

ECMA

EUROPEAN COMPUTER MANUFACTURERS ASSOCIATION

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STANDARD ECMA-36

FOR

DATA INTERCHANGE ON 9-TRACK  
PHASE ENCODED MAGNETIC TAPE  
AT 63 bpm (1600 bpi)

December 1971

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## BRIEF HISTORY

On April 30, 1965, ECMA adopted their Standard ECMA-6 for a 7 Bit Coded Character Set for Input/Output. In the form adopted, it included no proposals for implementation in media which were deliberately left as the subject for future standards. Standard ECMA-5 defines Data Interchange on 7 Track Magnetic Tape at a density of 8 row-per-mm and Standard ECMA-12 defines Data Interchange on 9 Track Magnetic Tape at a density of 31,5 row-per-mm.

This Standard ECMA-36 is directed to Data Interchange on 9 Track Magnetic Tape at a density of 63 bpmm Phase Encoded.

It has been adopted by the General Assembly of ECMA on December 1971.

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FOREWORD

Standard ECMA-5 sets out the parameters for magnetic tape which may be used to interchange data between electronic data processing installations, at the low density of 8 rows per mm. Standard ECMA-12 sets out the same parameters but at the higher density of 31,5 rows per mm. Both standards use NRZ 1 recording technique.

This Standard ECMA-36 sets out the same parameters but at the still higher density of 63 bits per mm, using the technique of Phase Encoding.

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

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 on data files.

In ECMA-5, the problems encountered due to the packing density of 8 rows per mm did not create any serious difficulty with respect to the definitions or the quantitative values assigned to the various parameters.

The present Standard, however, comprises certain definitions and quantitative values in clauses 6.2 and 6.3 which provide the most meaningful checks possible at the present time. It is emphasized that this Standard is concerned with the specification of magnetic tape and as such it is not appropriate that it should make recommendations in reaction to writing or reading equipment. Nevertheless, when writing an interchange tape in accordance with this Standard, and especially when reading it, certain difficulties and technical shortcomings have to be faced.

Appendix A deals with the procedures and instrumentation for measuring flux reversals spacing, Appendix B deals with the requirements of the reference read head and Appendix C with the transportation of data-bearing magnetic tapes. These Appendices are not part of the Standard.

## 1. SCOPE

To provide a standard for a 12,7 mm wide magnetic tape with reel to enable mechanical interchangeability of tape between information processing systems utilizing the ECMA 7-bit Coded Character Set. This proposal refers solely to magnetic tape for digital recording using the 63 bits per mm Phase Encoding method on which the direction of magnetization is nominally longitudinal as opposed to nominally transverse.

## 2. DEFINITIONS

For the purpose of this Standard the following definitions apply:

### 2.1 Magnetic Tape

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

### 2.2 Reference Tape

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

### 2.3 Secondary Reference Tape

A tape intended for routine calibrating purposes, the performance of such a tape to be known and stated in relation to that of a reference tape.

### 2.4 Signal Amplitude

Signal Amplitude is defined as the peak-to-peak amplitude generated by the interchange tape at the density in question as sensed by the read head defined in Appendix B. Signal Amplitude is to be measured at a point in the read chain where it is proportional to the rate of change of the longitudinal component of the flux at the tape surface.



#### 2.5 Average Signal Amplitude

Averaging shall be done over a minimum of 4000 flux transitions which for the interchanged tape may be segmented into groups of 70 flux transitions each.

#### 2.6 Reference Amplitude Tape

The Reference Amplitude Tape is the primary standard for unrecorded tape held by the NBS. (Secondary signal amplitude reference tapes are available from NBS under Part. No. SRM 3200).

#### 2.7 Reference Field

The minimum field applied to the Reference Amplitude Tape which causes an output signal equal to 95% of the maximum signal output at 126 ftpmm.

#### 2.8 Standard Reference Amplitude

The Standard Reference Amplitude is that amplitude that has been selected as a result of exchanging tapes between manufacturers under the auspices of the NBS at 126 ftpmm. It represents the nominal value of signal amplitude for this Standard.

The NBS measurements system is used to establish this amplitude. The current used is 1,8 times that required to produce the reference field. Measurement is made after demagnetization effects have stabilized.

#### 2.9 Reference Edge

When a tape is lying flat with the oxide side uppermost and the direction of movement for recording from left to right, the reference edge is the one farthest from an observer or nearer the top of a page (see Fig. 1).

#### 2.10 In Contact

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

### 2.11 Track

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

### 2.12 Packing Density

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

### 2.13 Row

A row consists of 9 transversely related data flux transitions.

### 2.14 Position of Flux Transition

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

## 3. ENVIRONMENT

### 3.1 Testing Environment

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

Temperature:  $(23 \pm 2)^{\circ}\text{C}$

RH : 40% to 60%

Conditioning  
before testing: 24 hours

### 3.2 Operating Environment

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

Temperature:  $16^{\circ}\text{C}$  to  $32^{\circ}\text{C}$

RH : 20% to 80%

Wet bulb  
temperature: not greater than  $26^{\circ}\text{C}$

### 3.3 Transportation and Storage Environment

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

Temperature: 4°C to 32°C

RH : 20% to 80%

## 4. CHARACTERISTICS OF TAPE

### 4.1 Tape Width and Tolerance

The width of tape shall be 12,7 mm + 0 mm  
- 0,1 mm

### 4.2 Tape Length

Splice-free tested tape shall be available in lengths not exceeding 753 m. If the length of tape is less than 731 m and the length is required to be stated, it shall be subject to a tolerance of + 3% - 0%.

### 4.3 Material

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

### 4.4 Thickness of Tape

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

### 4.5 "E" Value

The "E" value is defined as the radial difference between the edge of the reel flange and the outside layer of tape, when the tape is wound at a tension between 1,4 N and 2,8 N on the specified reel. The difference value shall be always greater than 3,2 mm.

#### 4.6 Elastic 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 of 10°C to 50°C and 20% to 80% R.H., 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.

#### 4.7 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.

#### 4.8 Tape Wind

Tape shall be wound, oxide surface toward reel hub, in a clockwise direction, i.e. when the reel is viewed from the front, the loose end of the tape hangs from the right-hand side of the reel. Tape shall be wound with a tension between 1,4 and 2,8 N.

#### 4.9 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 below in clauses 4.9.1 to 4.9.8.

##### 4.9.1 Test Density

Tape shall be tested at 126 flux transitions per mm nominal.

#### 4.9.2 Test Recording Field

The Test Recording Field shall be 1,75 to 1,85 times the Reference Recording Field.

#### 4.9.3 Average Peak Amplitude

The average peak amplitude shall be in the range - 10% to + 25% of that output which would be obtained from the Reference Amplitude Tape under the same conditions.

#### 4.9.4 Ease of Erasure

When a previously recorded tape has been passed through an unidirectional field of 79500 ampere per meter (1000 oersteds) any remaining amplitude shall not exceed 3% of the amplitude of the Reference Signal Amplitude Tape, at 126 flux transitions per mm.

#### 4.9.5 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 on two consecutive tests exhibits 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 6.8.)

#### 4.9.6 Tests for Drop-Outs and Drop-Ins

These tests shall be carried out in the In-contact condition and over the entire tested area which shall extend from at least 0,2 m before the Beginning-of-Tape reflective marker (BOT) to at least 3 m beyond the End-of-Tape reflective marker (EOT). (See Figure 1).

#### 4.9.7 Drop-Outs

When a tape has been recorded at 126 flux transitions per mm as defined in Clause 4.9.2 any signal from

any track which is less in amplitude than 35% of that output which would have been obtained from the Reference Amplitude Tape under the same conditions, allowing for the effects of demagnetization, is a Drop-Out.

Recommendation: The number of rejected regions (not to exceed 10 mm per region) due to drop-outs in an interchange environment, is a matter of agreement between interchange parties. For purposes of evaluation of an unrecorded tape to be used for interchange, an average of one rejected region per 76 metre is the recommended maximum limit.

#### 4.9.8 Drop-Ins

When a tape has been erased on all tracks by constant field as defined in Clause 4.9.4 any signal from any track which exceeds in amplitude 10% of the Standard Reference Amplitude is a Drop-In.

#### 4.10 Reflective Markers

Reflective Markers used to indicate beginning and end of tape shall be placed on the side of the tape which does not carry the oxide coating. The Beginning-of-Tape marker (BOT) shall be adjacent to the reference edge, and the End-of-Tape marker (EOT) shall be adjacent to the opposite edge.

The width of the markers shall be  $4,8 \text{ mm} \pm 0,4 \text{ mm}$ , length  $30,0 \text{ mm} \pm 5 \text{ mm}$  and their thickness when measured after their application on the tape shall not exceed  $0,020 \text{ mm}$ .

The Beginning-of-Tape marker (BOT) shall be placed  $4,9 \pm 0,6 \text{ m}$  from the beginning of the tape and the End-of-Tape marker (EOT) shall be placed  $7,6 \text{ m} (+1,5 \text{ m}; - 0 \text{ m})$  from the end of the tape.

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

### 5. REELS

#### 5.1 Construction

5.1.1 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.

- 5.1.2 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.
- 5.1.3 Hub and flanges need not to be integral, but may be separate parts at the manufacturer's option as long as all other requirements of this Standard are met.
- 5.1.4 All dimensions shown in Fig. 2, including those in detail section, shall be held to the tolerances specified in Table 1.
- 5.1.5 In the hub, the surface between A and D is the reference for reel mounting.
- 5.1.6 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.
- 5.1.7 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.
- 5.1.8 Thickness of the flange may be varied, but must fall within the cross-hatched envelope defined by dimensions  $K_r$ , J, N,  $K_f$ . Bosses, ribs, or raised designs are permitted within the same envelope.
- 5.1.9 A finger guide on the front of the reel is necessary, but size, shape and location are optional (see Fig. 2).
- 5.1.10 Flange holes are optional. When provided, number, size and shape are optional.

## 5.2 Balance

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.

## 5.3 Moment of inertia

The moment of inertia of the full reel shall not exceed

$105 \cdot 10^3 \text{ gcm}^2$ . The maximum moment of inertia of an empty reel shall not exceed  $30 \cdot 10^3 \text{ gcm}^2$ .

5.4 Rigidity of the hub

Dimension A shall not reduce below 93,47 mm when the reel is fully loaded with tape wound at 3,3 N constant tension.

5.5 Owner Identification

A labelling area shall be provided on the front flange of the reel to provide ownership identification.

5.6 Manufacturer's Reel Identification

The manufacturer's identification may be placed on the reel.

5.7 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 be of a type which leave no residue when removed. The use of pencil or similar erasable marking is not allowed.

5.8 Write-enable ring

5.8.1 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.

5.8.2 All write-enable rings must have a tab to facilitate removal from the groove.

5.8.3 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

<u>Dimension</u>	<u>Nominal (mm)</u>	<u>Tolerance (mm)</u>
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
K <sub>f</sub>	3,18 max.	-
K <sub>r</sub>	2,03 max.	-
L	104,78 min.	-
M	18,24	± 0,13
N	15,80	+ 0,50 - 0,13
R	42,60	± 0,25
α	4°	± 15°

## 6. RECORDING

### 6.1 Method of Recording

The recording method shall be Phase Encoding, described as follows:

- 6.1.1 Those parts of the tape erased before the identification burst, the interblock gaps and the erased part of the tape following the last block written, shall be erased to the full width of the tape in a polarity such that the rim end of the tape is a north seeking pole.
- 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 data 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 transitions.

### 6.2 Equipment

The equipment used must satisfy the requirements of clauses 6.3 to 6.6 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 63 bit per mm nominal.
- 6.3.2 The long term average row spacing is the spacing between flux transitions that have been recorded

continuously at a nominal density of 126 flux transitions per mm, and must be measured over a length of tape of not less than 3,81 m.

The long term average row spacing shall be within  $\pm 4\%$  of the nominal spacing of 15,87 micrometre.

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

The short term average row spacing shall be within the limits of  $\pm 10\%$  of the long term average row spacing.

In addition, the short term average row spacing shall change at a rate not greater than 0,5% per row.

#### 6.4 Flux Reversal Timing

To determine bit transition timing the following four paragraphs must be considered together. The limits given in these paragraphs assume the use of the read channel defined in Appendix A.

- 6.4.1 The spacing between successive data bit flux transitions without an intervening phase flux transition shall be between 85% and 108% of the corresponding short term average row spacing.
- 6.4.2 The spacing between successive data bit flux transitions with an intervening phase flux transition shall be between 93% and 112% of the corresponding short term average row spacing.
- 6.4.3 The spacing between a phase flux transition and any adjacent data phase flux transitions shall be between 44% and 62% of the corresponding short term average row spacing.
- 6.4.4 The average distance between actual data bits in a sequence of flux reversals at 63 ftpmm and the predicted position of the data bits relative to flux reversals at 126 ftpmm preceding or succeeding the sequence shall not exceed  $\pm 6\%$  of the corresponding short term average spacing.

### 6.5 Total Skew of a Row

No data bit flux transition shall be displaced more than 15,87 micrometre from any bit flux transition in the same row when measured in a direction parallel to the reference edge.

### 6.6 Signal Amplitude

#### 6.6.1 Average Signal Amplitude of the Interchange Tape.

6.6.1.1 126 ftpmm. The Average Signal Amplitude shall be in the range - 35% to + 50% of the Standard Reference Amplitude.

6.6.1.2 63 ftpmm. The Average Signal Amplitude shall be less than 3 times the Standard Reference Amplitude.

#### 6.6.2 Minimum Signal Amplitude

To determine minimum Signal Amplitude, the following two paragraphs must be considered together.

6.6.2.1 No tapes when interchanged shall contain any adjacent flux transitions with nominal spacing of 7,925 micrometre where the respective peak-to-peak signal amplitude resulting from these adjacent flux transitions is less than 0,2 times the Standard Reference Amplitude.

6.6.2.2 No tapes when interchanged shall contain any adjacent flux transitions with a nominal spacing of 15,87 micrometre where the respective peak-to-peak signal amplitude resulting from these adjacent flux transitions is less than 0,20 times the Standard Reference Amplitude.

### 6.7 Erasure

The full width of the tape shall be DC erased so that the rim end of the tape is a north seeking pole.

## 6.8 Elongated Interblock Gaps

Tape shall not be employed for data interchange where the number of gaps which have been elongated due to erase instructions

either a) exceeds 2 when total number of blocks written is less than or equal to 400,

or b) is greater than 0,5% of the total number of blocks written in any other case.

No permanent parity errors are permissible in the data to be interchanged.

## 7. FORMAT

### 7.1 Number of Tracks

There shall be 9 tracks.

### 7.2 Track Dimensions

7.2.1 The written track width shall be 1,09 mm minimum.

7.2.2 The nominal centre line of track 1 shall be 0,74 mm from the reference edge. This is an exact dimension and should not be rounded off. The track positional tolerance is given in 7.2.4.

7.2.3 The centre line distance between adjacent tracks shall be 1,397 mm nominal. This is an exact dimension and should not be rounded off. The track positional tolerance is given in 7.2.4.

7.2.4 The actual position of the centre line of any track shall not diverge by more than 0,08 mm from its nominal position.

### 7.3 Track Identification

Tracks shall be numbered consecutively beginning at the reference edge with track # 1 and assigned as follows:

Track #	1	2	3	4	5	6	7	8	9
Environment Position	E <sub>3</sub>	E <sub>1</sub>	E <sub>5</sub>	P	E <sub>6</sub>	E <sub>7</sub>	E <sub>8</sub>	E <sub>2</sub>	E <sub>4</sub>

Bit P is the parity bit. Row parity is odd.

#### 7.4 Arrangement of Characters of the ECMA 7 Bit Coded Character Set

The relationship of the bits of the 7 Bit Coded Character Set (Standard ECMA-6) to the 8 positions of the environment is:

Bit	0	b <sub>7</sub>	b <sub>6</sub>	b <sub>5</sub>	b <sub>4</sub>	b <sub>3</sub>	b <sub>2</sub>	b <sub>1</sub>
Positions of Environment	E <sub>8</sub>	E <sub>7</sub>	E <sub>6</sub>	E <sub>5</sub>	E <sub>4</sub>	E <sub>3</sub>	E <sub>2</sub>	E <sub>1</sub>

where 0 is a high-order bit with value ZERO.

#### 7.5 Block Length

- 7.5.1 A block shall consist of a preamble, data and a postamble. The data portion of a block shall contain a minimum of 18 rows.
- 7.5.2 A data portion of a block shall contain a maximum of 2048 rows.
- 7.5.3 Preamble. Immediately preceding data in each block, a preamble shall be written consisting of 41 rows, of which 40 rows contain ZERO bits in all tracks followed by a single row of ONE bits in all tracks. When reading in the forward direction, the first flux transition of each preamble shall be a ZERO bit transition.
- 7.5.4 Postamble. Immediately following data in each block, a postamble shall be written consisting of 41 rows, of which the first row contains ONE bits in all tracks followed by 40 rows containing ZERO bits in all tracks. When reading in the backward direction, the first flux transition of each postamble shall be a phase transition.

## 7.6 Identification

The phase encoding recording method shall be identified by a burst of recording at the BOT marker. This burst shall consist of 63 flux transitions per mm on track # 4 and erasure on all other tracks. The identification burst shall begin 43,2 mm minimum before the hub end of the BOT marker, and continue past the hub end of the BOT marker but ending at least 12,7 mm before the first block.

## 7.7 Gaps

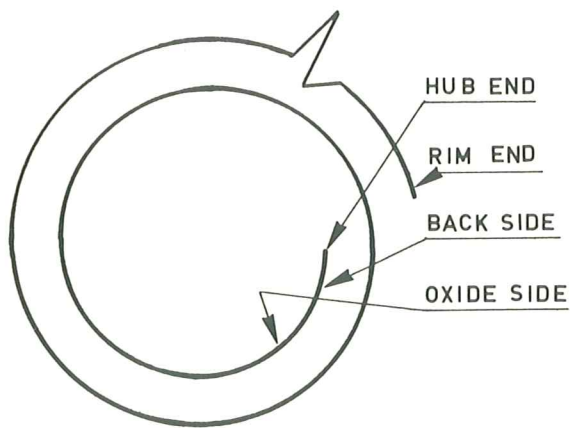
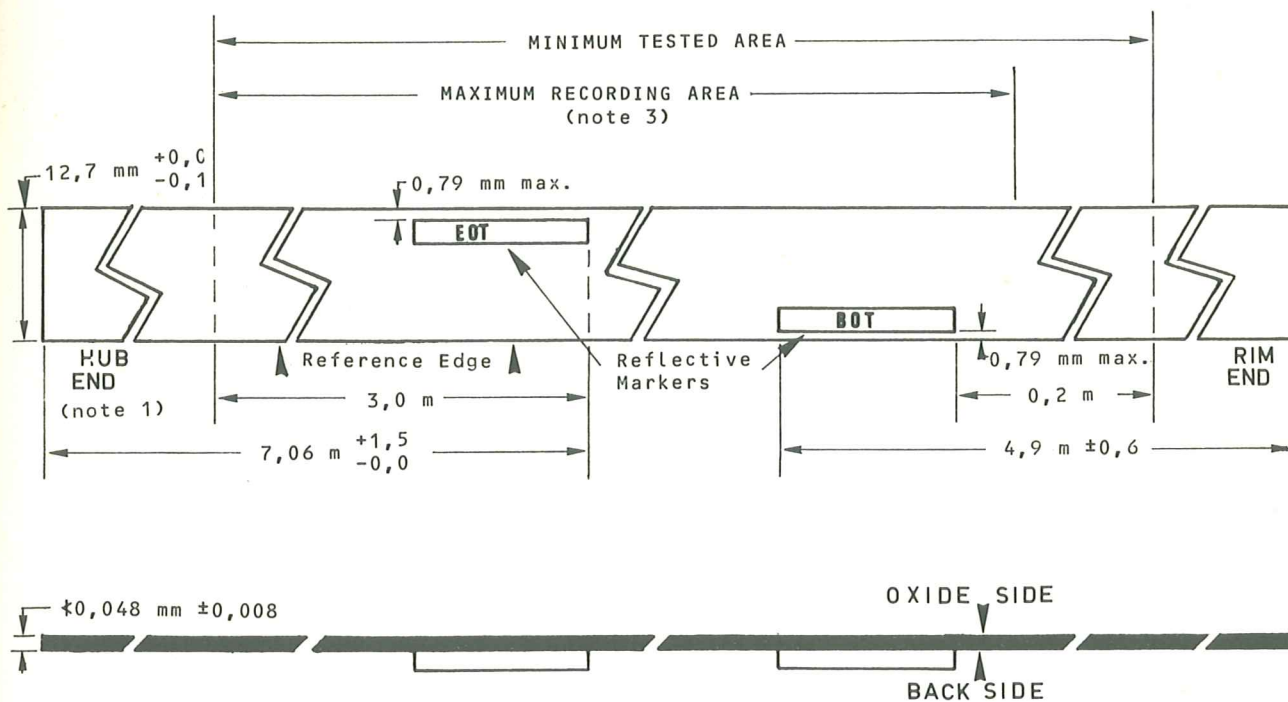
7.7.1 Interblocks Gaps. The interblock gap, of nominal length 15,24 mm shall have a minimum length of 12,7 mm and a maximum of 7,62 m arising from rejected regions.

7.7.2 Initial Gap. The gap between the hub end of the BOT marker and the first block shall be 76,2 mm minimum and 7,62 m maximum.

7.7.3 The tape shall be erased in the gaps.

## 7.8 Tape Mark

The tape mark is a control block consisting of 64 to 256 flux transitions, at 126 ftpmm in tracks # 2, # 5 and # 8. Tracks # 3, # 6 and # 9 are DC erased. Tracks # 1, # 4 and # 7 in any combination may be DC erased or recorded in the manner stated for tracks # 2, # 5 and # 8. For interchange purposes such as data transmission, all eight combinations of tape mark shall be treated as a DC<sub>3</sub> character ( See Standard ECMA-6).



Front view schematic of tape winding

Note:

BOT : Beginning of tape  
EOT : End of tape

1. Tape shall not be attached to the hub.
2. Photorefective markers shall not protrude beyond edge of tape and shall be free of wrinkles and excessive adhesive.
3. The right hand end of the maximum recording area is dependent upon the placement of the identifying burst, but should not extend beyond the tested area (see clause 7.6)

Figure 1 - REFLECTIVE MARKERS, RECORDING AREA AND TAPE WIND



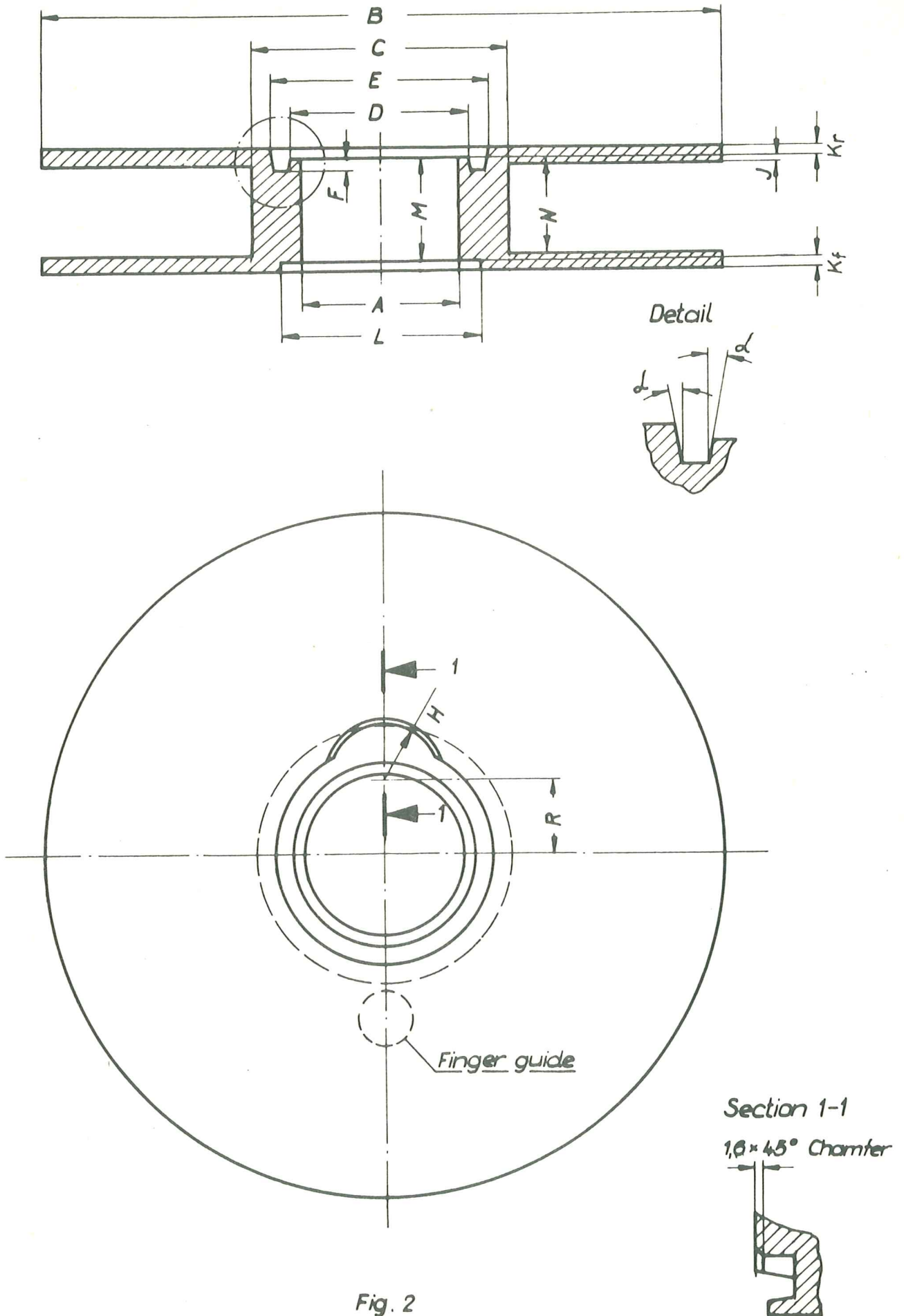
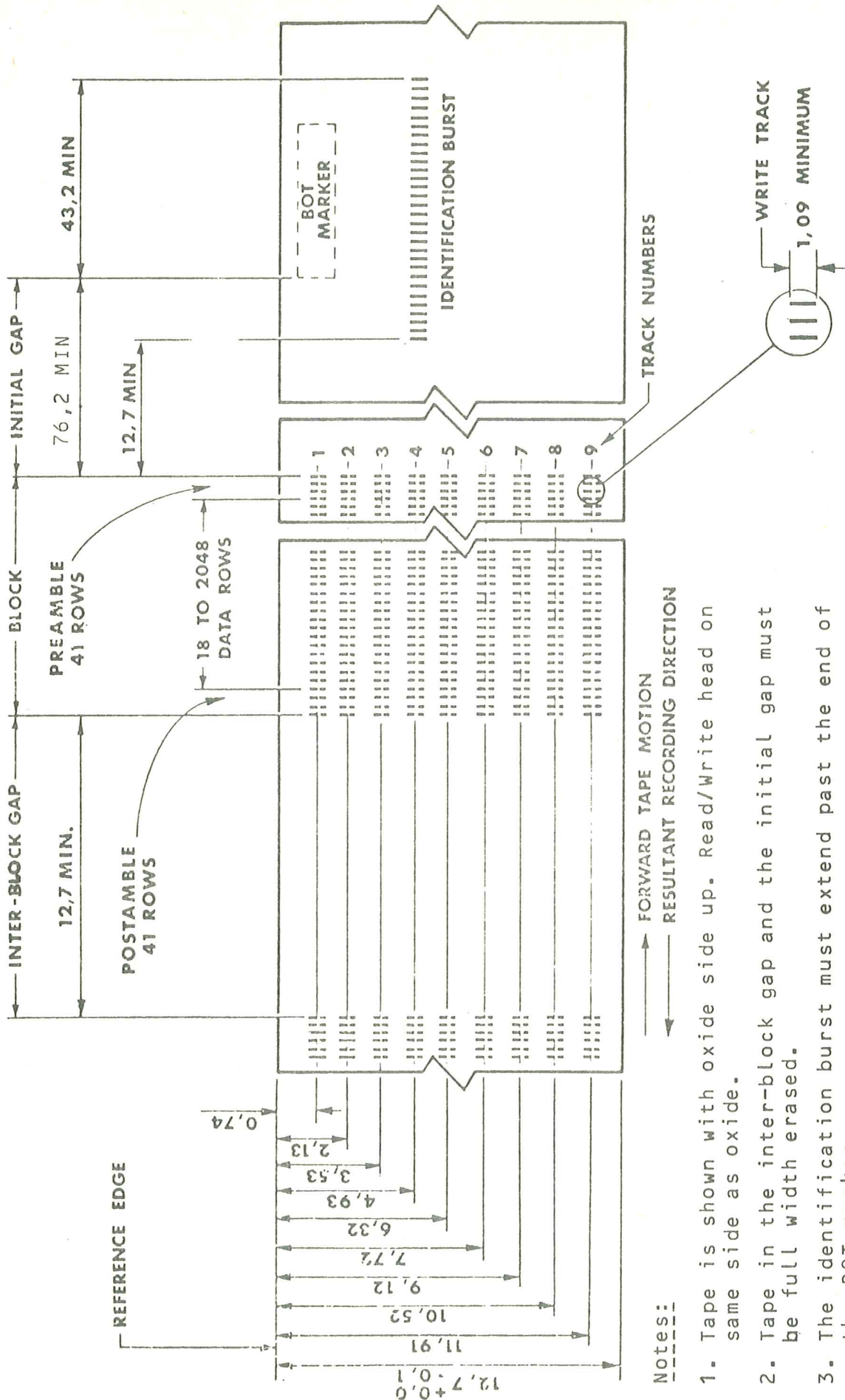


Fig. 2



FORWARD TAPE MOTION  
RESULTANT RECORDING DIRECTION

Notes:

1. Tape is shown with oxide side up. Read/Write head on same side as oxide.
2. Tape in the inter-block gap and the initial gap must be full width erased.
3. The identification burst must extend past the end of the BOT marker.
4. All dimensions are given in millimetres. All figures and dimensions are shown without the phase bit that may exist between tape character data bits.
5. Track tolerances are given in Clause 7.2 of specification.

Figure 3 RECORDING FORMAT (63 ROWS PER mm)

APPENDIX A

PROCEDURE AND INSTRUMENTATION FOR MEASURING  
FLUX REVERSAL SPACING

A.1 Procedure

The equipment used for recording tapes (tape transport) at 63 cpmm shall record on the magnetic tape to be used for interchange using the format described in the following six paragraphs.

A.1.1 Worst case Test Patterns

TEST PATTERN	
1	11111111
2	00000000
3	11110000
4	00001111
5	00010000
6	11101111
7	00010111
8	11101000
9	11001100
10	10101010
11	10101111
12	11110101
13	01010000
14	00001010

These test patterns are to be used in the following sequence:

1,1,1,3,2,2,2,4,6,3,4,4,6,6,3,5,5,5,7,8,7,8,7,8,9,9,9,  
10,10,10,12,11,14,13.

This sequence is to be repeated 3 times to constitute each tape block.

A.1.2 The tape shall be written in any start-stop mode of operation compatible with system operation.

A.1.3 Block Format

Two block formats will be generated. Each block format to be repeated 750 times together with inter-block gaps. All tracks shall be recorded simultaneously, each to meet the format specified as follows:

A.1.3.1 Format A

A.1.3.1.1 Tracks # 1, # 2, # 4, # 6, # 8 and # 9 shall contain each preamble, the 102 8-bit test patterns defined in A.1.1 and postamble.

A.1.3.1.2 Track # 5 shall contain the preamble, 816 ONE bits, and postamble. This track is written to provide a record of speed variations.

A.1.3.1.3 Tracks # 3 and # 7 shall contain each preamble, the sequence of test pattern 1 followed by test pattern 2 to be repeated 51 times, and postamble. These tracks are written to provide a means for locating any test pattern in a block defined in A.1.1.

A.1.3.2 Format B

A.1.3.2.1 Tracks # 1, # 3, # 5, # 7, # 8 and # 9 shall contain each preamble, the 102 8-bit test patterns defined in A.1.1, and postamble.

A.1.3.2.2 Track # 4 shall contain the preamble, 816 ONE bits, and postamble. This track is written to provide a record of speed variations.

A.1.3.2.3 Tracks # 2 and # 6 shall contain each preamble, the sequence of test pattern 1 followed by test pattern 2 to be repeated 51 times, and postamble. These tracks are written to provide a means for locating any test pattern in a block defined in A.1.1.

Note: On using either format described in A.1.3., odd parity is preserved in each character on the recorded tape.

A.1.4 The interflux spacings in each of the tracks containing the test patterns are to be measured at the output of the Amplifier-Limiter.

A.1.5 Each of the interflux spacings measured in A.1.4 is to be compared with the simultaneous average spacing between data bits. The maximum deviation thus obtained measured in percentage of the average spacing between data bits, shall be within the limits set in 6.4.

## A.2 Instrumentation

### A.2.1 Tape Transport

A.2.1.1 Constant tape speed 0,476 m/sec.  $\pm$  1%.

A.2.1.2 Reels of 731 m are accepted.

A.2.1.3 No Start-Stop requirements.

### A.2.2 Head

A.2.2.1 No voltage output specifications.

A.2.2.2 Read mechanical dimensions according to specifications plus the added constraint that the width of the physical gap be less than 2,8 micrometre but greater than 1,9 micrometre.

### A.2.2.3 Transfer Function

Test -- Amplitude and phase response relative to the magnetic field induced by a wire placed parallel and adjacent to the gap. The position of the wire shall be such as to maximize the head output.

Specification — In the frequency range of 7,5 kHz to 45 kHz, the magnitude characteristic shall be within 1 db from a + 6 db per octave line.

A.2.3 Impedance Match — Head to Amplifier

The input impedance of the amplifier shall be such as not to load the head + 0 db, - 0,1 db in the range of frequencies from DC to 200 kHz.

A.2.4 Amplifier — Differentiator

A.2.4.1 The frequency response of the amplifier without the frequency limiting lumped components shall be within the cutoff frequencies of:

Lower 3 db frequency 30 Hz  
upper 3 db frequency 1 MHz

The amplifier shall be flat within + 0 db, - 0,1 db in the frequency range of 1 kHz to 100 kHz.

A.2.4.2 The frequency limiting lumped components within the amplifier differentiator shall be designed to produce the following transfer function.

$$H(s) = \frac{A \cdot s}{(s + 1,00 \cdot 10^6) \cdot (s^2 + 1,59 \cdot 10^6 \cdot s + 1,21 \cdot 10^{12})}$$

where:

- A is the gain to be adjusted to produce 2 vpp output at 126 ftpmm.
- In the numerator, s produces differentiation.
- In the denominator the poles are designed for a 3 pole Bessel filter with a -3 db frequency of 120 kHz and a constant delay of 2,32 microsecond, with less than 1% deviation from the Zero frequency value up to 90 kHz.

A.2.5 Amplifier — Limiter

The gain of the limiter shall be such as to produce at the output, a minimum slope of 1V/40 nanosecond with a

30 kHz, 2 vpp input sine wave.

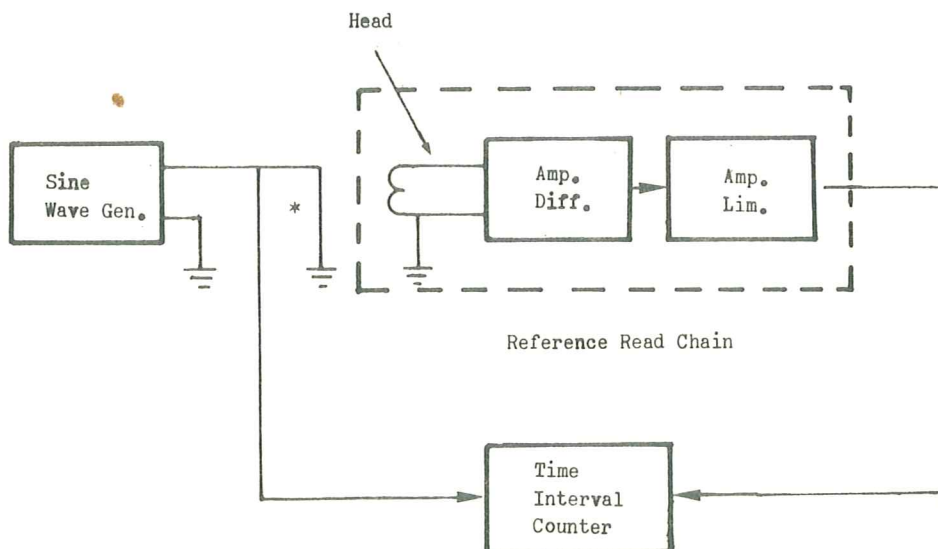
With the same input, the limiter shall introduce less than a 20 nanosecond asymmetry.

A.2.6 Over-all Response from Head Gap to Output of Amplifier-Limiter.

A.2.6.1 Equipment Needed

- Commercial sine wave generator able to generate frequencies in the range from 5 kHz to 50 kHz. The harmonic distortion content of the generator's sine wave output shall be such as to produce less than 1% harmonic distortion of the sine wave at the output of the amplifier differentiator.
- Commercial time-interval counter able to measure 5 microsecond with a resolution of 100 nanosecond.

A.2.6.2 Setup



\* Wire placed across the gap defined in A.2.2.3, "Test".

#### A.2.6.3 Test Description

With the generator's amplitude output set to give 2 volts peak-to-peak at the output of the amplifier-differentiator at each test frequency, vary the frequency of the generator from 7,5 kHz to 45 kHz. At each test frequency measure the time displacement between the positive/zero crossover of the current sine wave flowing through the gap-wire and the positive/transition at the output of the amplifier-limiter.

#### A.2.6.4 Specification for the Calibration of the Read Chain

The time delay between the positive zero crossover of the current sine wave flowing through the gap-wire and the positive transition at the output of the amplifier-limiter shall not vary more than  $\pm 400 \times (7500)/fn$  sec.\*, where  $f$  = test frequency, with respect to the time delay measured at 15 kHz, in the range of frequencies from 7,5 kHz to 45 kHz.

\* Note: This value is equivalent to  $\pm 1$  degree at 7,5 kHz.



APPENDIX B

REQUIREMENTS OF THE REFERENCE READ HEAD

B.1 Physical Gap Length: 1,9 to 2,8 micrometre.

B.2 Care must be taken to insure that reading is not influenced by poor tracking.

B.3 Transfer Function

In the frequency range from  $0,25f$  to  $1,50f$  the output shall be within 1 db from a + 6 db per octave line, where  $f = 63000 \times$  (transport speed in m/sec.) in Hz, is the fundamental frequency component of the signal generated at 126 ftpmm.

This is to be tested by energizing the head with a field produced by a sinusoidal current flowing in a wire placed parallel and adjacent to the gap. The position of the wire shall be such as to maximize head output.

B.4 Track gap to tape separation. The average track gap to tape separation shall not exceed 0,5 micrometre.

B.5 The loss in signal amplitude due to azimuth error must be less than 0,1 db.

APPENDIX C

TRANSPORTATION HAZARDS

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

- C.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

- C.1.1. The free end of the tape should be secured to prevent any tendency to unwind.
- C.1.2 The use of rigid plastic containers free from dust or other extraneous matter.
- C.1.3 The plastic container(s) to be fitted into a rigid box containing adequate shock absorbent material.
- C.1.4 The final box must have a clean interior and a lid construction that provides sufficient sealing to prevent the ingress of dirt or water.
- C.1.5 The orientation of the spools within the final box should be such that their axes are horizontal.
- C.1.6 The final box should be clearly marked to indicate its correct orientation.
- C.2 Extremes of temperature and humidity sets up stresses within the body of the tape.

Recommendation

- C.2.1 Extreme high temperature must be avoided.
- C.2.2 Rapid changes in temperature and humidity must be avoided.

- C.2.3 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.
- C.2.4 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.
- C.3 Effects of stray magnetic fields: which could possibly cause corruption of data.

Recommendation

- C.3.1 A nominal spacing of not less than 80 mm 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.

