

ECMA

EUROPEAN COMPUTER MANUFACTURERS ASSOCIATION

STANDARD ECMA-5
FOR
DATA INTERCHANGE
ON 7 TRACK MAGNETIC TAPE
A 8 BITS PER mm (200 bpi)

3rd Edition — June 1970

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BRIEF HISTORY

On April 30, 1965, ECMA adopted their Standard ECMA-6 for a 7 Bit Character Code for Input and Output purposes. In the form adopted, it included no proposals for implementation in media which were deliberately left as the subject for future standards.

This Standard ECMA-5 for Data Interchange on 7 Track Magnetic Tape defines not only the implementation of this 7 Bit Code but facilitates Data Interchange with various other codes. It has been adopted by the General Assembly of ECMA on April 30, 1965.

THIS 3rd EDITION SUPERSEDES THE VERSION DATED DECEMBER 1966.

FOREWORD

This Standard ECMA-5 sets out the parameters for magnetic tape which may be used to interchange data between electronic data processing installations.

The parameters which are required to define adequately a magnetic tape for data interchange fall within three sections:

The first deals with the characteristics of the magnetic tape itself and of the reel on which it is wound.

The second deals with the dimensional and magnetic characteristics of the recording of data on the tape and the method of checking.

The third deals with the relation of the bits on a tape to coded characters and the format of data files.

Section 1 details the minimum number of physical parameters of the tape with test methods where necessary. The intention is to ensure that the properties of tape used for data interchange shall not vary sufficiently to nullify the effect of the requirements of the Standard.

Section 2 is based on a method of recording already in widespread use. To assist interchangeability and to simplify the design of the associated equipment, a single, low, density of recording is specified (8 rows per mm). A particularly important part of this section is the definition of the method of checking the information; data are arranged in blocks, with transverse and longitudinal parity checks.

Section 3 establishes a series of conventions to ensure that there is no ambiguity in the meaning given to the recorded bits on tape. Magnetic tape labels are the subject of a separate standard (ECMA-13).

In the Appendix, which is not part of the Standard, recommendations are made in connection with the transportation of the tape.

The guiding principle in preparing this Standard has been to place the minimum constraint on equipment design consistent with successful implementation.

SCOPE

To provide a specification for 12,70 mm 7 track magnetic tape to enable mechanical and magnetic interchangeability of tape between information processing systems. This Standard refers solely to magnetic tape for digital recording on which the direction of magnetization is nominally longitudinal as opposed to nominally transverse.

DEFINITION OF TERMS

For the purpose of this Standard the following definitions apply :

Magnetic Tape

Tape which will accept and retain magnetic signals intended for input, output and storage purposes on computers and associated equipment.

Reference Tape

A tape which has been arbitrarily selected for a desirable property.

Secondary Reference Tape

A tape whose performance is known and stated in relation to that of a Reference Tape intended for routine calibrating purposes.

Reference Field

The minimum field applied to the Reference Recording Field Tape which causes an output signal equal to 95% of the maximum signal output at the specified packing density.

Reference Recording Field Tape

The Reference Tape which is selected as a standard for recording field.

Reference Signal Output Tape

The Reference Tape which is selected as a standard for signal output.

Reference Signal Level

The signal level which would be obtained from a Reference Signal Output Tape. This level shall be measured on a corresponding track for the same relative pass.

Reference Pulse Width Tape

The Reference Tape which is selected as a standard for pulse width.

Saturating Field

The minimum field which can be applied to a tape above which no significant increase of signal output will result.

Erasing Field

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

Track

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

Reference Edge

The reference edge is that which is chosen arbitrarily as a reference for the layout of tracks and the siting of markers.

In Contact

An operating condition in which the oxide side of a tape is in contact with the magnetic head.

Leaders

Those integral parts of a complete tape which lie outside the tested portion.

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.

Pulse Packing Density

The number of reversals of magnetization per unit length of track.

Reel

A reel has no tape wound on it. A "full reel" is a reel completed with a tape.

TEST ENVIRONMENT

Unless otherwise stated, all measurements made on a tape to check the requirements of this specification and all tests prescribed for a tape in the document will be carried

out under the environmental conditions of $23^{\circ}\text{C} \pm 2^{\circ}\text{C}$ and 40% RH to 60% RH, after at least 24 hours conditioning.

SECTION 1 - CHARACTERISTICS OF TAPE AND REEL

1.1 Tape Width and Tolerances

The width of tape shall be $12,70 \text{ mm} + 0,00$
 $- 0,10$

1.2 Tape Length

Splice free tested tape of 0,048 mm overall thickness shall be available in lengths not exceeding 753 m. As other tape thicknesses are standardized the maximum tape length permitted will be standardized accordingly. If the length of tape is less than 730 m and the length is required to be stated, it shall be subject to a tolerance of + 3% - 0%.

1.3 Material

The tape shall consist of a nominal 0,036 mm thick base material (e.g., oriented polyethylene terephthalate or equivalent) coated on one side with a strong yet flexible layer of ferromagnetic material dispersed in a suitable binder.

1.4 Thickness of Tape

The overall thickness of tape and oxide coating, not including any markers, shall be $0,048 \text{ mm} + 0,008 \text{ mm}$, with a maximum oxide coating thickness of $0,015 \text{ mm}$.

Other tape thicknesses would satisfy the requirements of this proposal but are not standardized at this time.

1.5 Change in Width

The material shall be such that no change in the tape width greater than 0,25% can occur when the tape has been subjected to any combination of temperature and humidity within the ranges 10°C to 50°C and 20% to 80% RH.

1.6 Elasto-plastic Properties

The elastic properties of the tape shall be such that when subjected to a tension of 10 N for a period of three minutes under any combination of temperature and relative humidity within the ranges 10°C to 50°C and 20% to 80% RH, the permanent elongation measured with negligible tension after a second three minutes interval shall be less than 0,5%.

The elastic modulus for a single smooth application of tension in three minutes or less, down to the time set by the inertia of the tape itself shall be such that the elongation is less than 0,5% under a tension of 4,5 N. For the convenience of testing, the measurement may be performed with a tension applied for three minutes.

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 cord.

The tape, when new, shall be tested in accordance with Clauses 1.8 to 1.17.

1.8 Pulse Packing Density (for Testing Purposes)

For the purpose of testing tape in accordance with this Standard, the pulse packing density shall not be less than that of the system with which the tape is to be used. In addition, for this test the flux reversal should be uniformly spaced.

1.9 Recording Current

The recording current used for test purposes shall be between 200% and 220% of the current required to produce the Reference Field.

1.10 Average Peak Output

The average peak output is defined as the average peak value of the output voltage over at least 1000 consecutive pulses. When a tape has been recorded with the recording current defined in Sub-clause 1.9 on all tracks then played back on a system, each channel of which has been calibrated by means of a Secondary Reference Signal Output Tape, the average peak output shall be within $\pm 10\%$ of the output of the Reference Signal Output Tape.

It is required that when performing this test, the output signal must be measured on a corresponding track for the same relative pass for both Secondary Reference Output Tape and the tape under test (i.e., Read-whilst-Write or Read-on-first-pass-after-Write).

1.11 Ease of Erasure

When a tape has been recorded according to this specification and then passed through an unidirectional steady field of 79500 A per m, the average peak output level of the remaining unwanted signal plus tape noise shall

not exceed 3% of the output of the Reference Signal Output Tape. The erasure field shall be reasonably uniform, e.g. the field in the middle of a solenoid.

1.12 Tests for Drop-outs and Drop-ins

These tests shall be carried out in the In-Contact condition. The length of the tape tested shall be continuous and shall extend from 0,2 m before the beginning of tape reflective marker to 3 m beyond the end of tape reflective marker.

1.13 Drop-Out

When a tape has been recorded with all permissible consecutive reversals of recording current, as defined in Sub-clause 1.9, on all tracks, then played back on a system each channel of which has been calibrated as in Sub-clause 1.10, any signal from any track which is less in amplitude than 50% of the output of the Reference Signal Output Tape is a drop-out.

It is required that when performing this test, the output signal must be measured on the same relative pass for both the Secondary Reference Output Tape and the tape under test (i.e., Read-whilst-Write or Read-on-first-pass-after-Write).

1.14 Drop-In

When a tape has been recorded on all tracks by a constant recording current, as defined in Sub-clause 1.9, then played back on a system calibrated as defined in Sub-clause 1.10, any signal from any track which exceeds in amplitude 10% of the output of the Reference Signal Output Tape is a drop-in.

It is required that when performing the test, the output signal must be measured on the same relative pass for both the Secondary Reference Output Tape and the tape under test (i.e., Read-whilst-Write or Read-on-first-pass-after-Write).

1.15 Rejected Regions

A rejected region is an area of tape extending across the full width of the tape and not more than 10 mm in length which contains areas of tape which on two consecutive test recordings exhibit drop-outs or drop-ins.

NOTE: The method proposed in this Standard for data interchange allows the use in practical conditions of tapes with rejected regions. (See Clause 2.14.)

1.16 Testing Machine

As testing is intended to measure the performance of a tape under operating conditions, the type of testing machine to be used is a matter for negotiation with either the manufacturer or the supplier.

1.17 Magnetic Properties

The magnetic properties of the tape are not defined here by B-H loops or similar parameters, but are defined by the testing procedures given in Clauses 1.10 to 1.14.

1.18 Print Through

A tape for testing shall be stored for 8 hours at 60°C during which time, changes shall be made in the relative humidity within the range of 20% to 80%. Immediately after the end of this period the peak print through signal shall not exceed 1% of the reference signal.

1.19 Reflective Markers

Reflective markers shall be placed on that side of the tape which does not carry oxide coating and shall be on opposite edges of the tape, the beginning of tape marker to be on the reference edge, (see Clause 2.1 and Fig. 1).

The width of the markers shall be 4,8 mm + 0,5 mm, length 30,0 mm + 5 mm and their thickness when measured in situ, shall not exceed 0,013 mm.

The beginning of tape marker shall be placed 4,3 m to 5,6 m from the beginning of the tape and the end of tape marker shall be placed 7,6 m + 1,5 m - 0 m from the end of the tape.

The surface of the reflective markers shall be non-conductive.

1.20 Reels

1.20.1 Reels shall be constructed such, that any profile section taken through the centre axis of the reel conforms to Fig. 2 except where taken so as to pass through the relieved portion of the write-enable ring groove. The section shall, in this case, conform to the profile of Fig. 2 with appropriate deviations permitted at the ring groove relief as illustrated in the detail.

1.20.2 Reels are not symmetrical, the flange differing primarily as to the presence or absence of the write-enable ring, which must be adjacent to the mounting pedestal for correct machine operation.

- 1.20.3 Hub and flanges need not to be integral, but may be separate parts as the manufacturer's option as long as all other requirements of this standard are met.
- 1.20.4 All dimensions shown in Fig. 2, including those in detail section, shall be held to the tolerances specified in Table 1.
- 1.20.5 In the hub, the surface between A and D is the reference for reel mounting.
- 1.20.6 With respect to the mounting reference surface, any point of the inside surfaces of the flanges, defined by dimensions J and N, must fall within the specified tolerances.
- 1.20.7 The outside cylindrical surface of the hub shall be concentric with the bore (dimensions C and A respectively of Fig. 2) within 0,25 mm.
- 1.20.8 Thickness of the flange may be varied, but must fall within the cross-hatched envelope defined by dimensions K_p , J, N, K_f . Bosses, ribs, or raised designs are permitted within the same envelope.
- 1.20.9 A finger guide on the front of the reel is necessary, but size, shape and location are optional (see Fig. 2).
- 1.20.10 Flange holes are optional. When provided, number, size and shape are optional.
- 1.20.11 The full reel should be balanced about its normal axis of rotation irrespective of the existence or lack of flange holes. Any amount by which the full reel is out of static balance shall not exceed 1,5 g cm.
- 1.20.12 The moment of inertia of the full reel shall not exceed $102,5 \cdot 10^3 \text{ g cm}^2$. The maximum moment of inertia of any reel shall not exceed $50 \cdot 10^3 \text{ g cm}^2$.
- 1.20.13 Dimension A shall not reduce below 93,47 mm when the reel is fully loaded with tape wound at 3,3 N constant tension.
- 1.20.14 Owner Identification. A labelling area shall be provided on the front flange of the reel to provide ownership identification.
- 1.20.15 Manufacturer's Reel Identification. The manufacturer's identification may be placed on the reel.
- 1.20.16 Interchange Label. A labelling area shall be provided on the front flange. Suitable labels shall be used for marking the contents of the reel of the tape. Adhesive labels, if employed, shall leave no residue when removed. The use of pencil or similar erasable marking is not allowed.

- 1.20.17 When installed in the write-enable ring groove, the top surface of the write-enable ring must be such that it does not protrude above the mounting reference surface.
- 1.20.18 All write-enable rings must have a tab to facilitate removal from the groove.
- 1.20.19 Dimensions and materials used must be such that the write-enable ring may be installed and removed with reasonable effort and remain seated during normal use. Furthermore, the ring must be constructed so as not to interfere with normal tape transport performance.

TABLE 1

Dimension	Nominal (mm)	Tolerance (mm)
A	93,68	+ 0,13 - 0,08
B	266,70	+ 0,50
C	130,18	+ 0,13
D	98,42	+ 0,13
E	111,46	+ 0,13
F	6,35	+ 0,25 - 0,00
H	19,05	+ 0,38
J	2,46	+ 0,13 - 0,50
Kf	3,18	maximum
Kr	2,03	maximum
L	104,78	minimum
M	18,24	+ 0,13
N	15,80	+ 0,50 - 0,13
R	42,60	+ 0,25
α	4°	+ 15'

SECTION 2 - FORM OF RECORD ON TAPE

2.1 Reference Edge

Figure 3 defines the reference edge of the tape in relation to the oxide side of the tape and the forward direction of movement of the tape during recording. Tape should be guided with respect to the reference edge.

2.2 Track Configuration

There shall be seven tracks on the tape. The written track width shall be 1,20 mm. The distance from the centre line of any track to the reference edge shall be $[1,01 + 1,78 (n-1) \pm 0,11]$ mm, where n is the track number.

2.3 Track Identification

The tracks shall be numbered consecutively 1 to 7 with track 1 adjacent to the reference edge.

2.4 Density

The nominal density shall be 8 transverse rows per mm.

2.5 Spacing of Rows

For the purpose of defining the location of recorded data on the tape, the position of a flux reversal representing a binary one is defined as the point of maximum free space surface flux density normal to the tape surface.

Rows of data shall be separated by a nominal 0,125 mm. For such rows the longitudinal spacing between any one in any row and any one in either adjacent row shall be not less than 0,085 mm nor greater than 0,165 mm. The tolerance band containing any row of ones (data or check row) shall be 0,025 mm.

To define the length of tape occupied by a flux reversal the length of tape over which the component of free-space surface flux density normal to the surface of the tape exceeds 20% of its maximum value shall not exceed 0,076 mm.

2.6 Block Length

All blocks for data interchange shall consist of not less than 18 data rows and not more than 2048 data rows and in addition a longitudinal check row. Blocks of less than 18 rows may exist on a data interchange tape, but do not form part of the data to be interchanged.

2.7 Parity of Data Rows

The parity track shall be track 7 and all data rows shall have overall odd parity.

2.8 Longitudinal Check Row

This row, written at the end of a block, shall make the longitudinal parity of each track even for that block.

2.9 Longitudinal Check Row Gap

There shall be a gap of 0,50 mm + 0,08 mm between the last row of recorded data and the longitudinal check row.

2.10 Inter-block Gap

The gap shall be 19,0 mm nominal, 17,4 mm minimum and 7,6 mm maximum.

2.11 Erase Length

The minimum erase length shall be 51 mm. The maximum erase length shall be one erase operation. (See Clause 2.14.)

2.12 Lead Point Gap

There shall be a minimum of 75 mm from lagging end of beginning-of-tape reflective marker to first row on tape. There shall be no magnetic signals on the tape between the leading end of this marker and the first row.

2.13 Method of Recording

The Non Return to Zero Mark (NRZ1) method of recording shall be used where a one is represented by a change of direction of longitudinal magnetization. The recording field shall not be less than 40% above saturation field. The tape shall be magnetized such that the beginning of tape is a magnetic North Pole and the end of tape is a magnetic South Pole. This criterion shall apply also to erase sections and interblock gaps.

2.14 Quality of Tape for Data Interchange

Any information written must be valid at 35% of the reference signal level. Tape shall not be employed for data interchange where the number of erase operations exceeds 2 or 0,5% of the total number of blocks written whichever is larger. No permanent parity errors are permissible in the data to be interchanged.

One erase operation is defined as erasing of a length of tape not greater than the length of the original block + 55 mm.

The recording current used for tape interchange shall be between 120% and 220% of the current required to produce the reference field.

2.15 Data Content

All 64 binary combinations are permissible in tracks 1 to 6 of each row.

2.16 Transportation

The responsibility for ensuring that adequate precautions are taken during shipment shall lie with the sender. Since it is essential for a data bearing tape to be received in the same condition as it was sent out, guidance is given in the Appendix.

SECTION 3 - RELATION OF RECORDED BITS ON TAPE TO CODED CHARACTERS

3.1 Recording Conventions

The following conventions shall be adopted to relate binary digits recorded on the tape to coded characters or to digits within computers or similar equipment. (These also cover the case of data arranged as sequences of arbitrary binary digits.)

Any arrangement of data, which is to be interchanged, shall comply with the conventions of Clauses 3.2, 3.3 and 3.4.

3.2 Significance of Binary Digits

Within any one row on tape, the direction of increasing significance of the binary digits shall be from track 1 towards track 6.

Within a series of rows on tape, the direction of decreasing significance shall be from the start of a block towards its finish.

3.3 Sequence of Characters

Considering the recorded data as being in character form, the sequence of characters from the start towards the finish of a block shall correspond to the normal left to right sequence of a written line.

3.4 Filling of Unused Positions on Tape

In certain cases the arrangement of binary digits in groups of 6, within each row on tape, may not fit in exactly with the sizes of groups of digits in the equipment with which the data-interchange tape is used. In these cases it may be necessary to use "fill in" digits on the tape. Then:

- (i) The "fill in" digits shall be zeros
- (ii) The "fill in" digits shall be placed at the more significant end of a row.

3.5 Representation of the ECMA 7 Bit Code (Standard ECMA-6)

The arrangement for recording 7 bit coded characters shall be to regard each graphic within the dense 6 bit sub-set as a 6 bit character (omit b_6 and make $b_7 = b_6$). Such graphics will then be recorded as single rows. To allow the additional recording of the remaining characters in the 7 bit code, the use of 111111 plus parity is reserved.

The arrangement for recording the remaining characters in the 7 bit code, i.e. the controls in columns 0 and 1 and lower case letters in columns 6 and 7, shall be to place each character within two rows on the tape; the first row to record 111111 in each case and the second row to record a 6 bit representation of the character where columns 0 and 1 are mapped over columns 2 and 3 and columns 6 and 7 are mapped over columns 4 and 5. (Omit b_6 and make $b_7 = b_6$.)

The character 111111 followed by 111111 shall represent 1011111 in the 7 bit code.

3.6 Control Block

For the purpose of determining the beginning and end of data, a single row control block shall be allowed known as a Tape Mark which shall be accompanied by a longitudinal check row. Control blocks consisting of 2 to 17 transverse rows plus a longitudinal check row may exist only by agreement between sender and recipient of data. The Tape Mark shall be represented by the combination 0011111 including parity, which is in the left most bit position.

NOTE: The tape mark specified above is that internationally recognized, but other marks are also in common usage. The combination 000 1111 is widely used and users of this specification are advised to ensure that interchange tapes carry mutually recognized marks.

APPENDIX

Transportation of data bearing magnetic tapes involves three basic potential hazards :

1. IMPACT LOADS AND VIBRATIONS: which could cause damage to the spool, or movement within the tape pack, with consequential loss of wind tension.

RECOMMENDATION

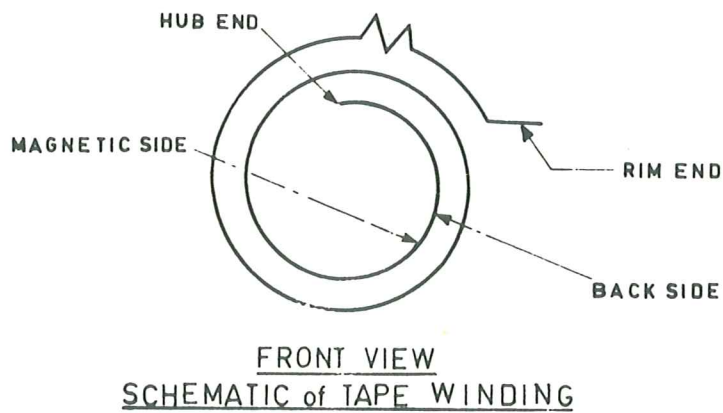
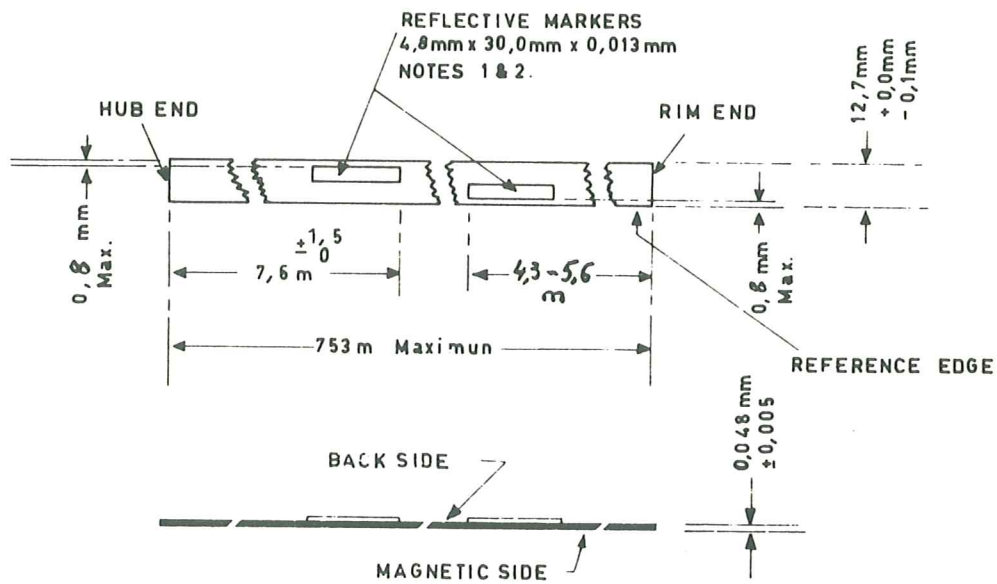
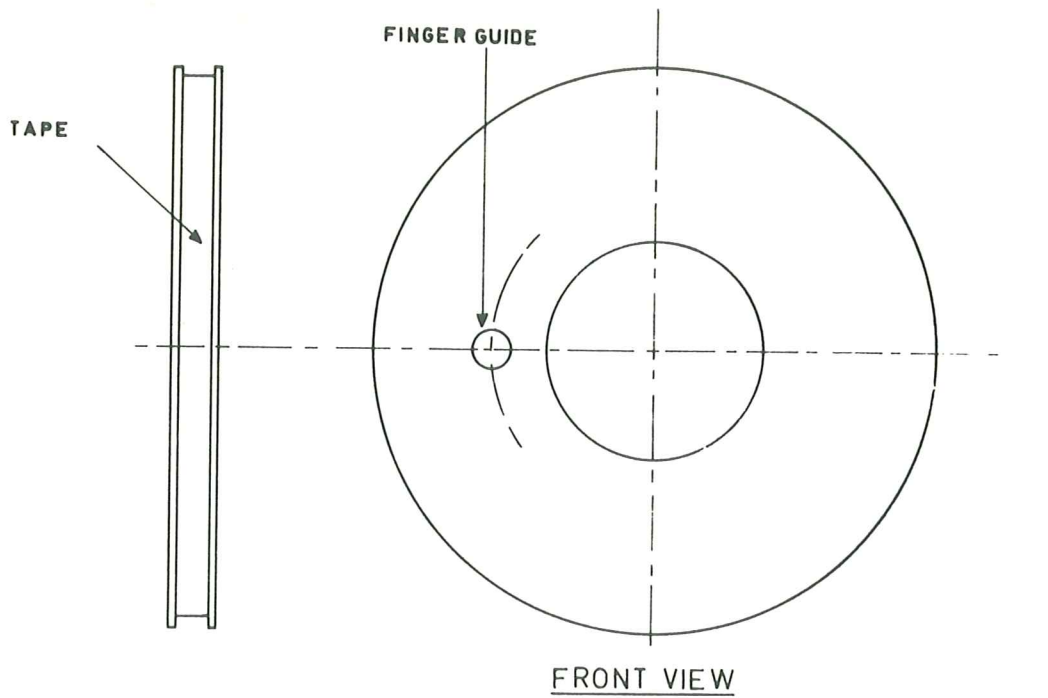
- a) The free end of the tape should be secured to prevent any tendency to unwind.
 - b) The use of rigid plastic container free from dust or other extraneous matter.
 - c) The plastic container(s) to be fitted into a rigid box containing adequate shock absorbent material.
 - d) The final box must have a clean interior and a lid construction that provides sufficient sealing to prevent the ingress of dirt and water.
 - e) The orientation of the spools within the final box should be such that their axes are horizontal.
 - f) The final box should be clearly marked to indicate its correct orientation.
2. EXTREMES OF TEMPERATURE AND HUMIDITY: which could set up stresses within the body of the tape.

RECOMMENDATION

- a) Extreme changes in temperature and humidity should be avoided wherever possible.
 - b) After completion of the writing operation, the tape should be wound fully on to the take-up spool and then completely rewound on to the spool to be interchanged at a tension of 1,4 to 2,8 N.
 - c) Whenever a tape is received it should be conditioned in the computer environment for a period of 2-6 hours, depending upon the type of transportation used.
3. EFFECTS OF STRAY MAGNETIC FIELDS: which would possibly cause corruption of data.

RECOMMENDATION

- a) A nominal spacing of not less than 8 cm should exist between the magnetic tape spool and the outer surface of the final container in which case it is considered that the risk of corruption will be negligible.



NOTES :

1. Reflector shall be firmly attached to tape with its own adhesive back and shall be free of wrinkles.
2. Reflector shall not protrude beyond edge of tape.

Fig. 1

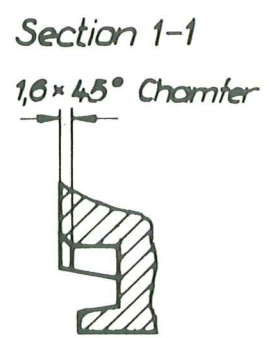
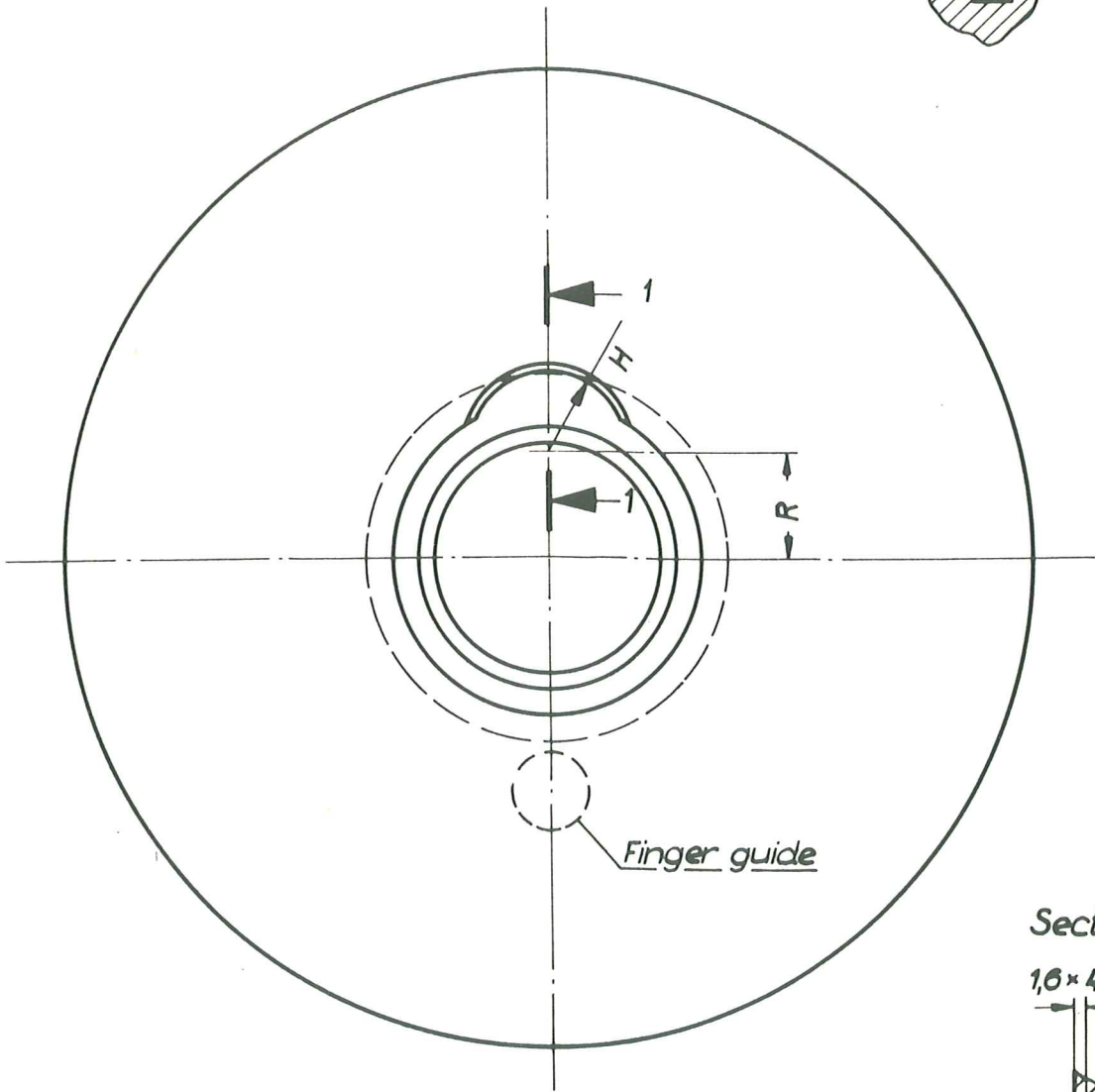
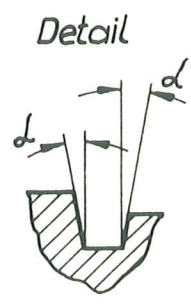
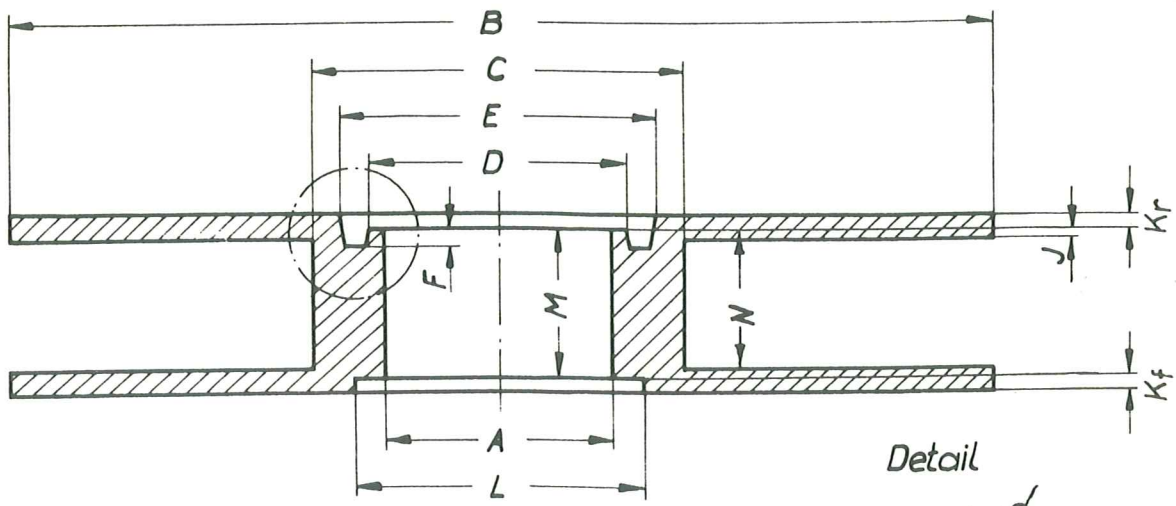
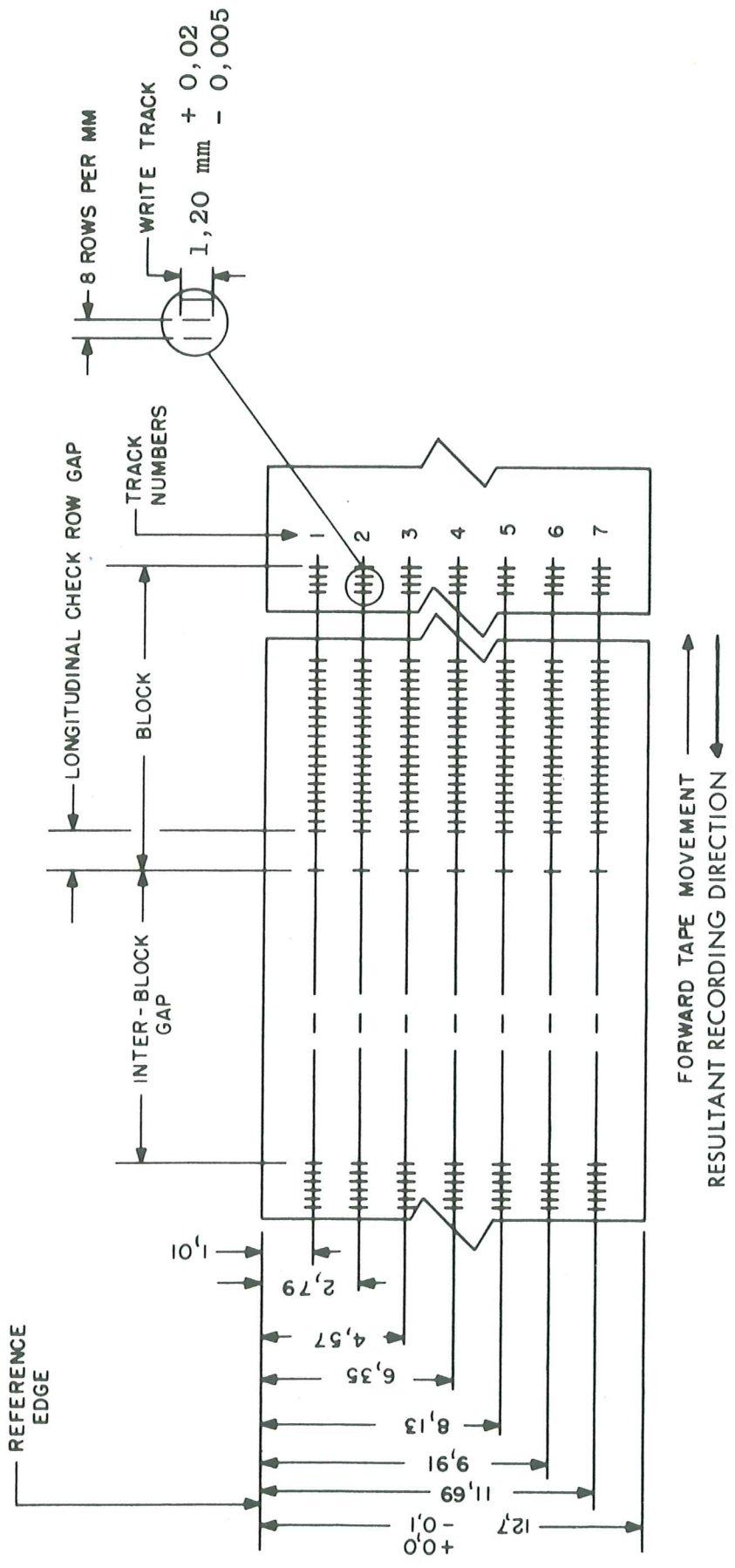


Fig. 2



NOTES

1. Tape is shown with oxide side towards observer.
Read/write head on same side as oxide.
2. Tape shown representing 1 bit in all tracks,
NRZI recording; 1 bit produced by reversal of
flux parity, tape fully saturated in each direction.

Fig. 3.

