| 5.1 Test densities | 9 |
| 5.2 Test tracks | 9 |
| 5.3 Typical field | 9 |
| 5.4 Average Signal Amplitude | 9 |
| 5.5 Ease of Erasure | 9 |
| 5.6 Defect Density | 9 |
| 5.6.1 Definitions | 9 |
| 5.6.2 Procedure | 10 |
| 5.6.3 Requirement | 10 |
| 5.7 Recording Area | 10 |
| SECTION IV - CHARACTERISTICS OF THE CARTRIDGE | |
| 6. CHARACTERISTICS OF THE CARTRIDGE | 11 |
| 6.1 General Description | 11 |
| 6.1.1 Dimension | 11 |
| 6.1.2 Cartridge positioning planes | 11 |
| 6.1.3 Attachment | 11 |
| 6.1.4 Mounting position | 11 |
| 6.1.5 Light sensing | 11 |
| 6.1.6 Cartridge-in-position sensing | 11 |
| 6.1.7 Cartridge door | 12 |
| 6.2 File Protection | 12 |
| 6.3 Physical Labels | 12 |
| 6.3.1 Location and size | 12 |
| 6.3.2 Interchange | 12 |
| 6.4 Tape Guides | 12 |
| 6.5 Speed | 12 |
| 6.6 Instantaneous Speed Variation (ISV) | 12 |
| 6.7 Low-frequency Speed Variation | 12 |
| 6.8 Acceleration | 12 |
| 6.9 Driving Force | 13 |
| 6.10 Total Inertia | 13 |
| 6.11 Dynamic Response | 13 |
| 6.11.1 Definition | 13 |
| 6.11.2 Requirement | 13 |
| 6.11.3 Procedure | 13 |
| 6.12 Tape Tension | 13 |

TABLE OF CONTENTS (cont'd)


| | Page |
|---|---|
| 6.12.1 Definitions | 13 |
| 6.12.2 Procedures | 14 |
| 6.12.3 Requirements | 14 |
| 6.13 Drive Ratio | 14 |
| 6.14 Tape Path Length | 14 |
| 6.15 Dynamic Tape Skew | 14 |
| 6.16 Electrical Resistance of the Belt Capstan | 15 |
| SECTION V - TRACK FORMAT | |
| 7. REFERENCE PLANE | 16 |
| 8. TRACK GEOMETRY | 16 |
| 8.1 Track Location | 16 |
| 8.2 Number of Tracks | 17 |
| 8.2.1 4-track format | 17 |
| 8.2.2 9-track format | 17 |
| 8.3 Track Width | 17 |
| 9. RECORDING | 17 |
| 9.1 Method of Recording | 17 |
| 9.2 Physical Recording Densities | 17 |
| 9.3 Average Bit Cell Length Variations | 17 |
| 9.3.1 Average bit cell length | 17 |
| 9.3.2 Long-term average bit cell length | 17 |
| 9.3.3 Short-term average bit cell length | 18 |
| 9.4 Flux Transition Spacing | 18 |
| 9.4.1 Instantaneous flux transition spacing | 18 |
| 9.4.2 Rate of change of average flux transition spacing | 18 |
| 9.5 Signal Amplitude of a Recorded Cartridge for Data Interchange | 19 |
| 9.5.1 Average Signal Amplitude at nominal maximum density | 19 |
| 9.5.2 Minimum Signal Amplitude | 19 |
| 9.5.3 Maximum Signal Amplitude | 19 |
| 10. ERASURE | 19 |
| 11. RECORDING OFFSET ANGLE | 20 |
| 12. USE OF TRACKS | 20 |
| 12.1 4-track Format | 20 |
| 12.2 9-track Format | 20 |
| 12.3 Summary of Requirements for Use of Tracks and Reference Burst | 21 |
| 13. CODED REPRESENTATION OF THE DATA | 22 |
| 13.1 Standards | 22 |
| 13.2 Coding Methods | 22 |

TABLE OF CONTENTS (cont'd)

| | Page |
|---|---|
| 14. RECORDING OF CODED CHARACTERS ON THE TAPE | 22 |
| 15. TRACK FORMAT | 24 |
| 15.1 Data Block | 24 |
| 15.1.1 Preamble | 24 |
| 15.1.2 Block Marker | 24 |
| 15.1.3 Data | 24 |
| 15.1.4 Block Address | 24 |
| 15.1.5 CRC (Cyclic Redundancy Check) | 26 |
| 15.1.6 Postamble | 26 |
| 15.2 File Mark Block | 26 |
| 15.3 Control Blocks | 27 |
| 15.4 Use of Control Blocks | 28 |
| 15.4.1 Track 0 | 28 |
| 15.4.2 Further uses of Control Blocks | 28 |
| 16. END OF RECORDED DATA | 29 |
| 17. RE-WRITING OPERATIONS | 29 |
| 17.1 Re-writing Rules | 29 |
| 17.2 Rejection Criterion | 29 |
| 18. UPDATING OPERATIONS | 30 |
| 19. READING OPERATIONS | 30 |
| SECTION VI - APPENDICES | |
| APPENDIX A - MEASUREMENT OF LIGHT TRANSMITTANCE | 40 |
| APPENDIX B - LAYER-TO-LAYER ADHESION | 44 |
| APPENDIX C - INSTANTANEOUS SPEED VARIATION | 45 |
| APPENDIX D - ELECTRICAL RESISTANCE OF THE BELT CAPSTAN | 49 |
| APPENDIX E - TAPE TENSION | 50 |
| APPENDIX F - EXAMPLE OF WRITING OPERATIONS | 52 |

# SECTION I

SCOPE AND CONFORMANCE
GENERAL DESCRIPTION
DEFINITIONS

# 1. SCOPE AND CONFORMANCE

## 1.1 Scope

This ECMA Standard specifies a tape cartridge using a 6,30 mm magnetic tape intended for digital recording at physical recording densities of 252 ftpmm and 394 ftpmm.

It specifies the mechanical, physical and magnetic properties of the cartridge. Tests for the surface quality of the tape are defined. The environmental conditions under which the cartridge is to be tested and operated are specified, and the conditions for storage are recommended.

It also specifies a recording method and a data format intended for use in the streaming mode of operation. Two alternative track formats are specified:

- a 4-track format, and
- a 9-track format.

This Standard provides for the physical interchange of cartridges between data processing equipments, and specify a data formal. A labelling standard for tape cartridges used in the streaming mode is being investigated. The availability of such a labelling standard will provide for full data interchange between data processing systems.

## 1.2 Conformance

A 6,30 mm wide, magnetic tape cartridge shall be in conformance with this Standard if it meets either all mandatory requirements of this Standard specified for the 4-track format or all mandatory requirements of this Standard specified for the 9-track format. The two formats shall not exist on the same cartridge.

# 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 Reference Signal Amplitude Tape Cartridge causes a signal output equal to 95% of the maximum signal output at the test density.

2.6 Test Recording Currents

The two recording currents:

- between 148% and 152% of the current required to produce the Reference Field at 252 ftpmm, and
- between 128% and 132% of the current required to produce the Reference Field at 394 ftpmm.

2.7 Signal Amplitude Reference Tape Cartridge

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

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

2.8 Standard Reference Amplitude

The Standard Reference Amplitudes (SRA) are the average peak-to-peak signal amplitudes of the Signal Amplitude Reference Tape Cartridge. These signal amplitudes shall be averaged over 10000 flux transitions.

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

$SRA_{394}$ is the average peak-to-peak signal amplitude when recording at 394 ftpmm using the appropriate Test Recording Current.

2.9 Average Signal Amplitude

The average peak-to-peak value of the signal output measured over at least 8000 consecutive flux transitions.

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 Reference Alignment Tape Cartridge

A tape cartridge containing a tape on which continuous information has been recorded. A Reference Alignment Tape Cartridge is optimized for perpendicularity of the written flux transitions to the cartridge positioning plane.

2.16 Recording Area

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

2.17 Erasing Field

A sufficient strength to remove the signals from the tape.

# SECTION II

# MECHANICAL AND PHYSICAL CHARACTERISTICS

# 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 °C ± 2 °C |
| RH | : | 40% to 60% |
| Conditioning before testing | : | 24 hours minimum |
| Wet bulb temperature | : | 18 °C maximum |

## 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 construction 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 be so 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.

# 4. CHARACTERISTICS OF THE TAPE

## 4.1 Mechanical Properties

### 4.1.1 Tape width

The width of the tape shall be:

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

### 4.1.2 Tape length

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

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

4.1.3 Tape thickness

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

| Overall thickness | Coating thickness |
| --- | --- |
| 19 um max. | 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 when rewinding.

4.1.4.1.2 Dimension

The diameter of the BOT holes shall be:

1,17 mm ± 0,05 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 indicates 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 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 at 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 at 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 on the outside, 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 resistance of the magnetic surface of any square sample of tape shall be between:

$$5 \cdot 10^5 \text{ Ohm} \quad \text{and } 10^9 \text{ Ohm},$$

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

# SECTION III

# MAGNETIC CHARACTERISTICS
# OF THE UNRECORDED FLEXIBLE DISK CARTRIDGE

## 5. 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 pass for both the Signal Amplitude Reference Tape Cartridge and the tape under test (i.e. either the 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.

### 5.1 Test densities

The test densities shall be 252 ftpmm and 394 ftpmm nominal. The densities to be used are specified for each test.

### 5.2 Test tracks

The test tracks shall be centrally located. The width of the test tracks is not specified; it shall be noted and used in the calculation of Defect Density in 5.6.

### 5.3 Typical field

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

### 5.4 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:

at 252 ftpmm : within ±25% of $SRA_{252}$

at 394 ftpmm : within ±25% of $SRA_{394}$

### 5.5 Ease of Erasure

When a tape has been recorded at 63 ftpmm with a recording current equal to 150% of the Test Recording Current for 252 ftpmm, 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.

### 5.6 Defect Density

#### 5.6.1 Definitions

##### 5.6.1.1 Threshold Level (TL)

The TL is measured relative to the Standard Reference Amplitude (SRA) and is expressed as a percentage of SRA.

5.6.1.2 Track Width (TW)

The TW is the width of the recorded track sensed by the Read Head.

5.6.1.3 Tested surface area

That surface containing recorded signals, exclusive of erased gaps or other non-used recording areas where errors are not detectable.

It is the product of TW and the total length of data track areas tested.

5.6.1.4 Rejected Region

Any head-to-tape separation, or anomaly in the oxide surface, which produces a loss of amplitude of the playback signal below TL is a missing pulse.

A Rejected Region is any 25,4 mm length of tested track containing one or more missing pulses.

5.6.1.5 Defect density

The total number of Rejected Regions observed, divided by the tested surface area.

It is expressed in defects per square millimeter ($D/mm^2$).

5.6.1.6 Effective Defect Diameter (EDD)

The EDD is calculated as follows:

$$EDD = (1 - TL/100) \cdot TW$$

5.6.2 Procedure

The test shall be carried out on any number of tracks over the entire length of the Recording Area (5.7).

The Physical Recording Density shall be 394 ftpmm.

The recording current shall be the Test Recording Current for 394 ftpmm.

The Threshold Level (TL) shall be selected.

5.6.3 Requirement

The Defect Density shall be less than, or equal to,

$$0{,}0341 \cdot e^{(-19{,}3 \cdot EDD)} \quad D/mm^2$$

5.7 Recording Area

The Recording Area shall be the part of the tape tested according to 5.1 to 5.6. In 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) and extends across the width of the tape.

# SECTION IV

# CHARACTERISTICS OF THE CARTRIDGE

# 6. CHARACTERISTICS OF THE CARTRIDGE

## 6.1 General Description

The cartridge shall be of a twin hub 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 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.

### 6.1.1 Dimension

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

### 6.1.2 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.

### 6.1.3 Attachment

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

### 6.1.4 Mounting position

It shall be possible to mount the cartridge in the drive 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.

### 6.1.5 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% (See Appendix A).

This requirement shall be satisfied for both:

- a 2000 K ± 200 K incandescent light source, and

- a 940 nm ± 5 nm LED light source.

### 6.1.6 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.

6.1.7 Cartridge door

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

## 6.2 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.

## 6.3 Physical Labels

6.3.1 Location and size

The rear surface of the cartridge and a part of the top side of the cartridge shall allow the use of labels (see Fig. 8).

6.3.2 Interchange

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

## 6.4 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.

## 6.5 Speed

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

*NOTE 2:*

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

## 6.6 Instantaneous Speed Variation (ISV)

An Instantaneous Speed Variation Event is said to have occurred 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 for agreement between the parties concerned.

See Appendix C for definitions and test method.

## 6.7 Low-frequency Speed Variation

The speed variation due to the sum of the components of the rate of change of speed in the range 0 Hz to 1000 Hz shall not exceed 4% of the nominal speed.

## 6.8 Acceleration

The cartridge shall be capable of withstanding acceleration and deceleration of the linear tape speed of 50,8 $m/s^2$.

6.9 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.

6.10 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.

6.11 Dynamic Response

6.11.1 Definition

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

6.11.2 Requirement

The natural resonant frequency shall be at least 60 Hz.

6.11.3 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.

6.12 Tape Tension

6.12.1 Definitions

6.12.1.1 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.

6.12.1.2 Instantaneous tension

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

6.12.1.3 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.

6.12.1.4 Transverse tape tension variation

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

6.12.2 Procedures

For text procedures see Appendix E.

6.12.3 Requirements

6.12.3.1 Value of instantaneous tension

6.12.3.1.1 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.

6.12.3.1.2 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 6.12.3.1.1 shall be met.

6.12.3.2 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.

6.12.3.3 Requirement for transverse tension variation

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

6.13 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.

6.14 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 3:*

*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.*

6.15 Dynamic Tape Skew

Dynamic tape skew is the variation of the angle that the centreline of the tape makes with Reference Plane B. It shall not exceed 7' of arc.

Measurement

Write flux transitions simultaneously on two test tracks over the entire recording area of the tape at speed v.

Using the same two gaps, read the tape in the forward and reverse directions, measuring the time differences between corresponding flux transitions.

The maximum time difference t and the distance d between the centrelines of the two test tracks are used to calculate the dynamic tape skew, viz.

$$\arc\tan\left(\frac{t \cdot v}{d}\right) \leq 7'$$

6.16 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 procedure described in Appendix D.

## 7. REFERENCE PLANE

The Reference Plane shall be the top of the base plate (identified as Plane B in the figures).

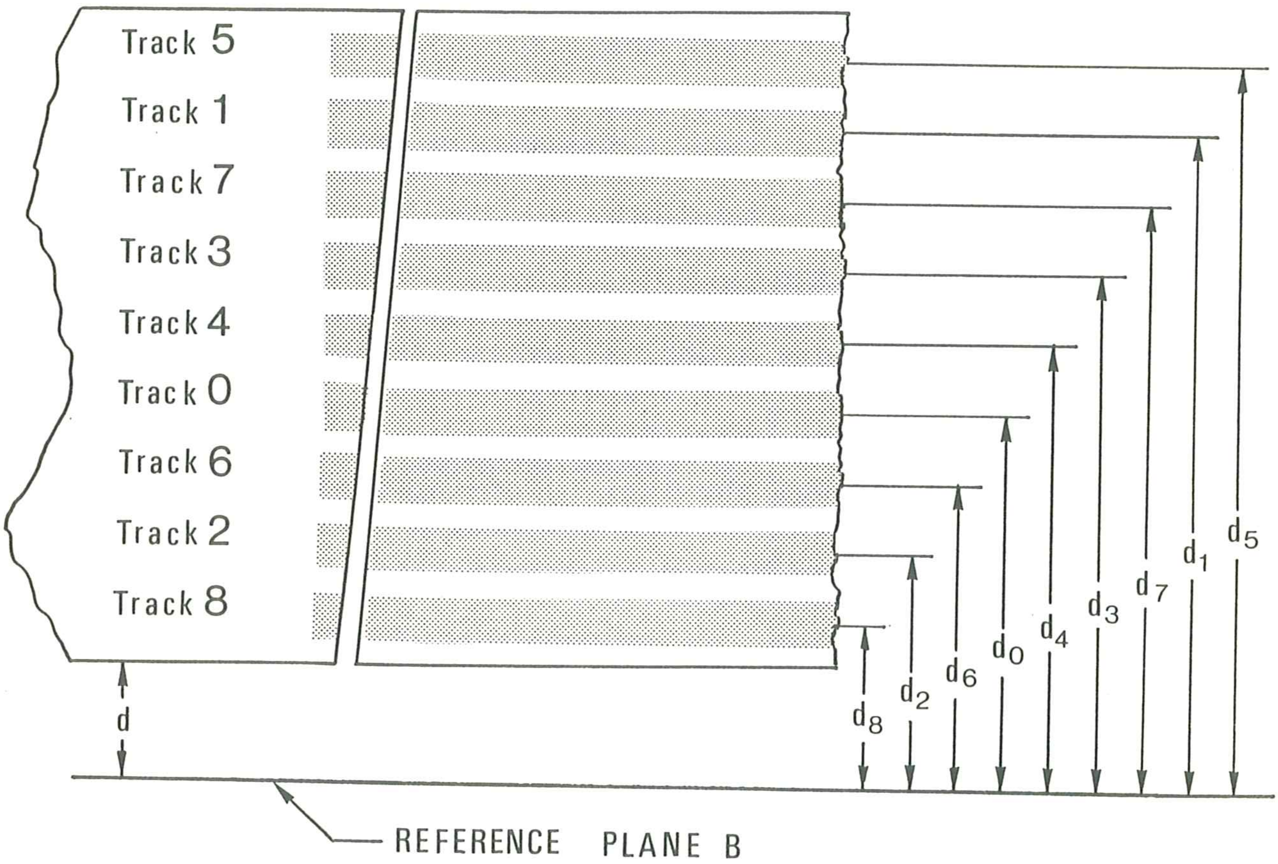
The Reference Edge shall be that edge of the tape which is nearer to the top of the base plate.

The location of the centre lines of the tracks is referred to the Reference Plane.

## 8. TRACK GEOMETRY

### 8.1 Track Location

The positions of the nine tracks are defined by specifying the distance of their centre lines from the Reference Plane.




$d$ = 1,778 mm nominal

$d_0$ = 4,369 mm ± 0,107 mm

$d_1$ = 6,807 mm ± 0,107 mm

$d_2$ = 3,150 mm ± 0,107 mm

$d_3$ = 5,588 mm ± 0,107 mm

$d_4$ = 4,978 mm ± 0,107 mm

$d_5$ = 7,417 mm ± 0,107 mm

$d_6$ = 3,759 mm ± 0,107 mm

$d_7$ = 6,198 mm ± 0,107 mm

$d_8$ = 2,540 mm ± 0,107 mm

### 8.2 Number of Tracks

#### 8.2.1 4-track format

In the 4-track format only tracks 0, 1, 2 and 3 are usable. Tracks are recorded sequentially from Track 0 (see also 12.1).

#### 8.2.2 9-track format

In the 9-track format all nine tracks are usable. Tracks are recorded sequentially from Track 0 (see also 12.2).

### 8.3 Track Width

The recorded track width shall be:

4-track format : Tw = 0,914 mm ± 0,025 mm

9-track format : Tw = 0,343 mm ± 0,013 mm

## 9. RECORDING

### 9.1 Method of Recording

The recording method shall be the Non Return To Zero Mark (NRZ1) method where a ONE is represented by a change of direction of longitudinal magnetization.

### 9.2 Physical Recording Densities

The nominal maximum physical recording density shall be 394 ftpmm. The nominal bit cell length shall be 2,54 um.

With the recording method used in this Standard, two other densities occur:

197 ftpmm
131 ftpmm

### 9.3 Average Bit Cell Length Variations

#### 9.3.1 Average bit cell length

The average bit cell length is the sum of the distances between the flux transitions in n bit cells divided by (n-1). The tests below may be made in any continuously recorded pattern, provided that the first and the last bit cell each contain a flux transition.

#### 9.3.2 Long-term average bit cell length

The long-term average bit cell length is the average bit cell length taken over at least 900 000 bit cells. The long-term average bit cell length shall be within ± 4% of the nominal bit cell length.

9.3.3 Short-term average bit cell length

The short-term average bit cell length is the average bit cell length taken over 126 to 130 bit cells. The short-term average bit cell length shall be within ± 7% of the long-term average bit cell length.

9.4 Flux Transition Spacing

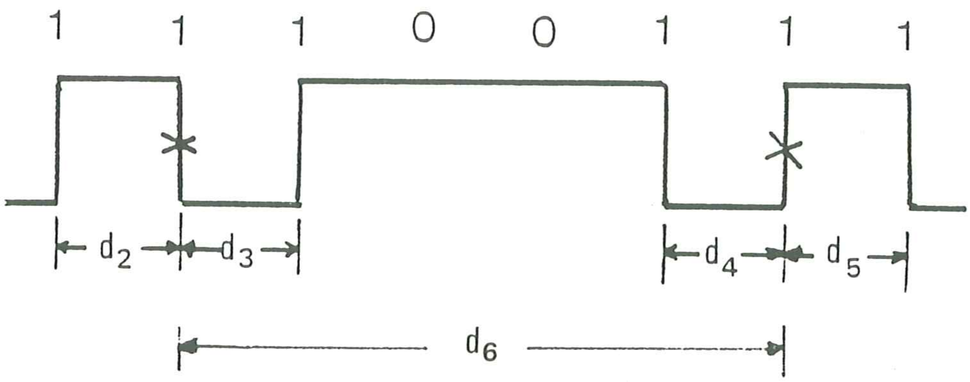
In the following tests the results are expressed as the ratio of measurements; the effects of variations in long-term average bit-cell length and short-term average bit-cell length are thereby eliminated.

9.4.1 Instantaneous Flux Transition Spacing

The instantaneous spacing between flux transitions is influenced by the reading and writing processes, the pattern recorded (pulse-crowding effect) and other factors.

Instantaneous spacings between flux transitions shall satisfy the following conditions.

In a sequence of flux transitions defined by bit pattern 11100111, e.g. as occurs in the Block Marker (see 15.1.2), the centre flux transition of each group of three ONEs is called a Reference Flux Transition. The spacing between any pair of contiguous ONE flux transitions shall not deviate by more than 35% from the bit cell length $d_1$ averaged over the five bit cells between reference flux transitions.



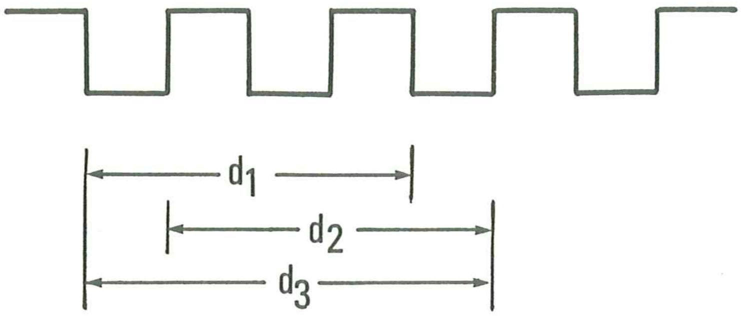

X denotes a Reference Flux Transition.

1,35 d1 ⩾ d2 ⩾ 0,65 d1
1,35 d1 ⩾ d3 ⩾ 0,65 d1
1,35 d1 ⩾ d4 ⩾ 0,65 d1
1,35 d1 ⩾ d5 ⩾ 0,65 d1

d1 = 0,20 d6

9.4.2 Rate of change of Average Flux Transition Spacing

In a sequence of flux transitions defined by the data pattern 1010 0101 the rate of change of the average flux transition spacing, averaged over 4 flux transition spacings, shall not exceed 0,0026 per flux transition spacing, i.e. in the pattern:




$$\frac{\left|\frac{d_1}{4} - \frac{d_2}{4}\right|}{\frac{d_3}{5}} \leqslant 0{,}0026$$

9.5 <u>Signal Amplitude of a Recorded Cartridge for Data Interchange</u>

For 4-track format the width of the track read shall be 0,508 mm ± 0,025 mm and shall be within the recorded track.

For the 9-track format the track read shall extend over the whole width of the recorded track.

When performing the tests, the output or resultant signal shall be measured on the same pass for both the Standard Amplitude Reference Tape Cartridge and the tape under test (i.e. the read-whilst-write pass or the first forward-read pass) on the same equipment. The signal amplitude shall be measured at a point in the read chain at which the signal is proportional to the rate of change of the flux induced in the head.

After writing, the cartridge shall meet the following requirements.

9.5.1 <u>Average Signal Amplitude at nominal maximum density</u>

At the nominal maximum density of 394 ftpmm the Average Peak-to-Peak Signal Amplitude of any track shall be within + 50% and - 35% of SRA394 (see 2.8). This averaging shall be made over the central 100 flux transitions of any 120 contiguous flux transitions in a block and over at least 100 blocks.

9.5.2 <u>Minimum Signal Amplitude</u>

When interchanged, a tape shall not contain in the valid information area any flux transition the base-to-peak signal amplitude of which is less than 25% of half of SRA394 (see 2.8).

9.5.3 <u>Maximum Signal Amplitude</u>

The peak-to-peak signal amplitude at 131 ftpmm shall be less than 3 times SRA394.

10. <u>ERASURE</u>

10.1 The tape shall be AC erased.

10.2 After erasure any remaining signal amplitudes at, or below, twice the frequency corresponding to the maximum physical recording density shall be less than 3% of SRA394.

## 11. 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.

## 12. USE OF TRACKS

### 12.1 4-track Format

12.1.1 Each track shall be a data track and shall be written serially.

12.1.2 Tracks shall be recorded in the numerical order of their track numbers, starting with Track 0.

12.1.3 Tracks 0 and 2 shall be recorded in the direction from the BOT marker to the EOT marker. Tracks 1 and 3 shall be recorded in the direction from the EOT marker to the BOT marker.

12.1.4 On Track 0 a Reference Burst recorded at the nominal maximum recording density of 394 ftpmm shall be written between the BOT marker and data recorded on Track 0. This Reference Burst shall commence at most 381 mm from the BOT marker and extend for a minimum of 76,2 mm and a maximum of 101,6 mm beyond the LP marker.

12.1.5 On Tracks 0 and 2 data shall commence at a minimum of 76,2 mm and at a maximum of 101,6 mm past the LP marker. No data for interchange shall be recorded beyond 914,4 mm past the EW marker.

12.1.6 On Tracks 1 and 3 data shall commence at a minimum of 25,4 mm and at a maximum of 50,8 mm past the EW marker.

On Track 1 the last Data or File Mark Block written shall end at a maximum of 101,6 mm and at a minimum of 2,54 mm before the LP marker, measured from the centre of the hole.

If Control Blocks are used at the ends of tracks (see 15.4.2.ii) they shall be recorded starting at least 2,54 mm after the LP marker on Track 1. A Long Preamble shall be recorded between the last Data or File Mark Block and the Control Block.

On Track 3 the last block written shall end at a maximum of 685,8 mm past the LP marker.

### 12.2 9-track Format

12.2.1 Each track shall be a data track and shall be written serially.

12.2.2 Tracks shall be recorded in the numerical order of their track numbers, starting with Track 0.

12.2.3 Tracks 0, 2, 4, 6 and 8 shall be recorded in the direction from the BOT marker to the EOT marker. Tracks 1, 3, 5 and 7 shall be recorded in the direction from the EOT marker to the BOT marker.

12.2.4 On Track 0 a Reference Burst recorded at the maximum nominal recording density of 394 ftpmm shall be written between the BOT marker and data recorded on Track 0. This Reference Burst shall commence at most 381 mm from the BOT marker and extend for a minimum of 76,2 mm and a maximum of 101,6 mm beyond the LP marker.

12.2.5 On Tracks 0, 2, 4, 6 and 8 data shall commence at a minimum of 76,2 mm and at a maximum of 101,6 mm past the LP marker. No data for interchange shall be recorded beyond 914,4 mm past the EW marker.

12.2.6 On Tracks 1, 3, 5 and 7 data shall commence at a minimum of 25,4 mm and at a maximum of 50,8 mm past the EW marker.

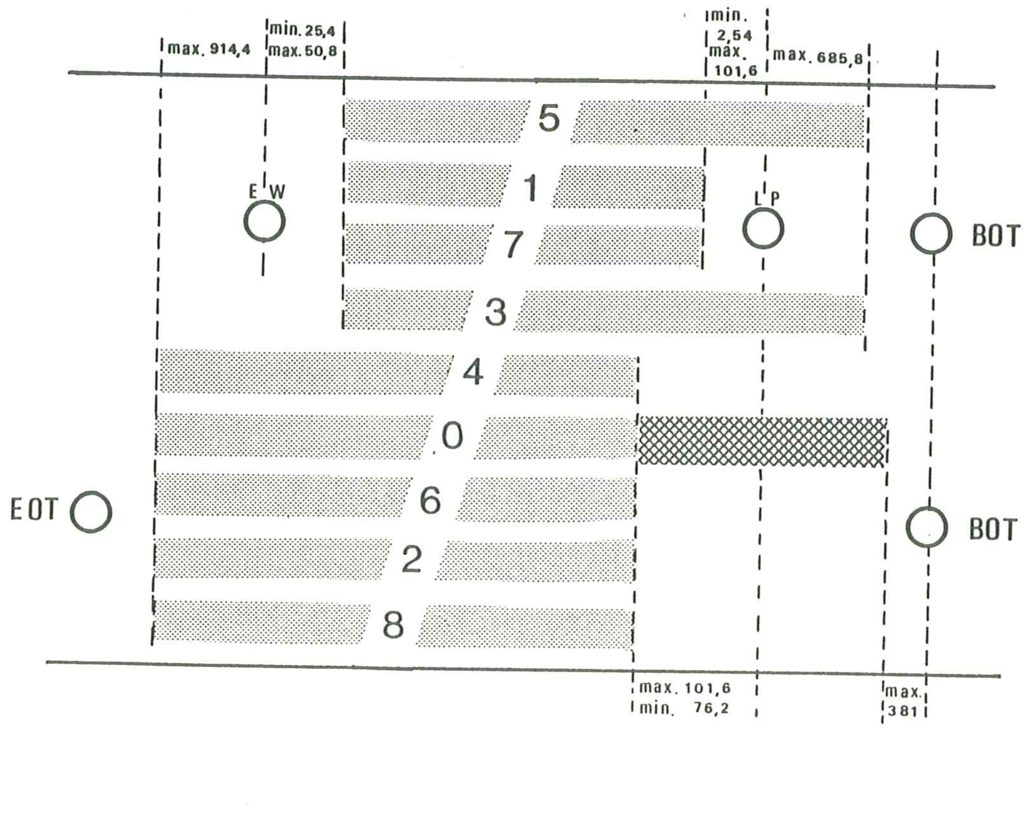
On Tracks 1 and 7 the last Data or File Mark Block written shall end at most 101,6 mm and at least 2,54 mm before the LP marker, measured from the centre of the hole.

If Control Blocks are used at the end of tracks (see 15.4.2 ii), they shall be recorded starting at least 2,54 mm after the LP marker on tracks 1 and 7. A Long Preamble shall be recorded between the last Data or File Mark Block and the Control Block.

On Tracks 3 and 5 the last block written shall end at a maximum of 658,8 mm past the LP marker.

12.3 Summary of Requirements for Use of Tracks and Reference Burst

The figure below summarizes the requirements in 12.1 and 12.2.



## 13. CODED REPRESENTATION OF THE DATA

### 13.1 Standards

The information intended for data interchange shall be coded and interpreted according to the relevant ECMA standards for the coding of information.

### 13.2 Coding Methods

13.2.1 When the coding method requires it, the coded representations to be recorded in the Data Field of a Data Block shall be regarded as an ordered sequence of 8-bit bytes.

Within each byte the bit positions shall be identified by B8 to B1. The high-order bit shall be represented in position B8 and the low-order bit in position B1.

When the data is encoded according to an 8-bit code, the binary weights of the bit positions shall be:

| Bit position | B8 | B7 | B6 | B5 | B4 | B3 | B2 | B1 |
|---|---|---|---|---|---|---|---|---|
| Binary weight | 128 | 64 | 32 | 16 | 8 | 4 | 2 | 1 |

When the data is encoded according to a 7-bit code, bit position B8 shall contain bit ZERO, and the data shall be encoded in bit position B7 to B1, using the same binary weight as shown above.

13.2.2 When the coding method requires it, the coded representations to be recorded in the Data Field of a Data Block shall be regarded as an ordered sequence of bit positions, each containing a bit.

For the purposes of this Standard the sequence of bits shall be regarded as an ordered sequence of 8-bit bytes. Within a byte successive bits of the coded representation shall be allocated to bit positions B8 to B1 in that order.

## 14. RECORDING OF CODED CHARACTERS ON THE TAPE

Prior to recording on the tape, the coded representations (see 13.) shall be transformed as described below, except for the following fields:

- Preamble (15.1.1)
- Block Marker (15.1.2)
- Postamble (15.1.6)
- The Data field of File Mark Blocks (15.2.1)

14.1 Each 8-bit byte shall be split into two groups of four consecutive bits, one group containing the four most-significant bits (B8 to B5) and one group containing the four least-significant bits (B4 to B1).

14.2 Each such 4-bit group shall then be transformed into a 5-bit group according to the following table:

| B8<br>B4 | B7<br>B3 | B6<br>B2 | B5<br>B1 | E4 | E3 | E2 | E1 | E0 |
|---|---|---|---|---|---|---|---|---|
| 0 | 0 | 0 | 0 | 1 | 1 | 0 | 0 | 1 |
| 0 | 0 | 0 | 1 | 1 | 1 | 0 | 1 | 1 |
| 0 | 0 | 1 | 0 | 1 | 0 | 0 | 1 | 0 |
| 0 | 0 | 1 | 1 | 1 | 0 | 0 | 1 | 1 |
| 0 | 1 | 0 | 0 | 1 | 1 | 1 | 0 | 1 |
| 0 | 1 | 0 | 1 | 1 | 0 | 1 | 0 | 1 |
| 0 | 1 | 1 | 0 | 1 | 0 | 1 | 1 | 0 |
| 0 | 1 | 1 | 1 | 1 | 0 | 1 | 1 | 1 |
| 1 | 0 | 0 | 0 | 1 | 1 | 0 | 1 | 0 |
| 1 | 0 | 0 | 1 | 0 | 1 | 0 | 0 | 1 |
| 1 | 0 | 1 | 0 | 0 | 1 | 0 | 1 | 0 |
| 1 | 0 | 1 | 1 | 0 | 1 | 0 | 1 | 1 |
| 1 | 1 | 0 | 0 | 1 | 1 | 1 | 1 | 0 |
| 1 | 1 | 0 | 1 | 0 | 1 | 1 | 0 | 1 |
| 1 | 1 | 1 | 0 | 0 | 1 | 1 | 1 | 0 |
| 1 | 1 | 1 | 1 | 0 | 1 | 1 | 1 | 1 |

Thus each 8-bit byte shall be recorded as a 10-bit byte on the tape.

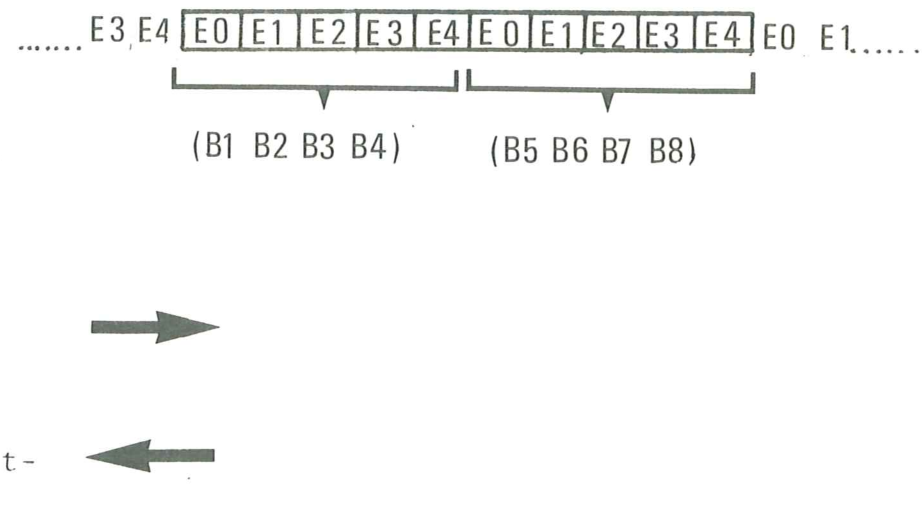
14.3 For each 8-bit byte of the coded representation the most significant 4-bit group is deemed to be recorded first. As a consequence the 5-bit group corresponding to B8 to B5 shall be recorded first starting with E4 and the 5-bit group corresponding to B4 to B1 shall follow.

Bits on track

Coded representation

Tape motion

Recording direction



## 15. TRACK FORMAT

Each track may contain Data blocks and File Mark blocks. Control blocks may be present as described in 15.4.

### 15.1 Data Block

A Data Block shall comprise the following fields:

| DATA BLOCK | | | | | |
|---|---|---|---|---|---|
| PREAMBLE | BLOCK MARKER | DATA | BLOCK ADDRESS | CRC | POSTAMBLE |

#### 15.1.1 Preamble

This field shall contain ONE bits, i.e. flux transitions recorded at the nominal maximum recording density of 394 ftpmm.

The Preamble of the 1st block of each track shall contain at least 15 000 and at most 30 000 ONEs. It is called a Long Preamble.

The Preamble of each of the following blocks of a track shall contain at least 120 and at most 300 ONEs. It is called a Normal Preamble.

However, a block shall contain a Preamble of at least 3500 and at most 7000 ONEs if the preceding block has an Elongated Postamble (see 15.1.6). Its recording shall begin at least 3000 and at most 3500 ONEs from the second CRC byte (see 15.1.5) of said preceding block. Such a Preamble is called Elongated Preamble.

If Control Blocks are used at the ends of tracks (see 15.4.2 ii), an Elongated Preamble shall be recorded between the last Data or File Mark Block on all tracks except Track 1 and Track 7. On Track 1 and Track 7 a Long Preamble shall be recorded between the last Data or File Mark Block and the Control Block.

#### 15.1.2 Block Marker

This field identifies the start of the data. It consists of a fixed bit pattern:

1 1 1 1 1 0 0 1 1 1

#### 15.1.3 Data

This field contains the data of the block. It comprises 512 bytes.

#### 15.1.4 Block Address

The Block Address shall comprise four bytes forming the following fields:

| BLOCK ADDRESS | | | |
|---|---|---|---|
| TRACK NUMBER | BLOCK TYPE | BLOCK NUMBER | |
| 1st byte | 2nd byte | 3rd byte | 4th byte |

15.1.4.1 Track Number

This byte shall specify the track number as follows:

(00) shall indicate Track 0
(01) shall indicate Track 1
(02) shall indicate Track 2
(03) shall indicate Track 3
(04) shall indicate Track 4
(05) shall indicate Track 5
(06) shall indicate Track 6
(07) shall indicate Track 7
(08) shall indicate Track 8

where (00) to (08) specify in hexadecimal notation the decimal numbers 0 to 8, respectively.

15.1.4.2 Block Type

This 4-bit field shall indicate whether the block is a Data Block, a File Mark Block or a Control Block.

0000 shall mean that the block is a Data Block or a File Mark Block (see 15.2).

0001 shall mean that the block is a Control Block (see 15.3 and 15.4).

Other bit combinations are reserved for future standardization and shall not be used.

15.1.4.3 Block Number

This field comprises the 20 bits from the 5th bit of the 2nd byte to the last bit of the 4th byte. It specifies in binary notation the block number from 1 to 1048575 by giving the weights 524 288, 262 144, 131 072, 65 536, 32 768, ..., 64, 32, 16, 8, 4, 2, 1 to these 20 bits. The most-significant bit is the 5th bit of the second byte, the least-significant bit is the last bit of the 4th byte.

15.1.4.4 GCR handling of Block Address

When recording the tape in GCR mode, the four bits of the Block Type and the four most-significant bits of the Block Number shall be considered as one 8-bit byte.

15.1.5 CRC (Cyclic Redundancy Check)

The 16 bits following the Block Address of a Data Block shall be a Cyclic Redundancy Check character. This 16-bit character shall be written in each block following the Block Address and immediately preceding the Postamble, the most-significant bit being recorded first (see 14.3). The polynomial generating the CRC shall be:

$$G(x) = x^{16} + x^{12} + x^5 + 1$$

The CRC generation shall start with the most-significant bit of the first data byte and end with the least-significant bit of the Block Number field of the Block Address.

Prior to operation all positions of the shift-register shall be set to ONE.

15.1.6 Postamble

This field shall contain ONE bits, i.e. flux transition recorded at the nominal maximum recording density of 394 ftpmm.

Each block shall be terminated by a Normal Postamble of at least 5 and at most 20 ONEs which is continuous with the Preamble of the next block.

If the drive is not ready to write the next block or if the block just written is a File Mark Block (see 15.2) an Elongated Postamble of at least 3500 and at most 7000 ONEs shall be written.

*NOTE 3:*

*This requirement, taken together with that in 15.1.1, ensures that there will be no gap in the sequence of ONEs between an Elongated Postamble and an Elongated Preamble; there may, however, be a phase shift.*

15.2 File Mark Block

A File Mark Block shall be identical with a Data Block but for the following exceptions.

15.2.1 Its Data field shall contain a fixed pattern:

0 0 1 0 1    0 0 1 0 1

For the purpose of calculating the CRC, when reading the tape, this recorded 10-bit pattern shall be deemed to represent the 8-bit byte 1111 1111.

15.2.2 The Postamble of a File Mark Block shall always be an Elongated Postamble.

15.2.3 A File Mark Block may be recorded between blocks anywhere on the tape.

15.2.4 The last block of an interchange cartridge shall be a File Mark Block. It may be omitted if Data Blocks are recorded on Track 3 beyond the LP marker in 4-track format or on Track 8 beyond the EW marker in 9-track format.

## 15.3 Control Blocks

A Control Block shall be identical with a Data Block but for the following exceptions.

15.3.1 The bit pattern of the Block Type (see 15.1.4.2) shall be 0001.

15.3.2 The Data field shall be as follows.

1st byte

(04) shall mean that the cartridge is recorded in 4-track format.

(09) shall mean that the cartridge is recorded in 9-track format.

2nd byte

(00) shall mean that the Control Block is a Dummy Control Block (see 15.4.2, iii).

(01) shall mean that the Control Block is the 1st block of a track (see 15.4.1.1 and 12.4.2, i).

(02) shall mean that the Control Block is the last block of a track (see 15.4.2, ii).

(03) shall mean that the next block is a File Mark Block (see 15.4.2, iv) and that its File Mark Number is specified by the 3rd and 4th bytes of this Control Block.

All other possible 252 bit combinations are reserved for future standardization and shall not be used.

3rd byte

When the 2nd byte is a (03) byte this byte specifies the most-significant digits of the File Mark Number (see 15.4.2, iv) in binary notation by giving to its bits the weights:

32 768   16 384   8192   4096   2048   1024   512   256

When the 2nd byte is not a (03) byte, this byte shall be a (00) byte.

4th byte

When the 2nd byte is a (03) byte this byte specifies the least-significant digits of the File Mark Number (see 15.4.2, iv) in binary notation by giving to its bits the weights:

128 64 32 16 8 4 2 1

When the 2nd byte is not a (03) byte, this byte shall be a (00) byte.

5th to 512th bytes

These bytes shall be set to (00).

15.4 Use of Control Blocks

The use of Control Blocks is optional. A tape containing Control Blocks as specified in 15.3 shall be acceptable for interchange. The recipient of the cartridge shall read the whole contents of each Control Block in order to check the CRC and to maintain the sequence of block numbers, but is permitted to ignore the Data Field.

If Control Blocks are included, the following rules apply.

15.4.1 Track 0

On Track 0 the first block shall always be a Control Block. The bytes of its Data field shall be set as follows:

1st byte : (04) or (09)
2nd byte : (01)
3rd to 512th byte: (00)

15.4.2 Further uses of Control Blocks

Control Blocks may be used in one or more of the following three cases:

i) A Control Block shall be written as the first block on each track.

ii) A Control Block shall be written as the last block on each track, provided that the writing is continued on the following track. In this case, the contents of the 2nd byte in the Control Block depends upon whether the preceding (last) Data or File Mark Block was verified as good or bad.

If the last Data or File Mark Block was verified as good, the 2nd byte shall be set to (02).

If the last Data or File Mark Block was verified as bad, the 2nd byte shall be set to (00).

To allow time to verify the last Data Block, an Elongated Preamble shall be recorded prior to writing the Control Block, on all tracks except on Track 1 and Track 7.

On Track 1 and Track 7, a Long Preamble shall be recorded prior to writing the Control Block, in such a way that the Control Block Marker is located at least 2,54 mm after the LP Marker.

iii) A Control Block shall precede each File Mark Block. The second byte in the Control Block shall be set to (03).

In this case File Mark Blocks are numbered from 0 to 65535 by using the 3rd and 4th bytes of the Data Field in the Control Block as specified in 15.3.2. (This is in addition to their Block Number specified in 15.1.4.3).

## 16. END OF RECORDED DATA

The end of recorded data shall be indicated by a File Mark Block followed by at least 1143 mm of erased track.

If the end of the permissible recording area of the track is reached before this distance is passed, the measurement shall be continued on the next track, unless this was the last track.

## 17. RE-WRITING OPERATIONS

When recording the tape, some blocks may have to be re-written further down the tape. This is done to improve the system error rate. The decision criteria for the re-write operation are not a part of this Standard, except as specified in 9.5.3.

### 17.1 Re-writing Rules

17.1.1 A block n may be recognized as erroneous before or after block n+1 has been partly or completely written but it shall always be so recognized before writing of block n+2 commences.

17.1.2 An erroneous block shall not be erased, it shall be re-written further down the tape.

17.1.3 A correct block n shall be followed, not necessarily immediately, by a correct block n+1.

17.1.4 An erroneous block shall not be re-written more than 16 times.

17.1.5 Re-written blocks shall retain their Block Number, in addition, if applicable, File Mark Blocks shall retain their File Mark Block Number.

Examples of resulting track layouts are given in Appendix F.

### 17.2 Rejection Criterion

A magnetic tape cartridge intended for interchange shall be rejected if it contains at least one erroneous block recorded more than 17 times, whereby blocks numbered n+1 encountered before the last repeat of block n shall be ignored in this count (such blocks to be ignored are shaded in Appendix F).

## 18. UPDATING OPERATIONS

Each track is normally recorded continuously starting from the beginning of the track. If it is necessary to start a write operation in the middle of a track, the write current shall be turned on after the write head has passed at least 3000 flux transitions of the Postamble of the last block, but before the end of the Postamble.

## 19. READING OPERATIONS

When reading a tape conforming to this Standard, if a block is not correctly read it should be discarded and reading should continue immediately with the next block.

Blocks which were regarded as incorrect when written may be read correctly: the reading process must, therefore, use the block numbers to ensure that blocks are not read out of sequence.

When block n-1 has been correctly read, succeeding blocks with any number other than n should be discarded until a block numbered n has been correctly read. If block n+2 is encountered before n is correctly read, a read error has occurred and block n cannot be recovered.

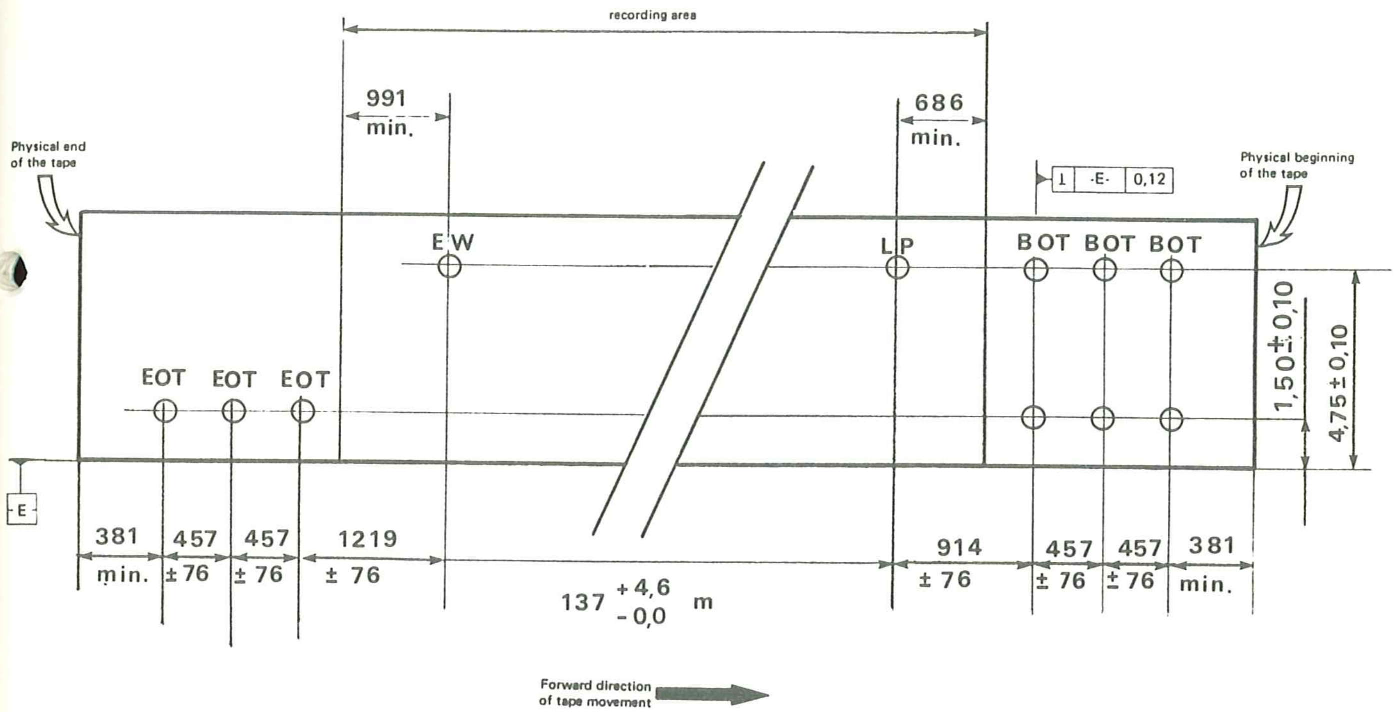



Fig. 1 - Position of the markers and recording areas
(magnetic surface shown)

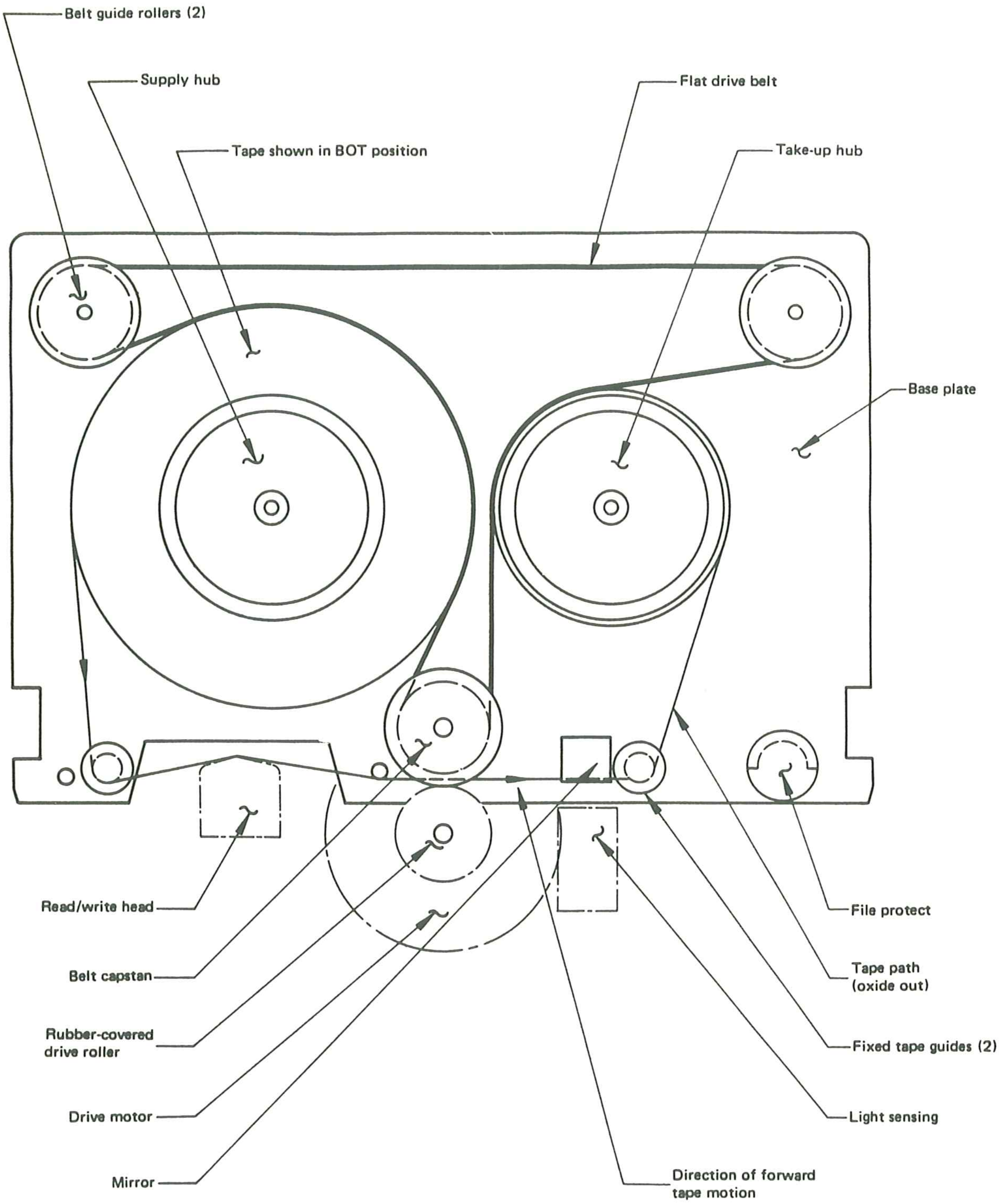



Fig. 2 - Cartridge diagram

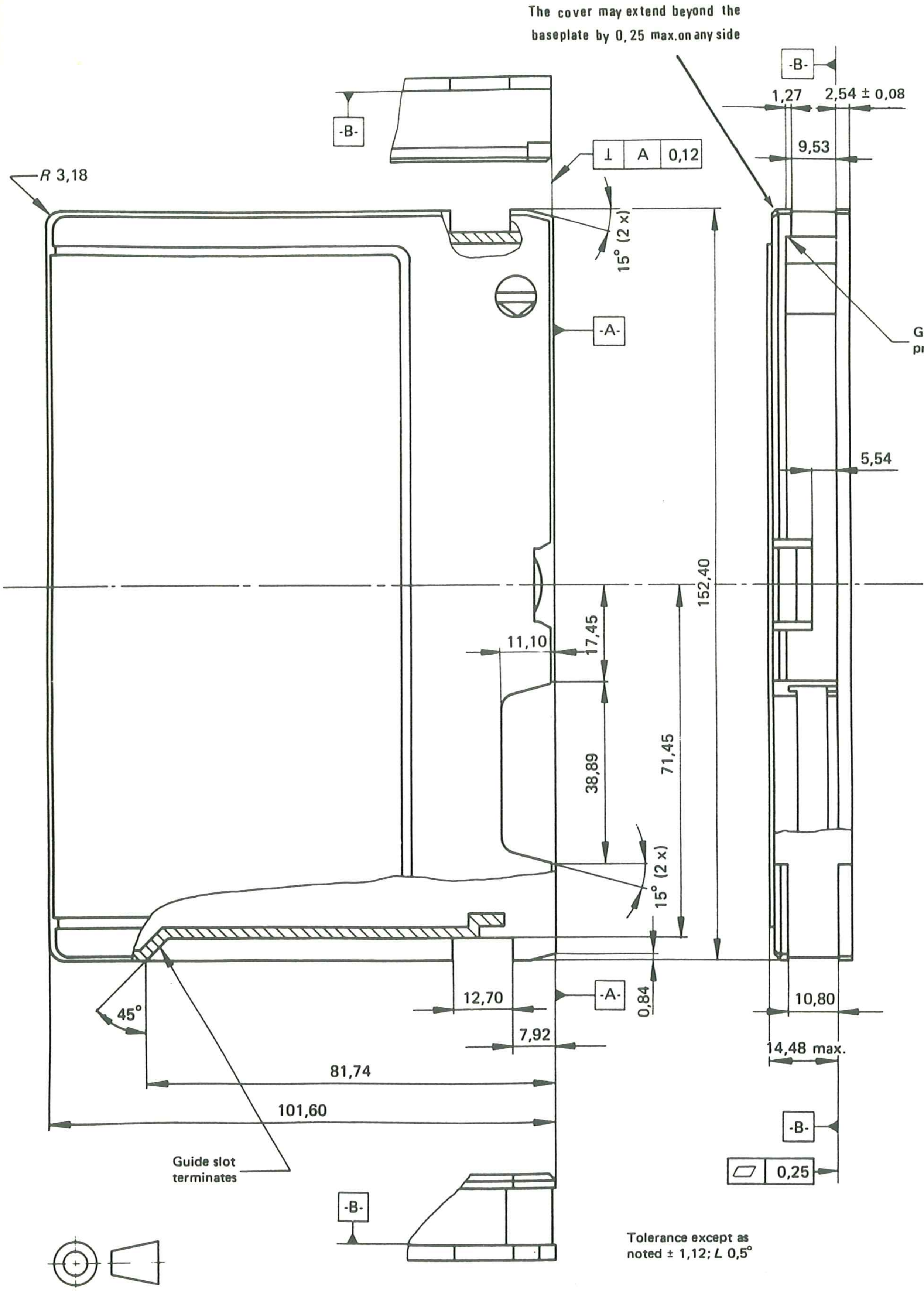



Fig. 3 - Cartridge dimensions

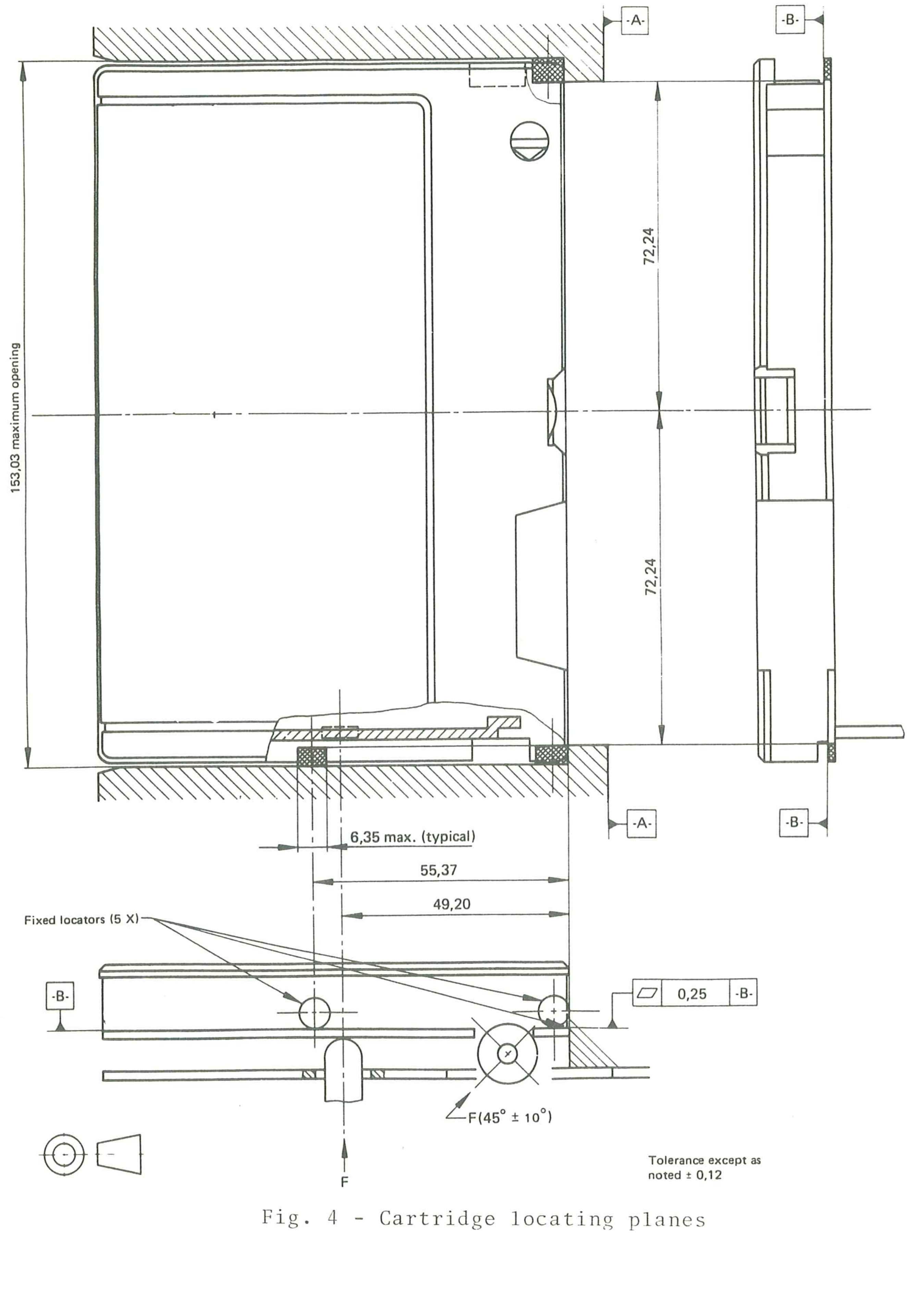



Fig. 4 - Cartridge locating planes

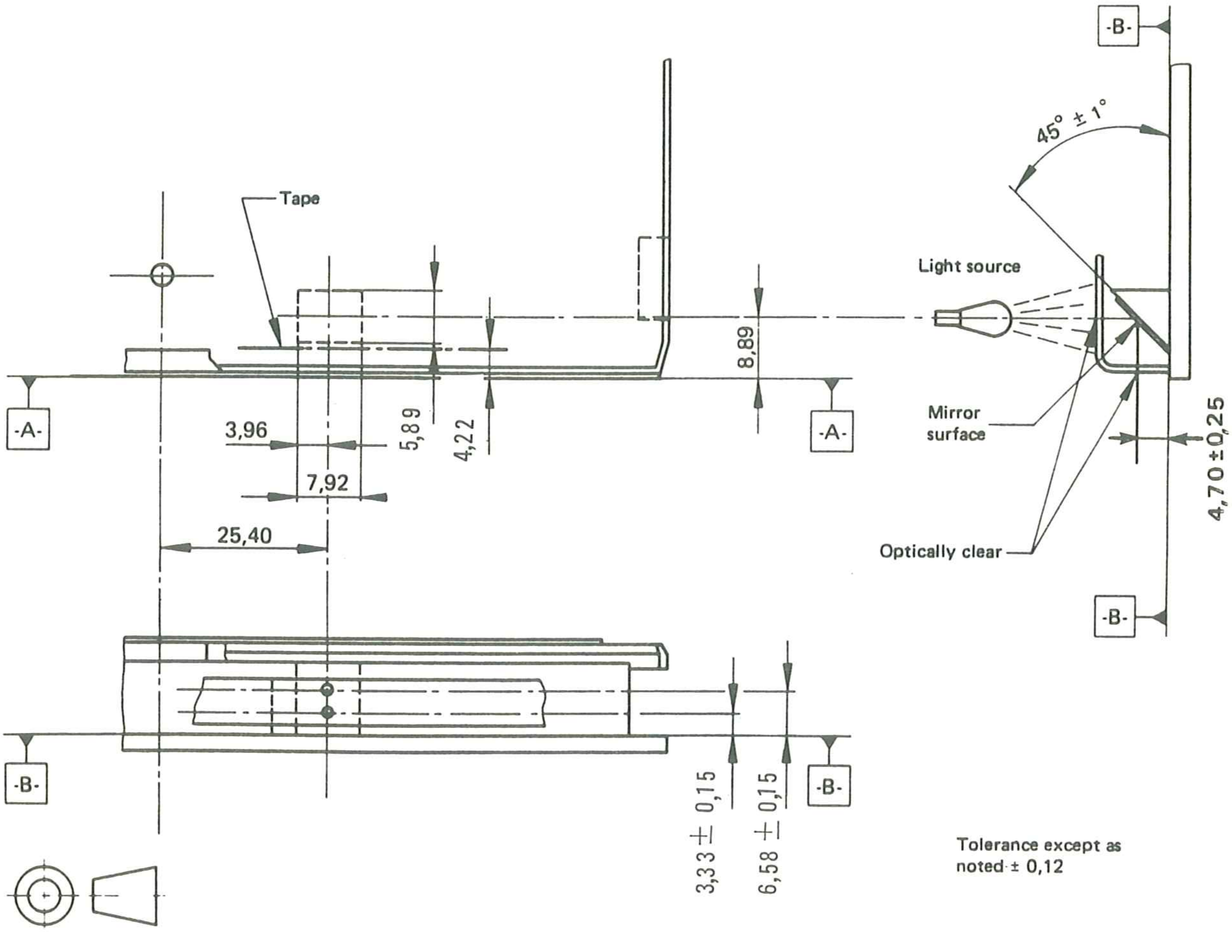



Fig. 5 - Light sensing

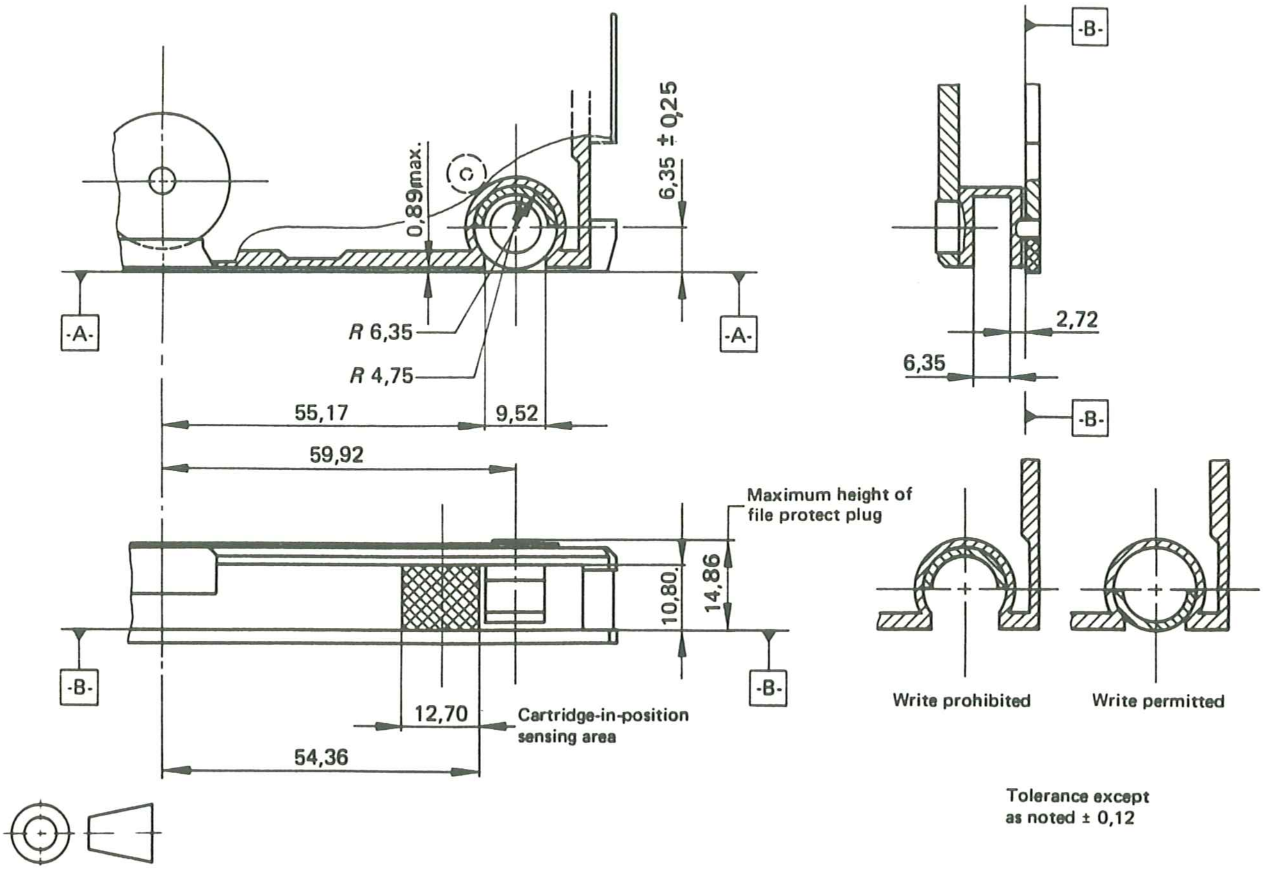



Fig. 6 - File protect and cartridge-in-position sensing

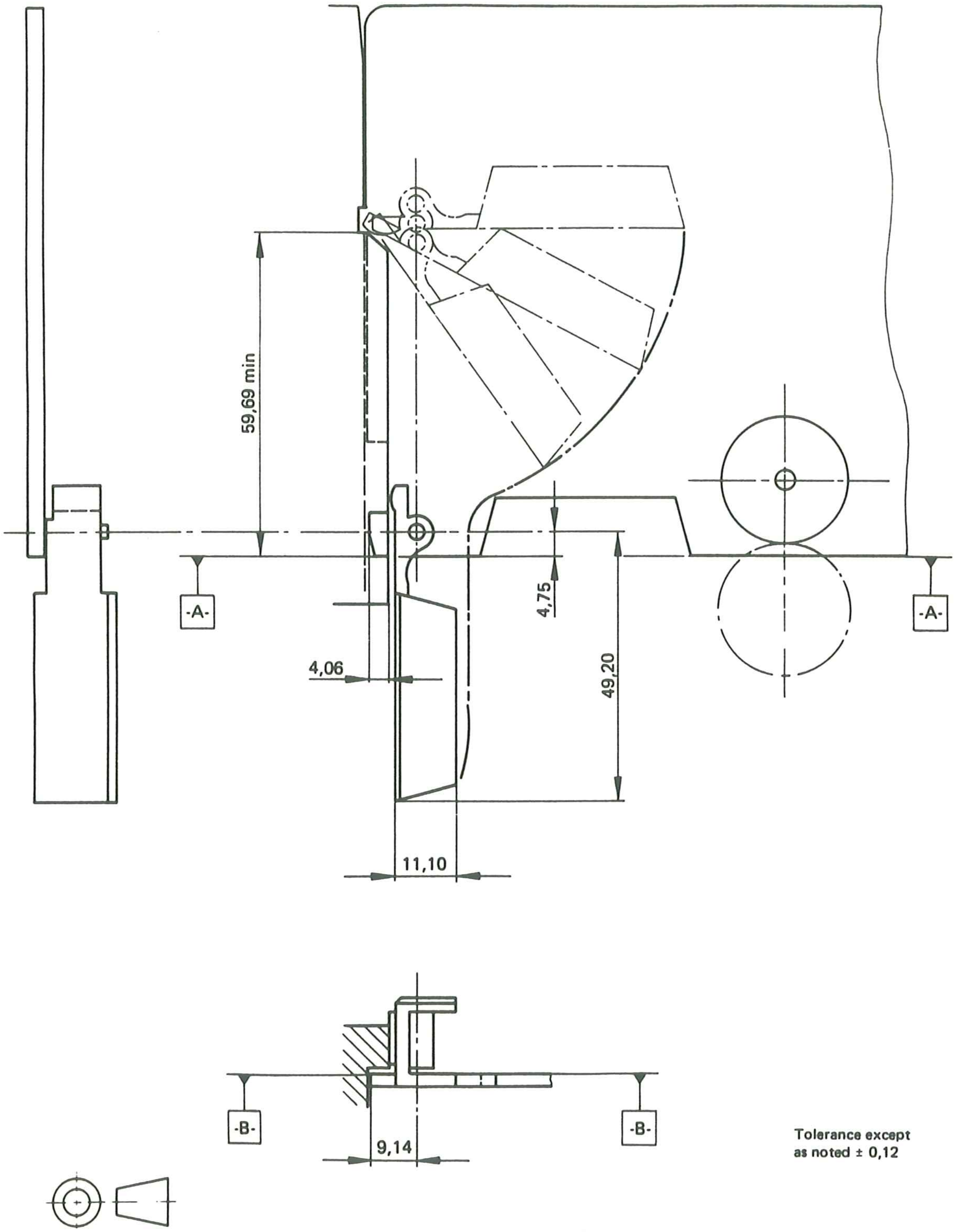



Fig. 7 - Cartridge door profile

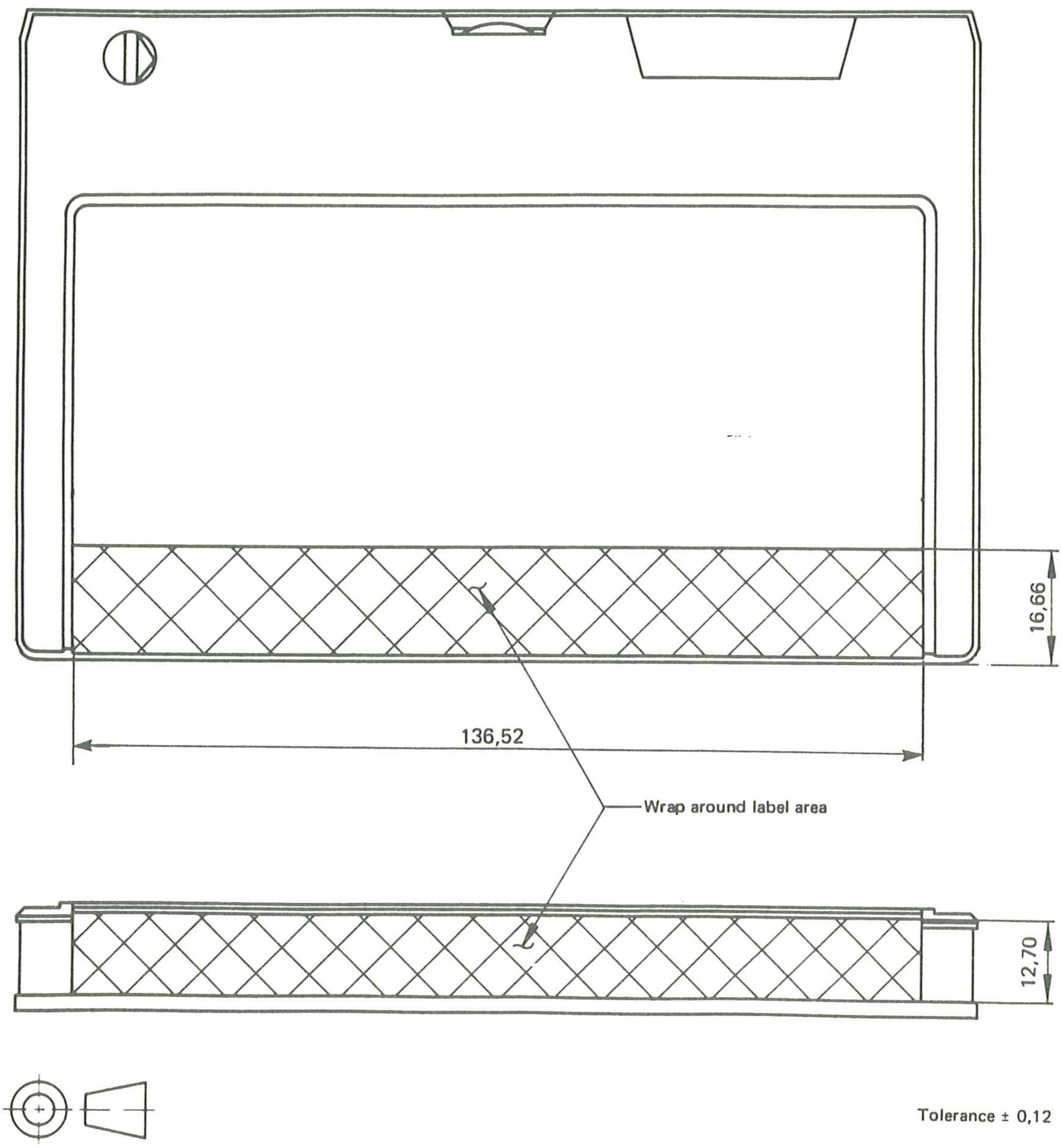



Fig. 8 - Label area

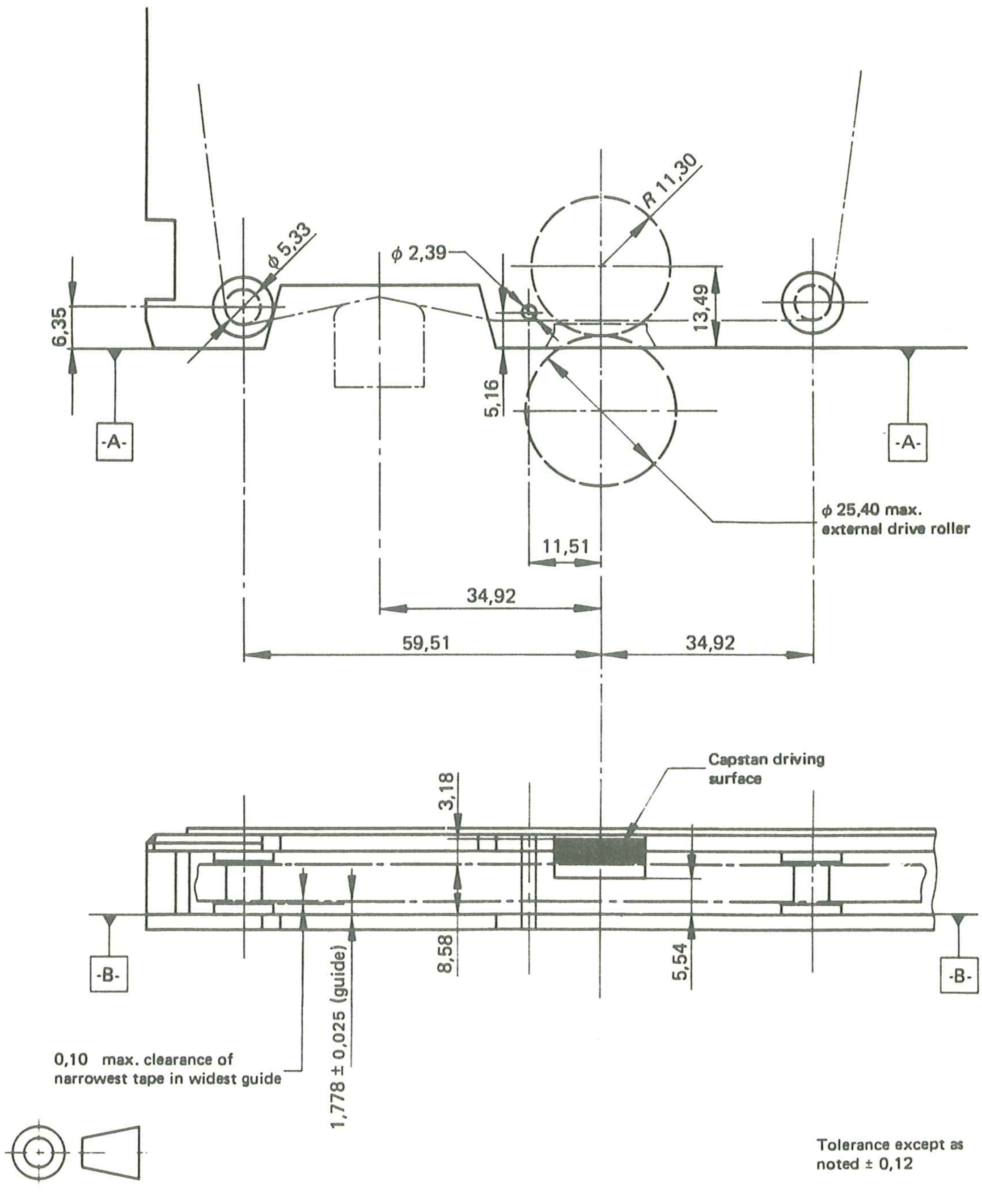



Fig. 9 - Tape path and drive dimensions

# 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 abel to set the measuring equipment to full scale defecttion (100%) a shunt potentiometer in the circuit must be provided or a sine 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:

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

where x = mean value of n observations,
$\sigma$ = 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 lets 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 $\sigma$ 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:

K = 2,33 and
n = 45 *

If T ⩽ 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 breaks 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*

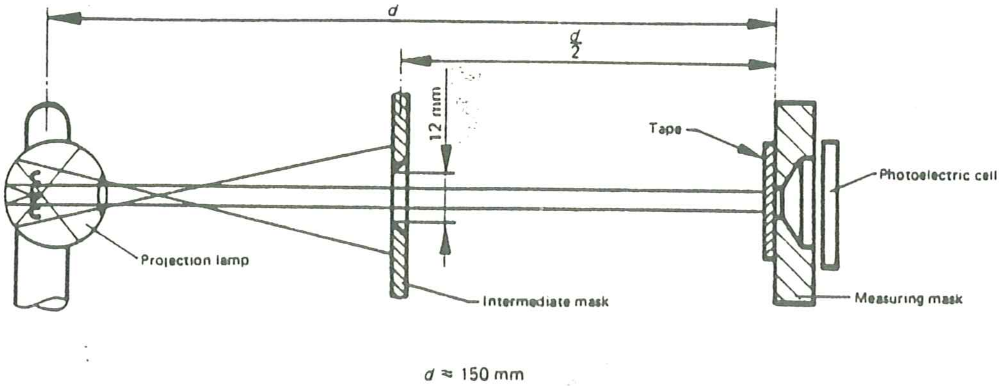



Fig. A.1 - Measuring device

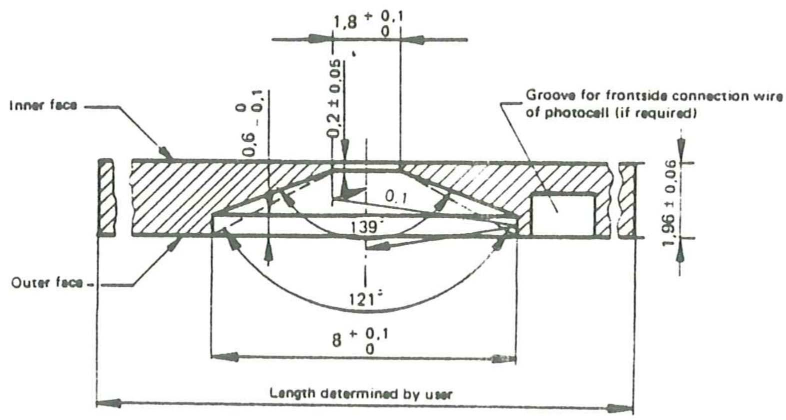
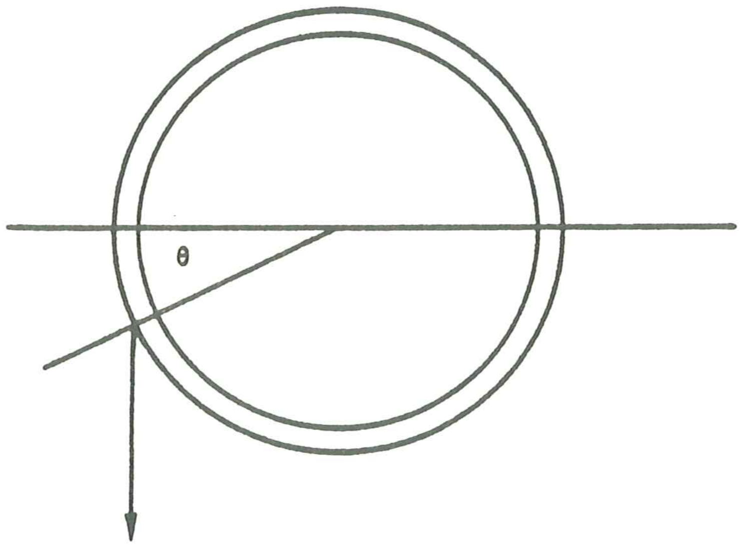



Fig. A.2 - Measuring mask

# 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 ($\Theta$) 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 $\alpha_1$, $\alpha_2$, ... $\alpha_K$, 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 ($\Delta t$). 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:

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

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.

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

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

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

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

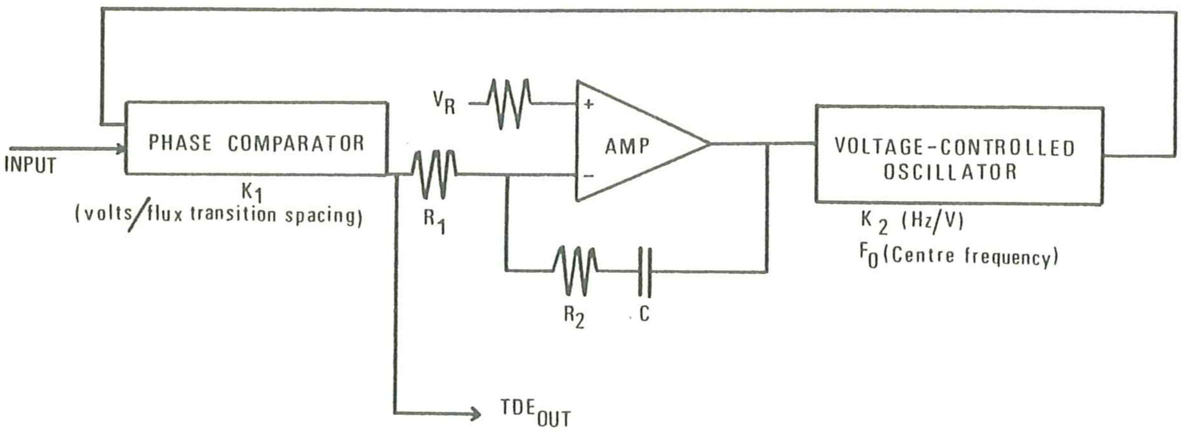



Fig. C1 STANDARD LOOP

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.

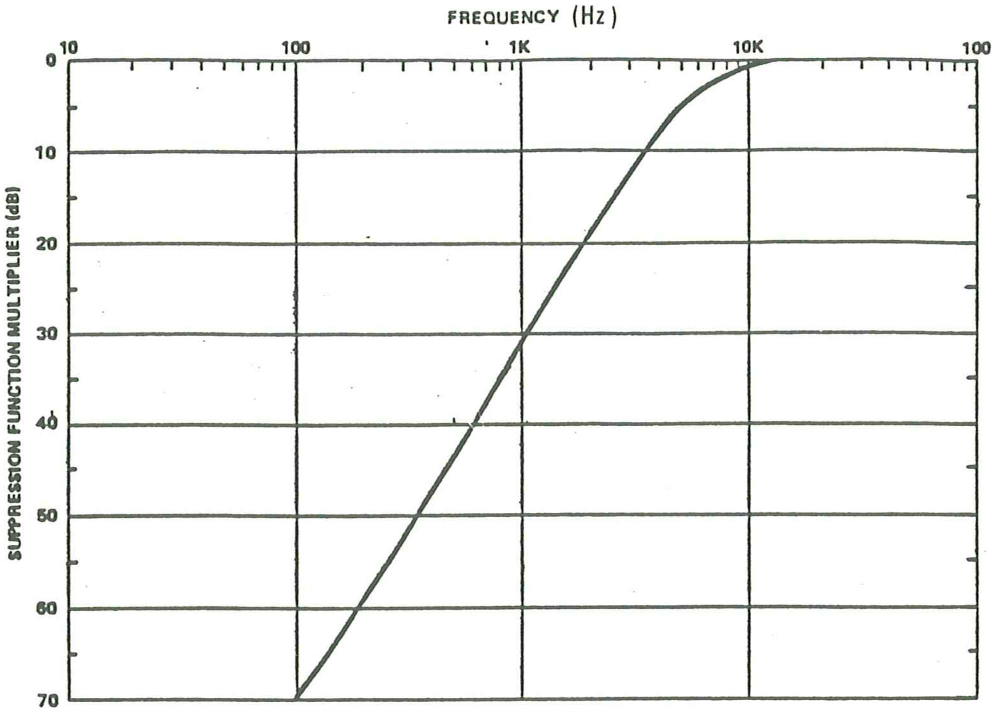



Fig. C2 Suppression Function

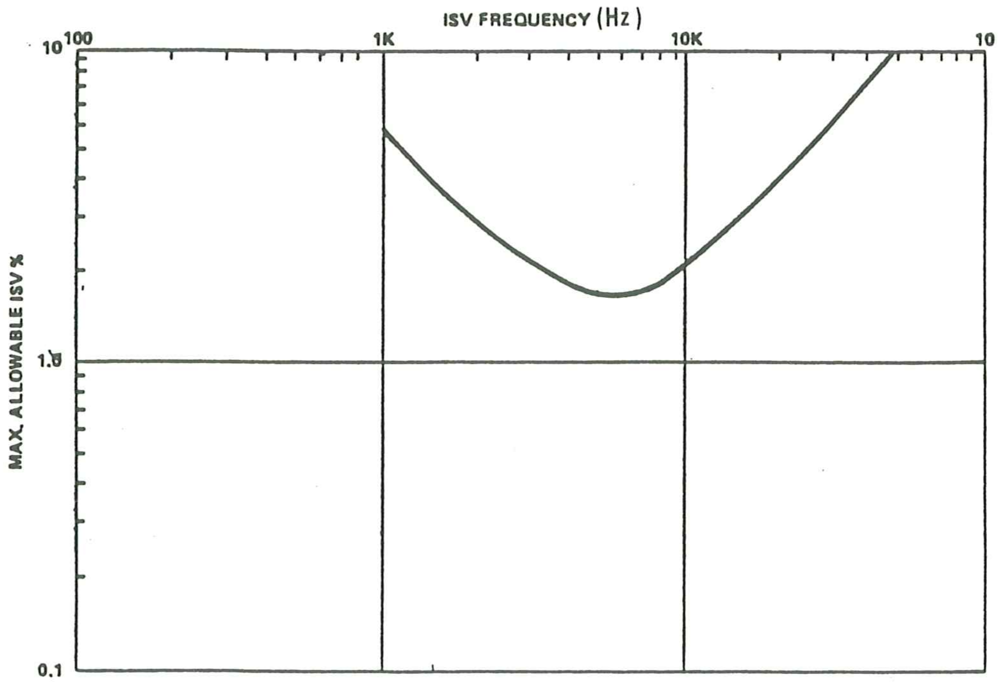
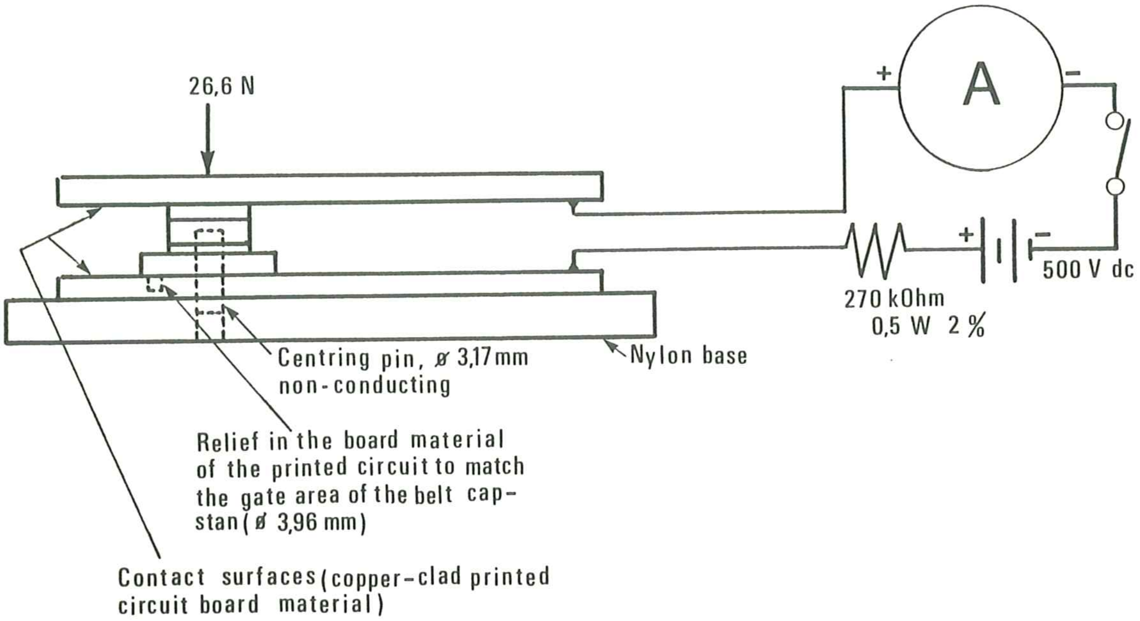



Fig. C3 Maximum Allowable ISV

# APPENDIX D

## ELECTRICAL RESISTANCE OF THE BELT CAPSTAN




### D.1 PROCEDURE

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

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

D.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.

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

### D.2 TEST RESULT

The current shall be 0,40 mA minimum.

# APPENDIX E

# TAPE TENSION

## E.1 TEST PROCEDURE FOR MEASURING INSTANTANEOUS TENSION

### E.1.1 Conditioning

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

### E.1.2 Tape Speed

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

### E.1.3 Position of the Measuring Transducer

E.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.

E.1.3.2 When inserted in the tape path it shall cause an increase in the tape path length within the limits of 6.14.

E.1.3.3 It shall be perpendicular to Reference Plane B ± 1°.

### E.1.4 Characteristics of the Measuring Transducer

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

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

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

## E.2 TEST PROCEDURE FOR MEASURING TAPE TENSION VARIATION

### E.2.1 Conditioning

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

### E.2.2 Position of Tape for Measurement

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

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

E.2.3 Characteristics of the Test Rod

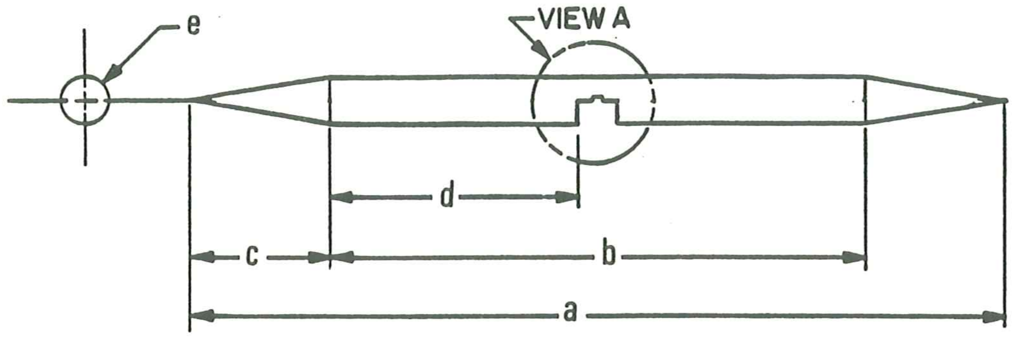
E.2.3.1 The form and dimensions of the test rod are given in Fig. E.1.

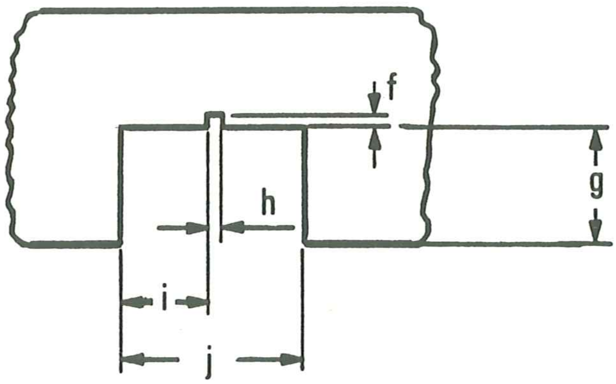
E.2.3.2 The mass of the test rod shall be 14 g. A suitable material is aluminium.

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

E.2.4 Position of the Test Rod

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




VIEW A

| | | |
|---|---|---|
| a | 138,43 | |
| b | 90,78 | |
| c | 23,83 | |
| 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 | |

Dimension of the rod

## APPENDIX F

## EXAMPLE OF WRITING OPERATIONS