

ECMA

EUROPEAN COMPUTER MANUFACTURERS ASSOCIATION

STANDARD ECMA - 34

FOR

DATA INTERCHANGE ON 3,81 mm
MAGNETIC TAPE CASSETTE
(32 bpmm, Phase Encoded)

2nd Edition – July 1973

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ECMA European Computer Manufacturers Association
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BRIEF HISTORY

ECMA TC19 was set up by ECMA in January 1970 with aim to 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.

It appeared to be a fact that the 3,81 mm tape cassette was already used and will be more used in computer applications. The urgent need for a standard for this type of cassette was therefore recognized and TC19's first efforts were directed to setting up the present Standard ECMA-34, which was issued in September 1971.

This standard was presented to ISO/TC 97 as a proposed draft for an international standard. Similar work was also in progress in the American National Standard Institute (ANSI). As a result ISO/TC97/SC11 eventually adopted a final draft for an international standard at their April 1973 meeting.

The present 2nd Edition of Standard ECMA-34 is in its content identical to the future ISO standard. It has been adopted by the General Assembly of ECMA in June 1973.

THIS 2nd EDITION SUPERSEDES THE VERSION DATED SEPTEMBER 1971

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1. SCOPE

- 1.1 To set a standard for a 3,81 mm magnetic tape cassette to provide data interchange and physical interchangeability between information processing systems utilizing the ECMA 7-bit Coded Character Set (ECMA-6) and its extensions (ECMA-35).

The cassette is of the twin hub coplanar type, loaded with a 3,81 mm wide magnetic tape for digital recording using the 31,5 bits per mm phase encoding method. The direction of magnetization is in the longitudinal direction of the tape.

NOTE: Throughout the remainder of the Standard for the sake of simplicity the recording density is stated as 32 bpmm, nominal.

- 1.2 The Standard applies to cassettes and data used for interchange. Where it applies for testing only, this is specifically stated.

2. DEFINITIONS AND EXPLANATION OF TERMS

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 Cassette

A tape cassette arbitrarily selected for a given property for calibrating purposes.

2.3 Secondary Reference Tape Cassette

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

2.4 Reference Recording Field Tape

The Reference Tape Cassette selected as a standard for recording field.

Note: This cassette is the same as the Signal Amplitude Reference Tape Cassette mentioned in 2.7.

2.5 Reference Field

The minimum field which, when applied to the Reference Recording Field Tape Cassette causes a signal output equal to 95 % of the maximum signal output at the specific test packing density (see 4.2).

2.6 Test Recording Current

A recording current between 145 % and 155 % of the current required to produce the Reference Field.

2.7 Signal Amplitude Reference Tape Cassette

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

Note: A Master Standard for Signal Amplitude, based on reference tape cassettes and heads will be established as the result of work by National Standardization Organizations and National Laboratories, coordinated by the US National Bureau of Standards.

Secondary Signal Amplitude Reference Tape Cassettes will also be made available through these organizations.

An Interim Signal Amplitude Reference Tape Cassette certified by PTB (Physikalische-Technische Bundesanstalt, Braunschweig, GERMANY) is available through ECMA, see Appendix C). At the completion of the work by NBS, a calibration factor will be published defining the ECMA reference relative to the level agreed by ISO/TC 97/SC 11. It is believed that this factor will be in the range 0,97 to 1,03.

2.8 Standard Reference Amplitude

The Standard Reference Amplitude is the average peak-to-peak signal amplitude derived from the Signal Amplitude Reference Tape Cassette, at a density of 63 ftpmm using the Test Recording Current (see 2.6). The signal amplitude shall be averaged over 4000 flux transitions and shall be determined on the read-on-first-pass-after-write.

2.9 Average Signal Amplitude

The average peak-to-peak value of the signal output measured over at least 4000 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 Bit density

The number of bit flux transitions per unit length of track.

2.13 Position of flux transitions

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

2.14 Leader

Non-magnetic transparent tapes joined to each end of the magnetic tape, for reasons of strength and convenience.

2.15 Erasing field

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

2.16 Print through

Any unwanted signals induced in one layer of tape by the field of a deliberately recorded signal in an adjacent layer or layers.

2.17 Reference Alignment Cassette

A cassette containing tape on which continuous information has been recorded, where the optimum playback head gap alignment does not differ by more than $+ 3'$ from the vertical on the cassette support plane. (Currently, these cassettes are available with wavelengths of 7,5 μm and 4,75 μm .)

2.18 Typical Field

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

3. ENVIRONMENT AND TRANSPORTATION

3.1 Testing Environment

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

Temperature	: $(23 + 2)^{\circ}\text{C}$
RH	: 40 % to 60 %
Conditioning	
before testing	: 24 hours minimum

3.2 Operating Environment

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

Temperature	: 10°C to 45°C
RH	: 20 % to 80 %
Wet bulb	
temperature	: less than 26°C

The temperature is to be measured in the air immediately surrounding the cassette. Rapid temperature variations should be avoided.

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

3.3 Transportation and Storage Environment

During transportation and storage it is recommended that recorded cassettes are kept within the following conditions:

Temperature	: 4°C to 50°C
RH	: 20 % to 80 %

NOTE: Cassettes which have been exposed to temperatures exceeding the storage temperature range may exhibit degraded performance characteristics. Such cassettes should be subjected to a conditioning period of not less than 24 hours within the operating environment prior to use.

3.4 Transportation

Responsibility for ensuring that adequate precautions are taken during shipment shall be with the sender. During transport the reels of tapes shall be blocked to prevent any tendency to unwind. For transport a rigid container free from dust or extraneous matter shall be used. The final package must have a clean interior and construction preventing ingress of dust and water. It is recommended that a space of not less than 80 mm exists between cassette and outer surface of the final container, so that risk of damage due to stray magnetic fields will be negligible.

4. CHARACTERISTICS OF TAPE

The tape shall consist of a base material (e.g. oriented polyethylene terephthalate film or equivalent) coated on one side with a strong and flexible layer of ferromagnetic material dispersed in a suitable binder. The magnetic tape shall be continuous and splice-free. Tape or cassette 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.

4.1 Mechanical properties

4.1.1 Tape and leader width and tolerance

The width of tape and leader shall be:

$$3,81 \begin{matrix} + 0 \\ - 0,05 \end{matrix} \text{ mm}$$

4.1.2 Tape and leader length

4.1.2.1 Tape length

The length of the splice-free tape shall be:

$$86 \begin{matrix} + 4 \\ - 0 \end{matrix} \text{ m}$$

4.1.2.2 Leader length

The length of the leader tape shall be such that the distance from the cassette face to the beginning of the magnetic tape is (500 ± 50) mm when the leader tape is pulled out of the cassette through the opening nearest to the empty reel.

4.1.3. Tape and leader thickness

4.1.3.1 Thickness of tape

The overall thickness of tape and coating shall be minimum 15 μm and maximum 19 μm with a coating thickness of 5 ± 1 μm .

4.1.3.2. Thickness of leader

The thickness of the leader shall be 38 μm maximum.

4.1.4 Markers

4.1.4.1 The magnetic tape shall be provided with a beginning-of-tape and an end-of-tape marker (BOT and EOT).

4.1.4.2 Dimensions

The markers shall be circular holes and have a diameter of 0,60 mm \pm 0,05 mm.

4.1.4.3 Position

The distance of the marker centres from the physical beginning and end of the magnetic tape (for BOT and EOT respectively) shall be 450 \pm 30 mm. The distance between tape centreline and marker centreline shall be less than 0,1 mm.

4.1.5 Light transmittance

4.1.5.1 Light transmittance of tape

The tape and the backing tape shall have each a light transmittance of less than 1 % measured according to Appendix B.

4.1.5.2 Light transmittance of leader

The leader tape shall transmit 75 % or more light, measured according to Appendix B.

4.1.6 Elastoplastic properties

4.1.6.1 The elastic properties of the tape shall be such that when subjected to a tension of 0,5 N for a period of three minutes under any combination of temperature and relative humidity within the ranges of clause 3.1, the elongation shall be between 0,08 % and 0,50 % .

4.1.6.2 The elastoplastic properties of the tape shall be such that when subjected to a tension of 3 N for a period of three minutes under temperature and humidity conditions as mentioned in 3.1 the (permanent) elongation measured with negligible tension after a second three minutes interval shall be less than 1,0 %.

4.1.6.3 The elastic properties of the tape shall be such that its tensile yield force - defined as the force required to elongate a sample by 3 % - shall be at least 4,5 N.

Procedure: Use a static weighing-constant rate of grip separation tester capable of indicating the load to an accuracy of \pm 2 %. Clamp a specimen of tape at least 180 mm in length with an initial 100 mm separation between jaws. Elongate the specimen at a rate of 50 mm per minute until minimum elongation of 10 % is reached. The force required to produce an elongation of 3 % is the tensile yield force.

4.1.6.4. The elastic properties of the leader shall be such that when subjected to a tension of 1,0 N for a period of three minutes under temperature and humidity conditions as mentioned in 3.1 the elongation shall be between 0,08 and 0,50 % .

4.1.7 Longitudinal curvature

There shall be a minimum radius of curvature for the edge of the tape, defined and tested by allowing a 1 m length of tape to unroll and assume its natural curvature on a flat surface. The minimum radius shall be 33 m which if measured over an arc of a circle, corresponds to a deviation of 3,8 mm from a 1 m chord.

4.1.8 Tape-to-leader connection

4.1.8.1 Dimensions

If a backing tape is used, this shall not extend more than 18 mm from the gap between leader and tape. The actual gap itself shall be 0,5 mm maximum. No overlap is permitted.

The thickness of the backing tape shall be 50 um maximum.

4.1.8.2 Tape-to-leader alignment

At the area of the splice there shall be no lateral discontinuity greater than 50 um.

4.1.8.3 Strength

After being subjected to a longitudinal static force of 2 N for 24 h under the conditions of 3.2, the connection shall meet the requirements of 4.1.8.1.

4.1.9 Tensile strength

The tape shall be suitable for use with instruments applying a maximum continuous load of 2 N, provided that the requirements of 6.8 are met.

4.1.10 Layer-to-layer adhesion

Layer-to-layer adhesion must be sufficiently low to meet the test of Appendix A.

4.2 Tests of magnetic properties

The magnetic properties of the tape are defined by the testing requirements given in this section.

4.2.1 Test density

Tape shall be tested at 63 ftpmm nominal.

4.2.2 Typical field

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

4.2.3 Average Signal Amplitude

When a tape has been recorded with the Test Recording Current, then played back on a system which has been calibrated by means of a Signal Amplitude Reference Tape Cassette recorded under the same conditions, the Average Signal Amplitude of the tape under test shall be within $\begin{matrix} + 25 \% \\ - 10 \% \end{matrix}$ of the Standard Reference Amplitude.

The output signal from the tape under test shall be measured on the Read-on-first-pass-after-write.

4.2.4 Ease of erasure

When a tape has been recorded with the Test Recording Current, and then passed through a longitudinal steady erasure field of 79500 A per m (1000 oersteds) the Average Signal Amplitude of the remaining unwanted signal shall not exceed 3 % of the Standard Reference Amplitude. The erasure 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.

4.2.5 Test for Drop-Outs and Drop-Ins

These tests shall be carried out in the in-contact condition and over the entire usable recording area which shall, in length, extend from 350 mm before the BOT-marker to 350 mm beyond the EOT-marker, and in width over the track widths as defined in 7.2.

When performing these tests, the output signal from the tape under test shall be measured on the Read-on-first-pass-after-write.

4.2.5.1 Drop-Outs

When a tape has been recorded with the Test Recording Current, any playback signal, when measured base-to-peak, which is less than 50 % of half the Standard Reference Amplitude is a drop-out.

4.2.5.2 Drop-Ins

When a tape has been recorded with a constant recording current equivalent to the Test Recording Current, any playback signal, when measured base-to-peak which exceeds 10 % of half the Standard Reference Amplitude is a drop-in.

4.2.6 Rejected regions

A rejected region is an area of tape extending across the width of either track and not more than 10 mm in length, which on two consecutive tests exhibits drop-

outs or drop-ins, (see 6.6). The acceptable number of rejected regions in an interchange environment is a matter of agreement between interchange parties.

4.2.7 Print-through

A tape for testing shall be written with a suitable pattern using the test recording current, re-wound and stored for a minimum of 16 h at 60°C. At the end of this period the measured print-through signal shall not exceed 2 % of the Standard Reference Amplitude.

As the decay of the print-through signal on a section of tape is extremely rapid after it has been removed from the coil, the time elapsing between the tape leaving the coil and it passing over the test read head shall not exceed 500 ms.

4.3 Electrical Properties

4.3.1 Surface Resistance

The surface resistance of the tape shall be less than:
 10^9 ohm per square

NOTE: Resistance per square: The surface resistance of a square area of any size, measured between electrodes placed on two opposite sides of the square. The unit of the measurement is ohm.

5. TAPE CASSETTE

5.1 Identification of cassette sides

5.1.1 The cassette has its two sides distinguished and labelled "A" and "B", respectively, corresponding to tracks No. 1 and No 2 (see Figure 1).

5.1.2 The back surface is provided with two holes whose minimum area, depth and section are indicated in Fig. 1. Writing on a track is enabled by closing the outer surface of the corresponding hole. When a closing device other than a plug is used it must remain attached to the cassette.

5.1.3 The back surface is provided with one slot slightly off-center (see Figure 1).

This slot makes it possible to distinguish between the sides A and B, both visually and mechanically.

5.2 Mechanical characteristics

The mechanical characteristics which define the coplanar tape cassette and which permit physical interchangeability of cassettes on any recorder for data interchange of different manufacture are specified in Figures 1 - 6.

5.3 Basic specifications

Furthermore, the following basic specifications apply:

5.3.1 Tape path and guidance

Requirements are shown in Figure 3.

5.3.2 Cassette support planes

The cassette shall be supported by the write/read instrument only where the total cassette thickness is obligatory, i.e. the hatched areas in Figure 5.

5.3.3 Holes in back surface

The positions and dimensions of the holes in the back surface are given in Figure 1. The dimensions of the write-enable plug, if used, shall be compatible with the hole dimensions as shown in Figure 1 and must be such that it may be installed and removed with reasonable effort and remain seated during normal use. The write-enable device must not protrude beyond the back surface and it must not be recessed by more than 1 mm. The write-enable device shall at least close the cross hatched area as shown in Fig. 1.

5.3.4 Window area

The maximum window area shall be in accordance with the dimensions given in Figure 6. The maximum allowable increase in cassette thickness (required, for example, to accommodate marks indicating amount of wound and unwound tape) is given for each support plane.

5.3.5 Withdrawal force

The minimum withdrawal force of the leader tape from the hub attachment shall be a static load of 10 N for a period of 10 min.

5.3.6 Tape winding

The tape shall be wound on the hubs with the magnetic coating out in such a way that, when recording on Track No. 1, and looking at label A, the tape is unwound in an anticlockwise direction.

5.3.7 Friction torque of the full hub

The maximum friction torque of the full hub in the cassette shall be $2 \cdot 10^{-3}$ N.m.

5.3.8 Friction torque of both hubs

The maximum friction torque of both hubs measured in the cassette itself at the nearly full hub shall be $2,7 \cdot 10^{-3}$ N.m. With a holdback torque of $0,8 \cdot 10^{-3}$ N.m applied to the nearly empty hub, the required maximum torque to be applied to the nearly full hub shall not exceed $5,5 \cdot 10^{-3}$ N.m.

5.3.9 Pressure pad

The cassette shall be provided with a pressure pad to hold the magnetic tape against the write/read head.

The pressure of the pad upon the head shall be 0,005 to 0,015 N/mm², when the minimum distance between head and reference line lies between 3,1 mm and 3,8 mm. This pressure shall be measured on a symmetrically positioned circular cylindrical surface having a radius between 10 mm and infinity (see Fig. 2).

Under the above conditions and with $0,8 \cdot 10^{-3}$ N.m holdback torque applied to the nearly empty hub, the required maximum torque applied to the nearly full hub shall not exceed $16 \cdot 10^{-3}$ N.m to start tape motion, and shall not exceed $12,5 \cdot 10^{-3}$ N.m to continue tape motion.

Measured from the centreline of the cassette, the pressure pad shall extend on both sides of this centreline in the direction of tape travel a minimum of 2,5 mm and a maximum of 4 mm. Up to the distance of 2,5 mm, the pressure requirements still apply. The pressure pad shall be symmetrically positioned, and the distance between pressure pad and cassette support planes surrounding the reference holes shall not exceed 3,5 mm. Those values shall also be valid in actual working conditions.

No magnetic material may be used for the cassette construction near the position of the write/read head. No screening shield may be used and the pressure pad and its holder must be of non-magnetic material.

5.3.10 Tape guides

The tape touches the cassette at points on either side of the tape head recesses (indicated by arrows U and L). (See Figure 3).

Guides are required at these positions. Between the outer guides (P and S) there must be a closed construction so as to prevent dust entering the cassette.

The guides indicated by the letter L shall be perpendicular to the lower support plane (see 5.3.2). The guides indicated by the letter U shall be perpendicular to the upper support plane.

5.3.11 Transverse tolerances of tape position

5.3.11.1 Transverse tolerances without tape tension

The extreme position of the tape in the head region when no tape tension is present shall be limited by means incorporated in the cassette. The distance between cassette support planes surrounding the reference holes and those means shall lie between 3,5 mm and 3,7 mm.

5.3.11.2 Transverse tolerances with tape tension

If the tape is not influenced or touched by any external means (guides, heads, capstans), during wind and rewind, the tape edges shall have a distance of $4,1 \pm 0,2$ mm from the support plane surrounding the reference holes (see Figures 4 and 5). When track No. 1 is being used, the side B outer cassette surface is the reference plane. Conversely, when track No.2 is being used, the side A outer cassette surface is the reference plane.

5.4 Labelling of tape cassette

5.4.1. Label area

The maximum label area shall be in accordance with the dimensions given in Figure 6. The maximum allowable depression in the thickness of the cassette in the label area is given for each support plane.

5.4.2 Interchange

Suitable labels shall be used for marking contents of cassette. The use of pencil or erasable material is not allowed. Position and size of labels used shall be less than the provided depression of the label area.

5.4.3 Identification

The label shall have provisions for the identification of owner, manufacturer, cassette side and interchange label. The label shall indicate:

- 1) that the cassette is meant for data interchange purposes,
- 2) the use of track No. 2,
- 3) whether 7-bit or 8-bit coding is used (see 7.7),
- 4) the method of recording.

5.5 Magnetic Properties of the Cassette Housing

The magnetic properties of the cassette housing shall not impede bulk erasure of the tape by an external device.

6. RECORDING

6.1 Method of recording

The method of recording shall be phase encoding, described as follows:

- #### 6.1.1
- The tape before the first block, the interblock gaps and that part of the tape following the last block written, shall be erased with the same polarity.

This polarity is such that the begin of the relevant track is a North seeking pole.

This erasing process forms parts of the recording procedure.

- 6.1.2 A ZERO bit is defined as a flux transition to the polarity opposite to that of the interblock gap, when reading in the forward direction.
- 6.1.3 A ONE bit is defined as a flux transition to the polarity of the interblock gap, when reading in the forward direction.
- 6.1.4 Additional flux transitions shall be written at the nominal midpoints between bit flux transitions as defined in 6.1.2 and 6.1.3 if required, to establish the proper polarity for the succeeding bits. These flux transitions shall be called phase flux transitions.

6.2 Equipment

The equipment and tape used for interchange must satisfy the requirements of 6.3 to 6.8 inclusive.

All signal measurements are made at a point in the read chain where the amplitude is proportional to the rate of change of the longitudinal component of the flux at the tape surface.

6.3. Density of recording

- 6.3.1 The density of recording is 32 bpmm nominal
- 6.3.2 The long term average bit spacing is the spacing between bit flux transitions that have been recorded continuously at a nominal density of 32 ftpmm and must be measured over a length of tape of not less than 381 cm.

The long term average bit spacing shall be within ± 4 % of the spacing of 31,750 μm .

- 6.3.3 The short term average bit spacing referred to a particular bit spacing is the average of the preceding four bit spacings.

The short term average bit spacing shall be within the limits of ± 5 % of the long term average bit spacing.

In addition, the short term average bit spacing shall not change at a rate greater than 2 % per bit.

6.4 Flux transition spacing

- 6.4.1 The spacing between successive data bit flux transitions shall not differ by more than 10 % from the preceding bit spacing.
- 6.4.2 The spacing between a phase flux transition and the

preceding data bit flux transition shall be between 45 % and 55 % of the preceding bit spacing.

6.5 Signal Amplitude

6.5.1 Average Signal Amplitude

- 6.5.1.1 The average peak-to-peak signal amplitude of the interchanged tape cassette at 63 ftpmm shall not deviate by more than + 50 %, -35 % from the Standard Reference Amplitude. Averaging shall be done over a minimum of 4000 flux transitions, which for the interchange cassette may be segmented into blocks.
- 6.5.1.2 The average peak-to-peak signal amplitude at 32 ftpmm nominal shall be less than 2 times the Standard Reference Amplitude.
- 6.5.1.3 Averaging shall be done on the first-read-pass-after-interchange.

6.5.2 Minimum Signal Amplitude

No tape cassettes intended for interchange shall contain any adjacent flux transitions whose base-to-peak signal amplitude is less than 35 % of half of the Standard Reference Amplitude. This check is to be made during read-whilst-write or read-on-first-pass-after-write.

6.6 Number of elongated gaps

The number of gaps which have been elongated (see 7.11.4) due to erase instructions is a matter of agreement between interchange parties, but it is recommended that this number does not exceed 2, or alternatively 1 % of the total number of blocks written, whichever figure is larger.

6.7 Alignment error

When adjusted for maximum output, the azimuth angles for a Reference Alignment Cassette, and the information to be interchanged shall not differ by more than $\pm 15'$.

6.8 Tape winding torque

The take-up torque shall be at least $3 \cdot 10^{-3}$ N.m. The maximum continuous value of the take-up tape tension shall be constant or decrease with increasing reel diameter and shall not exceed 0,5 N. The above values apply during winding, re-winding, recording and playback.

6.9. Residuals of previous recordings

In the zone of the tape in which the outer edges of the tracks are allowed to vary (see 7.2.2), there can be residuals of previous recordings.

7. FORMAT

7.1 Number of tracks

There shall be two tracks.

7.2 Track dimensions

7.2.1 Track width

The track width shall be 1,45 mm nominal.

7.2.2 Distances between tape centreline and track edges

The distance between centreline of the tape and the outer edges of the tracks shall be between 1,830 mm and 1,905 mm. The distance between the tape centreline and the inner edges of the tracks shall be between 0,37 mm and 0,51 mm.

7.3 Track designation

7.3.1 With side "A" up the designation of the two tracks is as follows:

When the tape moves from left to right with the coating side facing the observer, and with the leader of side A to the right, the bottom track is designated track No. 1 and the upper track is designated track No. 2 (see Figure 1).

7.3.2 The recording starts with track No.1; at its conclusion the cassette may be turned over and the recording can be continued with track No. 2.

7.4 Use of tracks

The use of track No. 1 is reserved for data interchange. The use of track No. 2 is to be indicated on the label. If it is not used in the same way as track No. 1, reading of track No. 2 requires agreement between sender and recipient of the cassette.


7.5 Location of characters on the tracks


Each character is located in a byte of eight hit-positions along the track numbered from 1 to 8 in order of recording.

7.6 Sequence of recording

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

Bit-positions : ...4321^{byte}876543218765432...

Forward Tape motion : 

Resulting recording direction : 

7.7 Code

The characters are represented by means of the ECMA 7-Bit Coded Character Set (Standard ECMA-6) and, where required, of its extensions (Standard ECMA-35).

7.7.1 Recording of 7-bit Coded Characters

Each 7-bit coded character is recorded in bit-positions 1 to 7 of a byte; bit-position 8 is recorded with value ZERO. The relationship is as follows:

Bits of the 7-bit combination :	0	b ₇	b ₆	b ₅	b ₄	b ₃	b ₂	b ₁
Bit-position in the byte :	8	7	6	5	4	3	2	1

7.7.2 Recording of 8-bit Coded Characters

Each 8-bit coded character is recorded in bit-positions 1 to 8 of a byte. The relationship is 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-position in the byte :	8	7	6	5	4	3	2	1

7.8 Sequence of characters

The sequence of characters from start towards finish of a block is corresponding to the normal left to right sequence of a written line.

7.9 Data block

A data block shall consist of a preamble, data and a postamble. The data portion of a data block including the CRC (see 7.13) shall contain a minimum of 32 bits and a maximum of 2064 bits.

7.10 Control block

A control block (known as tape mark) shall consist of a preamble, two bytes of eight ZERO bits each, and a postamble

7.11 Gaps

7.11.1 Integrity of Gaps

The gaps shall be DC erased. Immediately before and after each block there shall be a length of at least 2,5 mm in which, exclusive of residual edge signals, there is no flux discontinuity capable of producing a read signal of more than 10 % of half the Standard Reference Amplitude.

In the remaining part of the gap one burst of spurious transitions can be tolerated, provided that the total length of the burst is less than 0,2 mm.

7.11.2 Interblock gaps

The interblock gap, defined as the distance between two successive data blocks shall have a minimum length of 17,8 mm, a nominal length of 20,3 mm, and a maximum length of 250 mm. Any gap in excess of 400 mm shall be considered end of data on this track.

7.11.3 Initial gap

The gap between the BOT marker and the first data block shall be 33 mm minimum and 250 mm maximum.

7.11.4 Elongated gap

A gap is an elongated gap if its length is between 50 mm and 250 mm.

7.12 Preamble and Postamble

7.12.1 Preamble

Immediately preceding data in each block the preamble "10101010" shall be written. When reading in the forward direction, the first flux transition shall be a ZERO transition.

7.12.2 Postamble

Immediately following data in each block the postamble "10101010" shall be written. When reading in the forward direction, the first flux transition shall be a ZERO transition.

7.13 Cyclic Redundancy Check (CRC)

The last 2 characters in the data portion of a data block shall be a Cyclic Redundancy Check (CRC). The 16-bit CRC shall be written in each data block following the data and immediately preceding the postamble. The polynomial generating the CRC is:

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

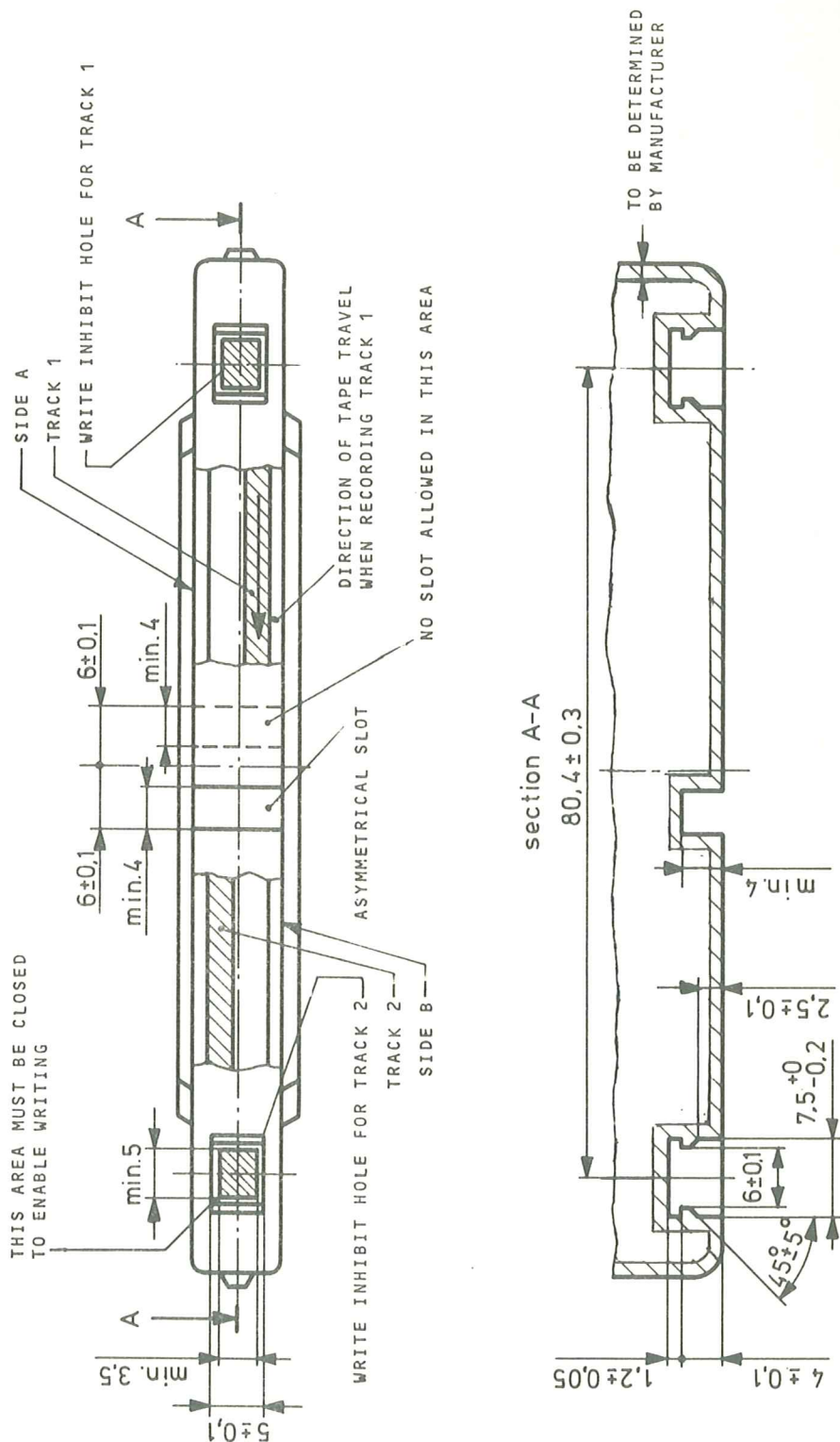


Fig. 1 Sides, track, holes and asymmetrical slot

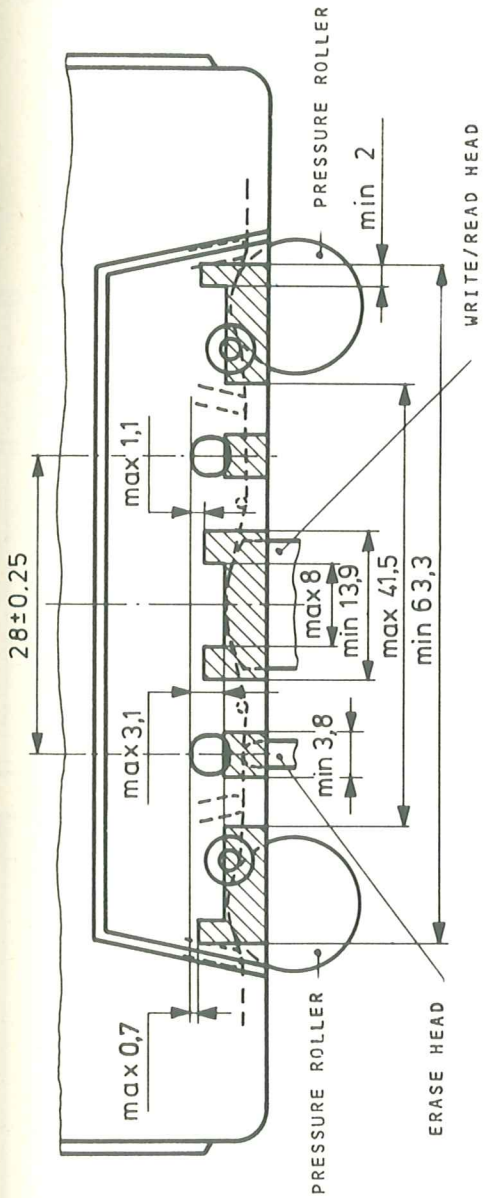


Fig. 2 Position of heads

NOTE to Fig. 2

Hatched areas define openings over the full height of the cassette aperture, unobstructed by fixed members, except for areas covered by the magnetic tape and pressure pad.

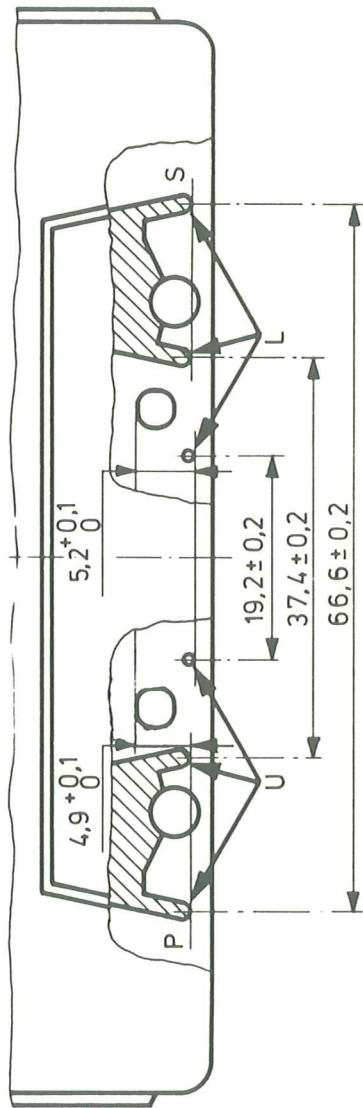
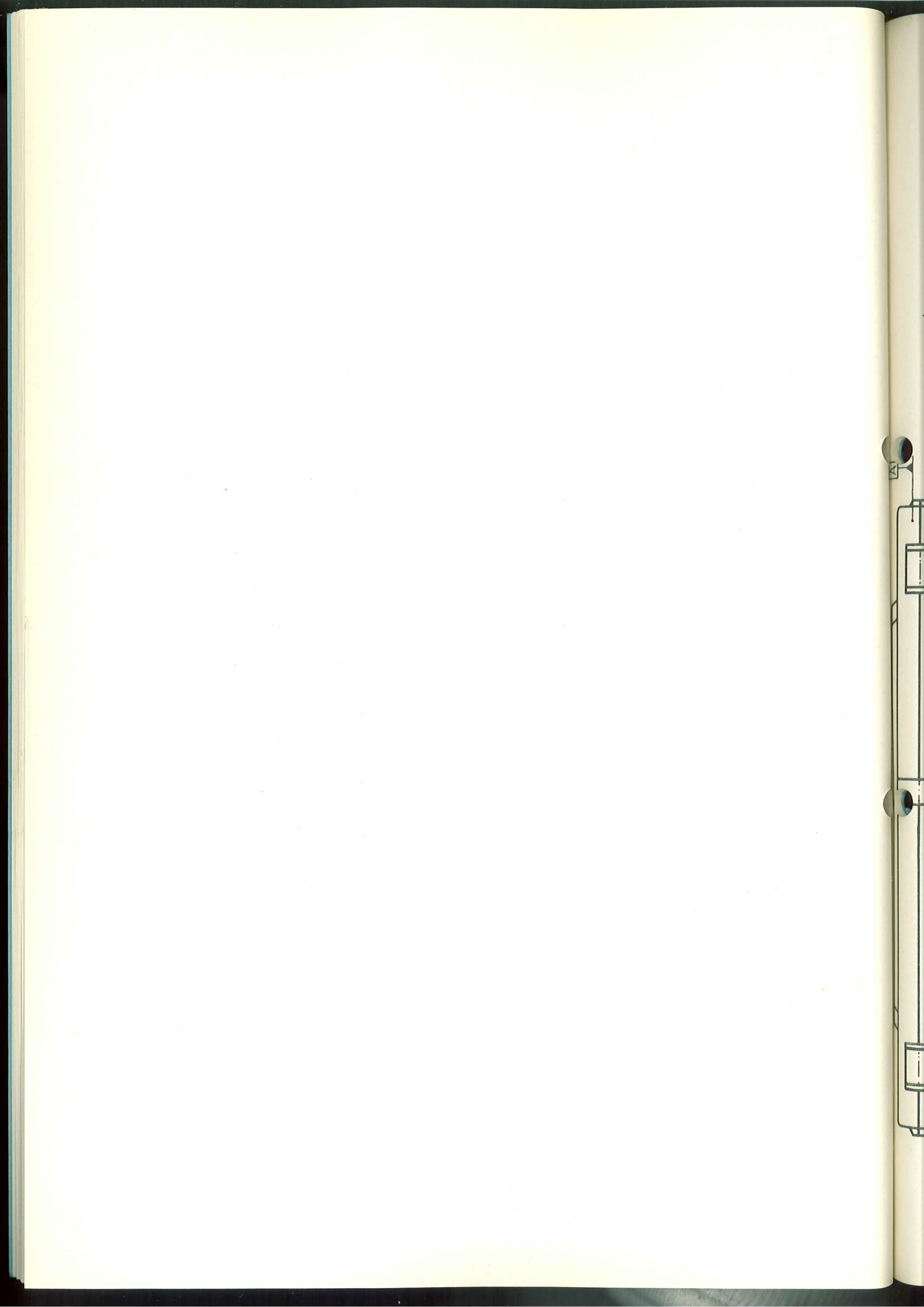


Fig. 3 Tape guides in cassette



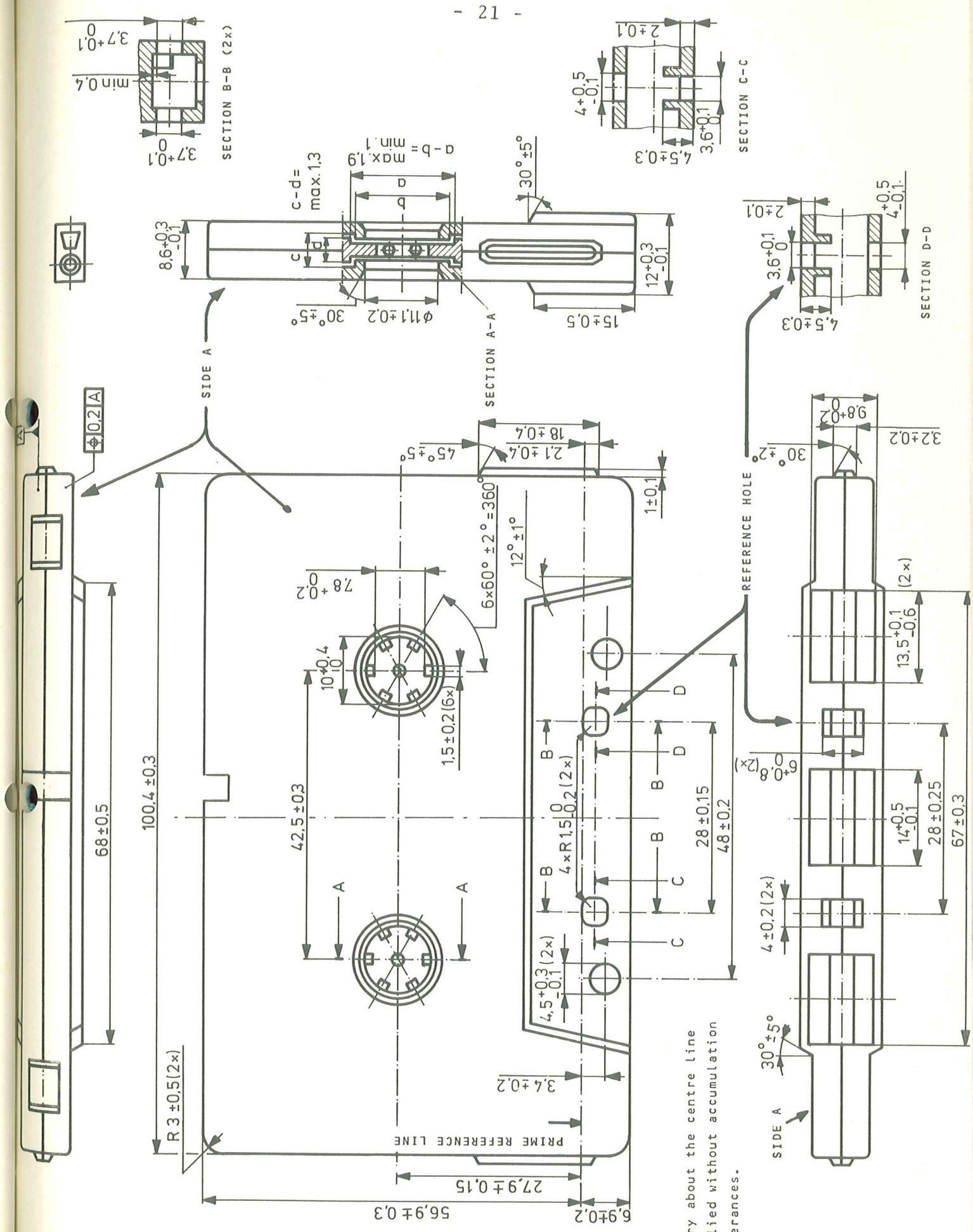


Fig. 4 Cassette dimensions

NOTE
Symmetry about the centre line is implied without accumulation of tolerances.

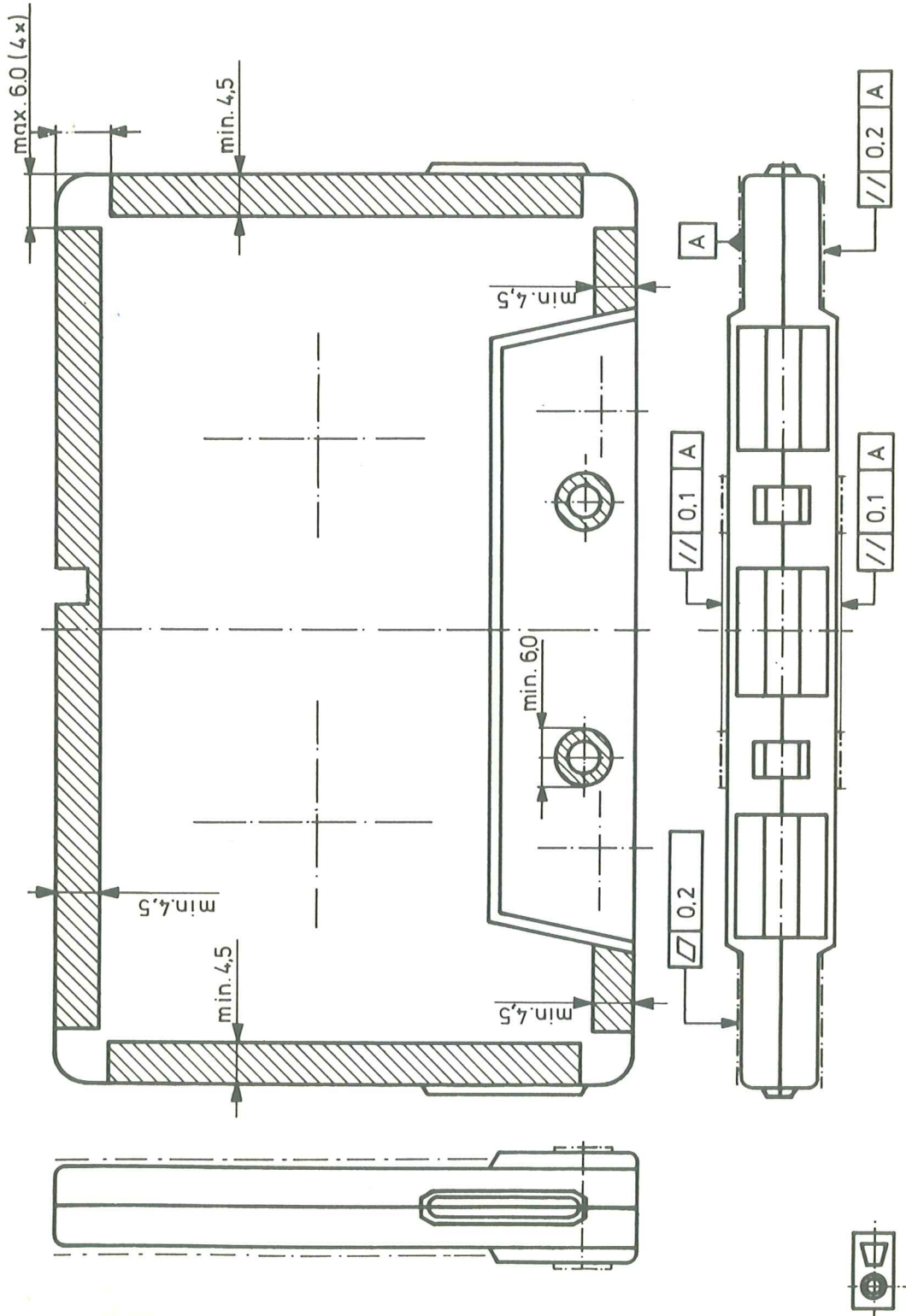


Fig. 5 Cassette support planes

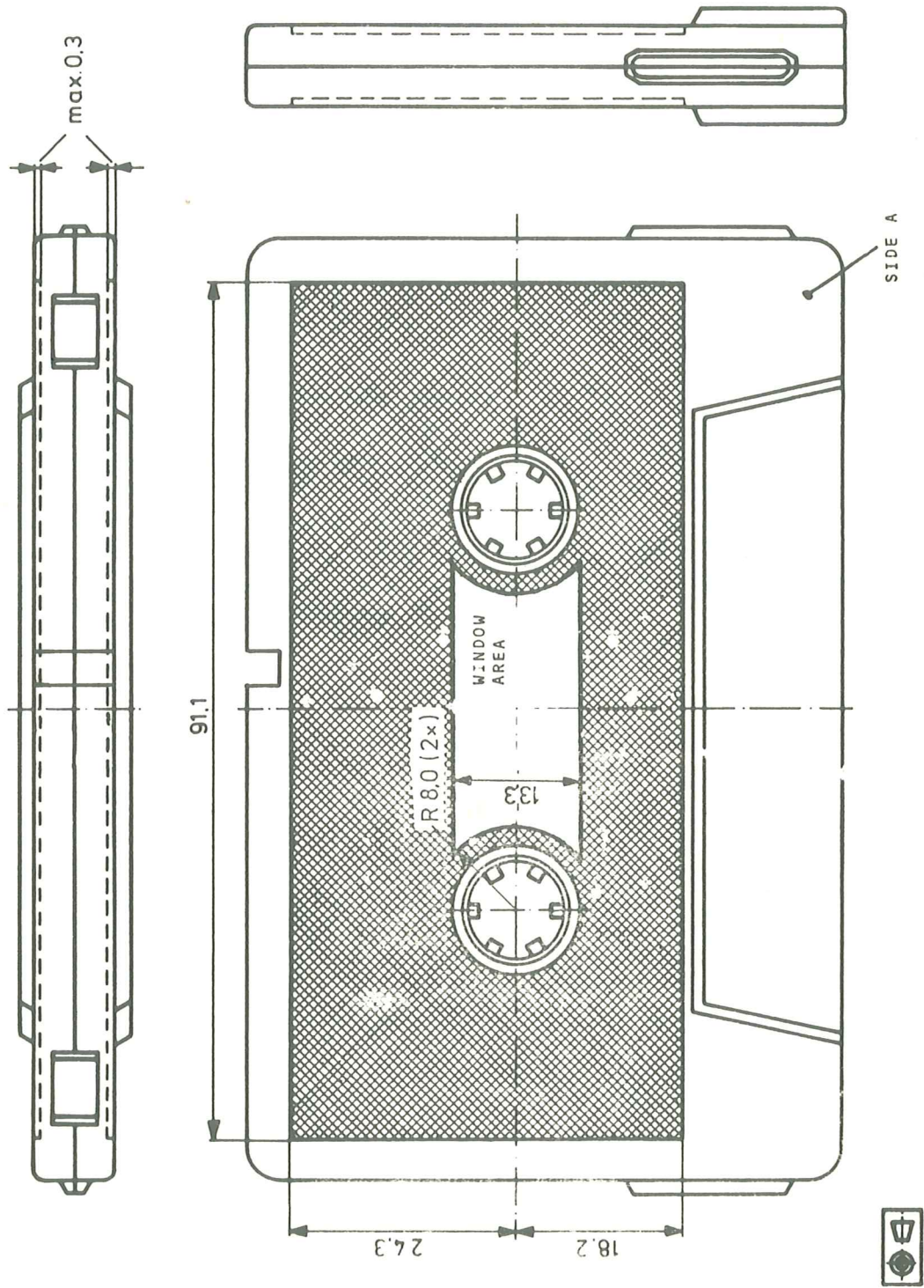
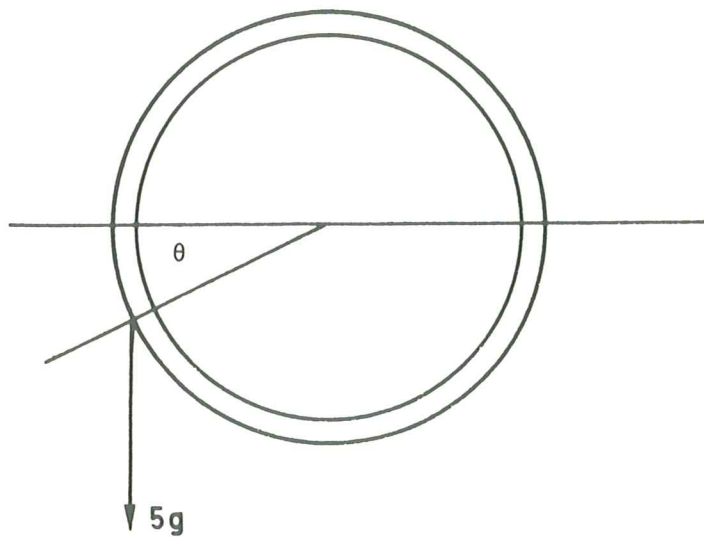


Fig. 6 Maximum label and window area dimensions

APPENDIX A

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 $45 \pm 3^{\circ}\text{C}$, 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 weight of 5 grammes at the end of tape as shown below, and the angle (θ) shall be smaller than 45° .



APPENDIX B

Measurement of Light Transmittance

B.1 Introduction

Characteristically, tape readers used in the data processing equipment are susceptible to the radiation transmitted through and scattered by the tape.

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 the tape. Device and test method simulate the more critical factors of typical tape readers.

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 (light) source
- the optical path
- the measuring mask
- the photo cell
- the measuring equipment

B.2 Description of the Test Device

B.2.1 Radiation (light) source

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

The colour temperature should be $2000^{\circ} \text{K} \pm 200^{\circ} \text{K}$ and a resulting illumination at the surface of the tape sample of about 5000 lux is recommended.

B.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 lamp by a distance of 150 mm.

A diaphragm of the form shown in Figure B1 is recommended in order to sensibly ensure that scattered radiation does not enter the mask area.

B.2.3 Measuring mask geometry

The measuring mask shall be constructed in one piece according to the drawing shown in Figure B2. 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.

B.2.4 Photo cell

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.

B.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 500Ω . The instrument, which could take the form of a moving coil metre with a full scale deflection of 50 μA , should be capable of measuring the maximum and minimum values to an accuracy of $\pm 1 \%$.

B.3 Test Procedure

B.3.1 For the purpose of the test a sample strip of tape not shorter than 250 mm is used.

- The measuring equipment is set to full scale deflection (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.

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

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

where \bar{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 O and gives the values for

$k = 2,33$ and

(*) $n = 45$

If $T \leq T_{max}$, the lot is accepted,

if $T > T_{max}$, the lot is rejected,

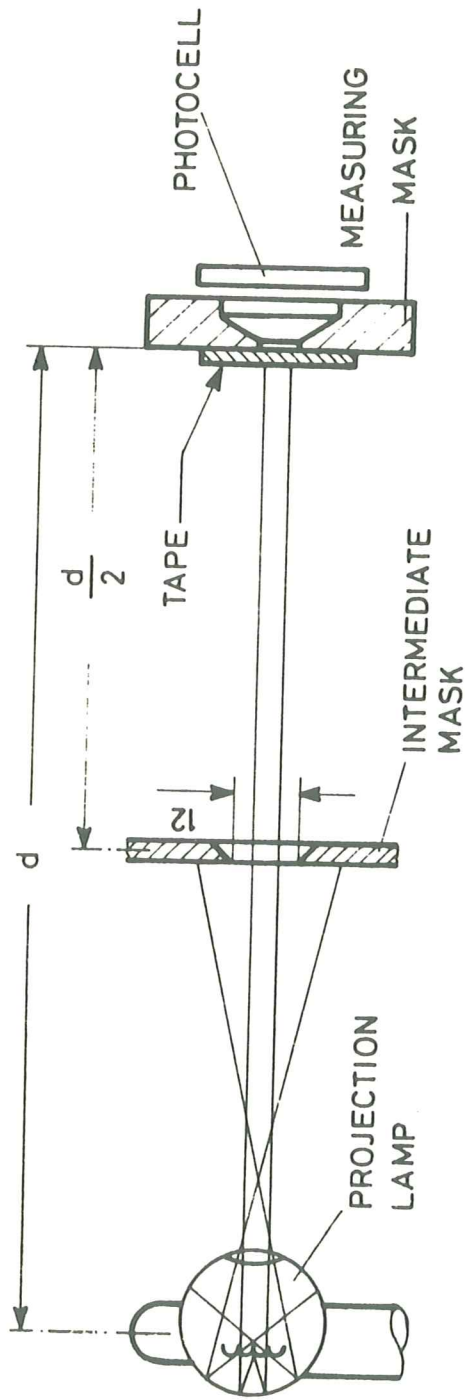
where T_{max} = maximum value of transmittance permitted.

B.4 Guidance on Construction

B.4.1 Experience has shown that a projector lamp is most suited as the radiation 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 lamp from a stabilized, regulated power supply.

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

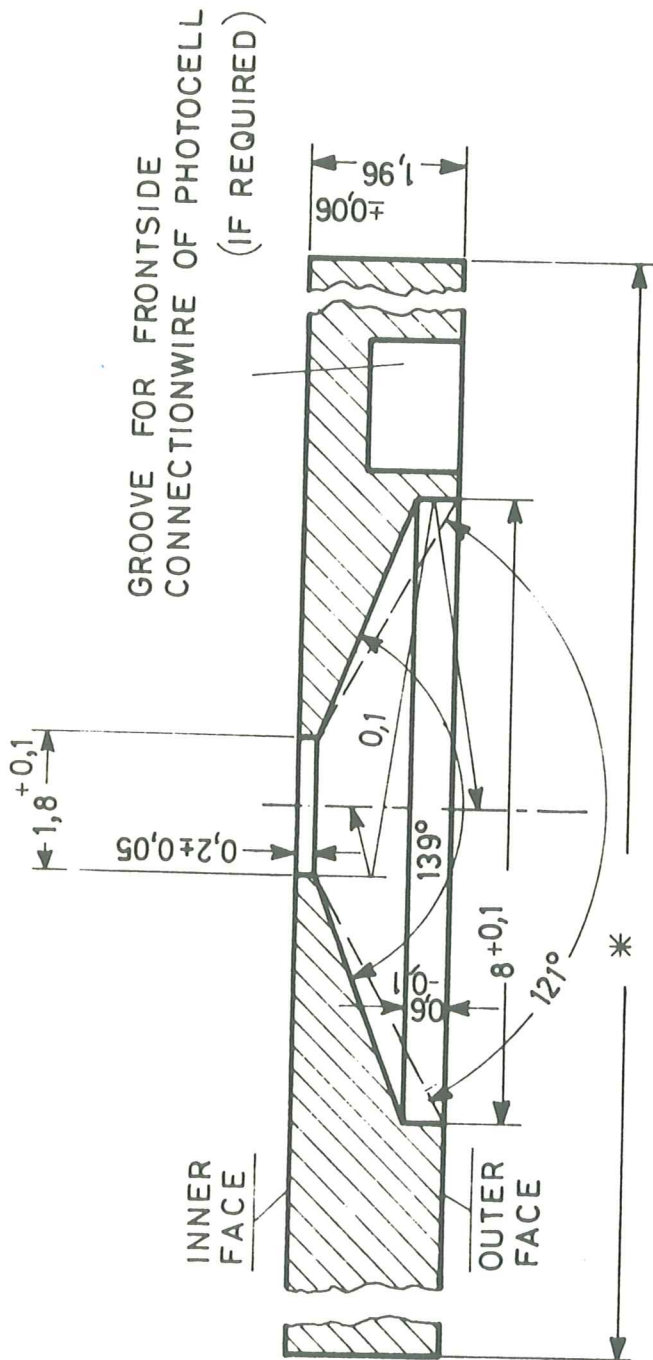
- B.4.2 Special attention must be paid to all surfaces parallel to the optical path and in close proximity to the mask and photocell to avoid reflection of light. Similarly, the method of inserting the tape must ensure that no ambient light leaks through any slot arrangement.
- B.4.3 The accuracy of the measurement is dependent not only on attaining the dimensional tolerances shown in Fig. 2 but also on the subsequent coating of the surfaces with a high quality optical matt black paint. Chemical methods are unlikely to prove satisfactory. 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.
- B.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.
- B.4.5 The possibility of inserting an opaque object and a filter glass before the measuring mask should be incorporated in the device. If the filter glass is such that a reading of approximately 50 % results, the accuracy of the test device in the area of 0 % and 50 % transmittance can be verified periodically.
- B.4.6 The test device should be cleaned periodically and accumulated dust removed.



d = approx. 150 mm

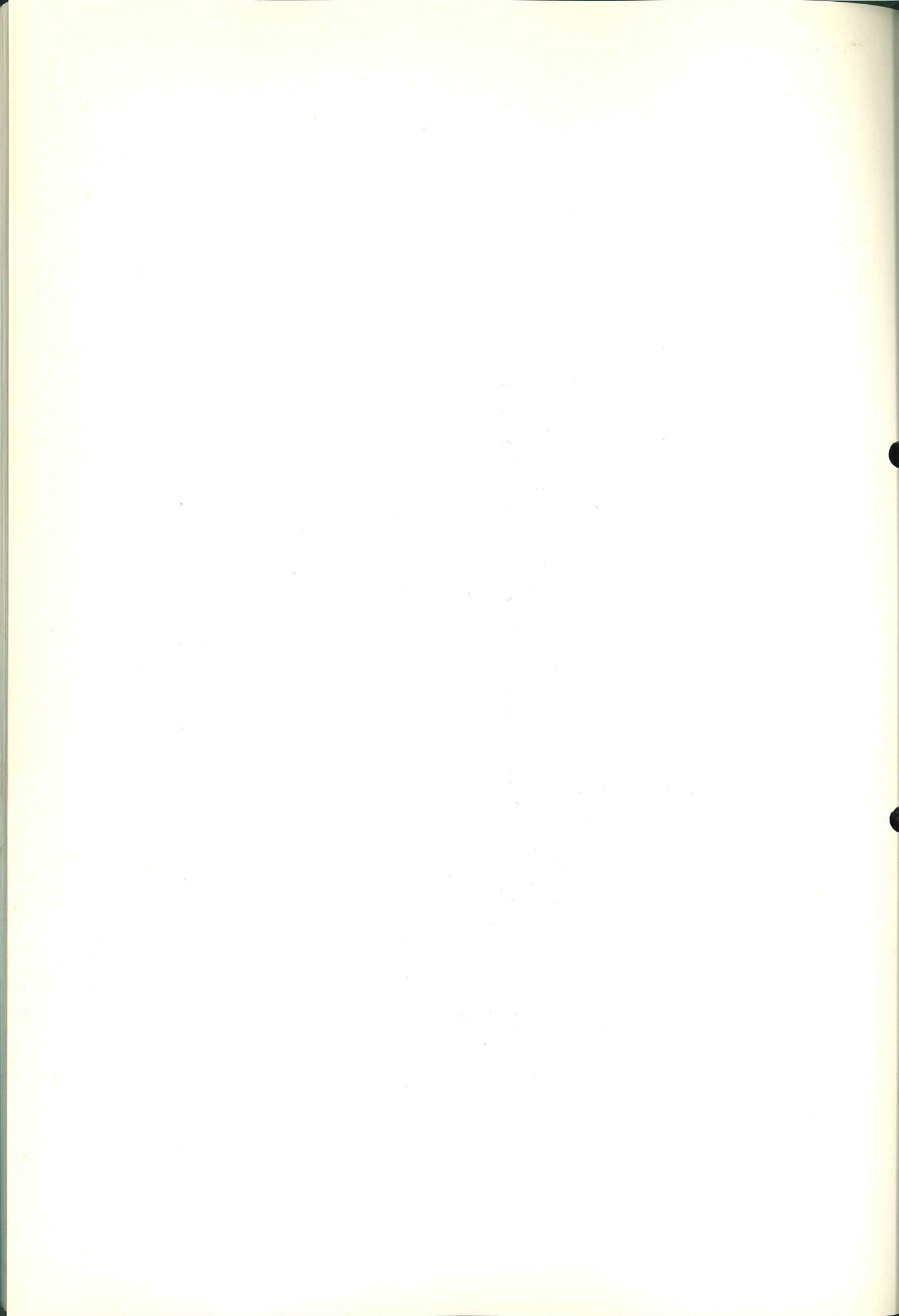
FIGURE B1 MEASURING DEVICE (DIAGRAM)





* DETERMINED BY USER

FIGURE B2 MEASURING MASK



APPENDIX C

REFERENCE CASSETTE FOR ECMA - 34

Under the auspices of ECMA Secondary Reference Tape Cassettes are available from BASF and Philips. These cassettes are certified by the Physikalische Technische Bundesanstalt (PTB) in Braunschweig, Germany. In the meantime further international work is in progress for the establishment of a Master Standard for Signal Amplitude. ISO/TC97/SC11 will ultimately decide on the signal level of this Master Standard. The calibration factor defining the ECMA reference relative to this master level will be very likely in the range 0,97 to 1,03.

These Reference Cassettes are intended for signal amplitude calibration as well as recording current adjustment.

The Secondary Reference Cassettes have been derived from a Master Reference Cassette whose output curve has been accepted by ECMA/TC19. Identical Master Reference Cassettes have been selected by Philips for use at BASF, Philips and PTB respectively. The Secondary Reference Cassettes are compatible with ECMA-34. Their labels indicate the differences in recording properties with respect to those of the Master Reference Cassette as follows:

Amplitude : X %
Typical field : Y %.

where:

$$X = \frac{\text{Signal amplitude of Secondary Reference Cassette}}{\text{Signal amplitude of Master Reference Cassette}} \cdot 100$$

(Both recorded with a recording current equal to 1,5 times that required to produce the Reference Field.)

$$Y = \frac{\text{Typical field of Secondary Reference Cassette}}{\text{Typical field of Master Reference Cassette}} \cdot 100$$

The values for X and Y are given with an accuracy of ± 1 %.

Requests for reference cassettes should be addressed to

The Secretary General
ECMA
114 Rue du Rhône

CH-1204 Geneva
Switzerland

These requests will be transmitted to one of the two firms providing the certified cassettes. The price is in the order of Swiss Fr. 200.--.

