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SMPTE STANDARD**SMPTE 279M-2001**Revision of
ANSI/SMPTE 279M-1996

for Digital Video Recording — 1/2-in Type D-5 Standard-Definition Component Video and Type HD-D5 High-Definition Video Compressed Data



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1 Scope

This standard specifies the content, format, and recording method of the data blocks containing video, audio, and associated data which form the helical records on 12.65-mm (0.5-in) tape in cassettes as specified in ANSI/SMPTE 263M.

In addition, this standard specifies the content, format, and recording method of the longitudinal record containing tracking information for the scanning head associated with the helical records, and also the longitudinal cue audio, and time and control code.

One video channel and four independent audio channels are recorded in the digital format. Each of these channels is designed to be capable of independent editing.

1.1 Standard-definition television operation

The video channel records and reproduces a component video signal of the 525-line, 29.97-Hz 25 or 30 frame rate system (hereafter referred to as the 525/60 system) or of the 625-line, 25-Hz 30 or 60 frame rate system (hereafter referred to as the 625/50 system).

1.2 High-definition television operation

The compressed video data stream, derived from the HD video signal conforming to SMPTE RP 209, is recorded by configuring the incoming data stream to the structure similar to the uncompressed 18-MHz sampled 525/60 component video signal. The recording system defined herein operates in one of the following three modes, depending on the input signal format:

Recording mode	Input signal	SMPTE standard
1	ANSI/SMPTE 125M	ANSI/SMPTE 125M
2	ANSI/SMPTE 267M	ANSI/SMPTE 267
3	SMPTE RP 209	SMPTE 342M

Figures 1 and 2 show block diagrams of the processes involved in the recorder.

2 Normative references

The following standards contain provisions which, through reference in this text, constitute provisions of this standard. All standards are subject to revision, and parties to agreements based on this standard are encouraged to investigate the possibility of applying the most recent edition of the standards indicated below.

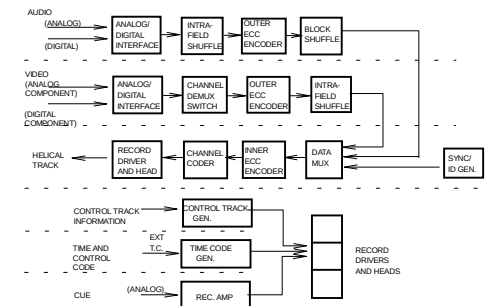


Figure 1 - Record block diagram.

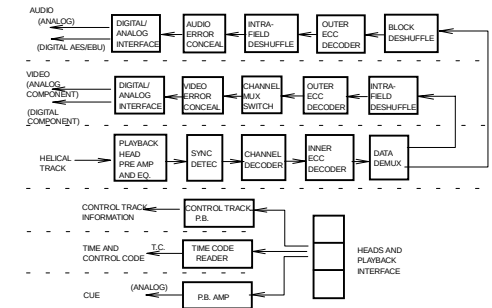


Figure 2 - Playback block diagram.

Figure 1 – Record block diagram

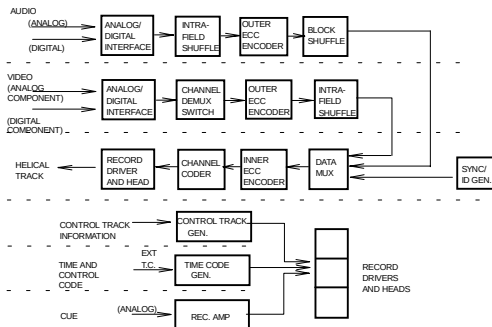


Figure 1 - Record block diagram.

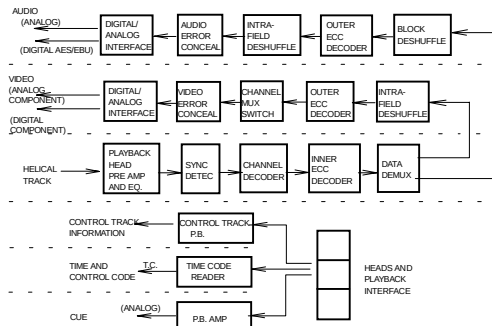


Figure 2 - Playback block diagram.

Figure 2 – Playback block diagram

AES3-1992, Digital Audio Engineering — Serial Transmission Format for Two-Channel Linearly Represented Digital Audio Data

ANSI/SMPTE 125M-1995, Television — Component Video Signal 4:2:2 — Bit-Parallel Digital Interface

ANSI/SMPTE 259M-1997, Television — 10-Bit 4:2:2 Component and $4f_{sc}$ Composite Digital Signals — Serial Digital Interface

ANSI/SMPTE 267M-1995, Television — Bit-Parallel Digital Interface — Component Video Signal 4:2:2 16×9 Aspect Ratio

SMPTE 342M-2000, Television — HD-D5 Compressed Video 1080i and 720p Systems — Encoding Process and Data Format

SMPTE RP 155-1997, Audio Levels for Digital Audio Records on Digital Television Tape Recorders

SMPTE RP 209-2000, Format for Transmission of HD-D5 Compressed Video and Audio Data over 360 Mb/s Serial Digital Interface

IEC 60461 (1986-09), Time and Control Code for Video Tape Recorders

IEC 60958 (1989-02), Digital Audio Interface

ITU-R BT.470-6 (11/98), Conventional Television Systems

ITU-R BT.601-5 (10/95), Studio Encoding Parameters of Digital Television for Standard 4:3 and Wide-Screen 16:9 Aspect Ratios

ITU-R BS.647-2 (03/92), A Digital Audio Interface for Broadcasting Studios

3 Environment and test conditions

3.1 Environment

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

- Temperature $20^{\circ}\text{C} \pm 1^{\circ}\text{C}$
- Relative humidity $(50 \pm 2)\%$
- Barometric pressure from 86 kPa to 106 kPa
- Tape conditioning not less than 24 h

- Center tape tension $0.31 \text{ N} \pm 0.05 \text{ N}$
(see annex A)

3.2 Reference tape

Blank tape for reference recordings should be available from any source meeting the tape characteristics as portrayed by this standard.

3.3 Calibration tapes

The calibration tapes meeting the requirements of 3.3.1 and clause 4 should be available from manufacturers who produce DTTRs and players in accordance with this standard.

3.3.1 Record locations and dimensions

Tolerances shown in tables 1 and 2 will be reduced by 50%.

3.3.2 Calibration signals

Two sets of signals shall be recorded on the calibration tape:

- a) Video: 100% color bars

Audio: 1-kHz tone at 20 dB below full scale on each audio channel

Cue: 1-kHz tone at reference level; 10-kHz tone at reference level

- b) A signal of constant frequency (i.e., one-half the Nyquist frequency) shall be recorded only on the tracks of field 0, segment 0 for the purpose of mechanical alignment. The recording level should conform to that in 6.6.3.

4 Video tape

4.1 Base

The base material shall be polyester or equivalent.

4.2 Width

The tape width shall be $12.650 \text{ mm} \pm 0.008 \text{ mm}$. The tape, covered with glass, shall be measured without tension at a minimum of five different positions along the tape using a calibrated comparator having an accuracy of 0.001 mm (1 μm). The tape width is defined as the average of the five readings.

Table 1 – Record location and dimensions (525/60 system)

Dimensions		Nominal	Tolerance
A	Time and control code track lower edge	0	Basic
B	Time and control code track upper edge	0.450	± 0.050
C	Control track lower edge	0.900	± 0.050
D	Control track upper edge	1.300	± 0.050
E	Program area lower edge	1.629	Derived
F	Program area width	10.020	Derived
G	Cue audio track lower edge	11.950	± 0.050
H	Cue audio track upper edge	12.550	± 0.050
I	Helical track pitch	0.0200	Ref
K0	Video sector 0 length	55.458	Derived
K1	Video sector 1 length	55.391	Derived
L	Helical track total length	116.397	Derived
M	Audio sector length	0.936	Derived
P1	Control track reference pulse to program reference point (see figure 4)	180.549	± 0.050
P2	Cue/time and control code signal, start of code word, to program reference point (see figure 4)	183.400	± 0.100
X1	Location of start of video sector V0	0	± 0.050
X2	Location of start of audio sector A1 ¹⁾	55.752	± 0.050
X3	Location of start of audio sector A2 ¹⁾	57.049	± 0.050
X4	Location of start of audio sector A3 ¹⁾	58.345	± 0.050
X5	Location of start of audio sector A4 ¹⁾	59.642	± 0.050
X6	Location of start of video sector V1 ¹⁾	60.938	± 0.050
Y	Program reference point	1.640	Basic
θ	Track angle	4.9384°	Basic
α_0	Azimuth angle (track 0)	-20.038°	± 0.150°
α_1	Azimuth angle (track 1)	19.962°	± 0.150°
NOTES			
1 Measurements shall be made under the conditions specified in 3.1. The measurements shall be corrected to account for actual tape speed (see figures B.1 and B.2).			
2 All dimensions are in millimeters.			
¹⁾ Audio channel numbers vary.			

Table 2 – Record location and dimensions (625/50 system)

	Dimensions	Nominal	Tolerance
A	Time and control code track lower edge	0	Basic
B	Time and control code track upper edge	0.450	± 0.050
C	Control track lower edge	0.900	± 0.050
D	Control track upper edge	1.300	± 0.050
E	Program area lower edge	1.716	Derived
F	Program area width	9.940	Derived
G	Cue audio track lower edge	11.950	± 0.050
H	Cue audio track upper edge	12.550	± 0.050
I	Helical track pitch	0.0180	Ref
K0	Video sector 0 length	55.066	Derived
K1	Video sector 1 length	54.993	Derived
L	Helical track total length	115.558	Derived
M	Audio sector length	0.936	Derived
P1	Control track reference pulse to program reference point (see figure 4)	179.606	± 0.050
P2	Cue/time and control code signal, start of code word, to program reference point (see figure 4)	182.995	± 0.100
X1	Location of start of video sector V0	0	± 0.050
X2	Location of start of audio sector A1 ¹⁾	55.344	± 0.050
X3	Location of start of audio sector A2 ¹⁾	56.631	± 0.050
X4	Location of start of audio sector A3 ¹⁾	57.918	± 0.050
X5	Location of start of audio sector A4 ¹⁾	59.205	± 0.050
X6	Location of start of video sector V1 ¹⁾	60.492	± 0.050
Y	Program reference point	1.728	Basic
θ	Track angle	4.9345°	Basic
α_0	Azimuth angle (track 0)	-20.035°	± 0.150°
α_1	Azimuth angle (track 1)	19.965°	± 0.150°
NOTES 1 Measurements shall be made under the conditions specified in 3.1. The measurements shall be corrected to account for actual tape speed (see figures B.1 and B.2). 2 All dimensions are in millimeters. ¹⁾ Audio channel numbers vary.			

4.3 Width fluctuation

Tape width fluctuation shall not exceed 5 μm peak to peak. Measurement of tape width fluctuation shall be taken over a tape length of 900 mm. The value of tape width fluctuation shall be evaluated by measuring the tape width at 10 points, each separated by a distance of 100 mm.

4.4 Tape thickness

Two types of tape thickness shall be permitted by this standard. The first tape thickness shall be 10.2 μm to 11.0 μm (referred to as 11 μm); the second tape thickness shall be 13.0 μm to 14.0 μm (referred to as 14 μm).

4.5 Transmissivity

Transmissivity shall be less than 5%, measured over the range of wavelengths 800 nm to 900 nm.

4.6 Offset yield strength

The offset yield strength shall be greater than 9 N for 11- μm tape and 10 N for 14- μm tape. The force required to produce 0.2% elongation of a 1000-mm test sample with a pull rate of 10-mm per minute shall be used to confirm the offset yield strength. The line beginning at 0.2% elongation parallel to the initial tangential slope is drawn and then read at the point of intersection of the line and the stress-strain curve.

4.7 Magnetic coating

The magnetic layer of the tape shall consist of a coating of metal particles or equivalent.

4.8 Coating coercivity

The coating coercivity shall be a class 1800 (144000 A/m) with an applied field of 400000 A/m (5000 Oe) as measured by a 50-Hz or 60-Hz B-H meter or vibrating sample magnetometer (VSM).

4.9 Particle orientation

The metal particles shall be longitudinally oriented.

5 Helical recording

5.1 Tape speed

The tape speed shall be 167.228 mm/s. The tolerance shall be $\pm 0.2\%$.

5.2 Record location and dimensions

5.2.1 The format requires full-width erasure for continuous recording and flying erasure for insert editing.

5.2.2 Record location and dimensions for continuous recording shall be as specified in figures 3 and 4 and tables 1 (525/60 system) and 2 (625/50 system). In recording, sector locations on each helical track shall be contained within the tolerance specified in figure 3 and tables 1 (525/60 system) and 2 (625/50 system).

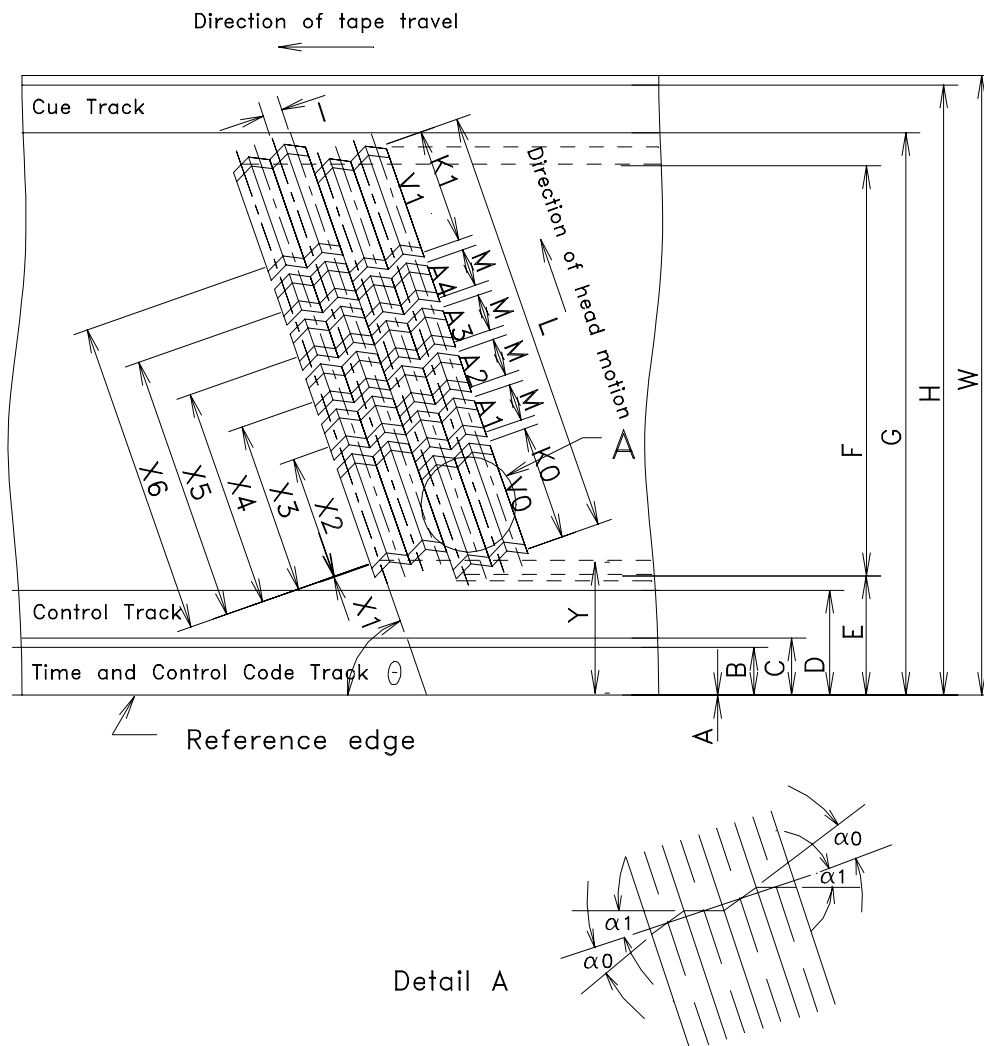
5.2.3 The reference edge of the tape for record location dimensions specified in this standard shall be the lower edge as shown in figure 3. The magnetic coating, with the direction of tape travel as shown in figure 3, is on the side facing the observer (measuring techniques are shown in annex B).

5.2.4 As indicated in figure 3, this standard anticipates a zero guard band between recorded tracks, and the record head width should be equivalent to the track pitch of 20 μm (525/60 system) or 18 μm (625/50 system). The scanner head configuration should be chosen such that the recorded track widths are contained within the limits of 18 μm to 22 μm (525/60 system) or 16 μm to 20 μm (625/50 system).

5.2.5 In insert editing, this standard provides a guard band of 2 mm (nominal) between the previously recorded track and the inserted track at editing points only. A typical track pattern for insert editing is shown in figure C.1 of annex C.

5.3 Helical track record tolerance zones

The lower edges of any eight consecutive tracks starting at the first track in each video frame shall be contained within the pattern of the eight tolerance zones established in figure 5. Each zone is defined by two parallel lines which are inclined with respect to the tape reference edge at an angle of 4.9384° basic (525/60 system) or 4.9345° basic (625/50 system).



NOTES

- 1 A1, A2, A3 and A4 are audio sectors.
- 2 V0 and V1 are video sectors.
- 3 Tape viewed from magnetic coating side.
- 4 Dimension X1 to X6 are determined by the program reference point as defined in figure 4.

NOTES

- 1 A1, A2, A3, and A4 are audio sectors.
- 2 V0 and V1 are video sectors.
- 3 The tape is viewed from the magnetic coating side.
- 4 Dimensions X1 to X6 are determined by the program reference point as defined in figure 4.

Figure 3 – Location and dimensions of recorded tracks

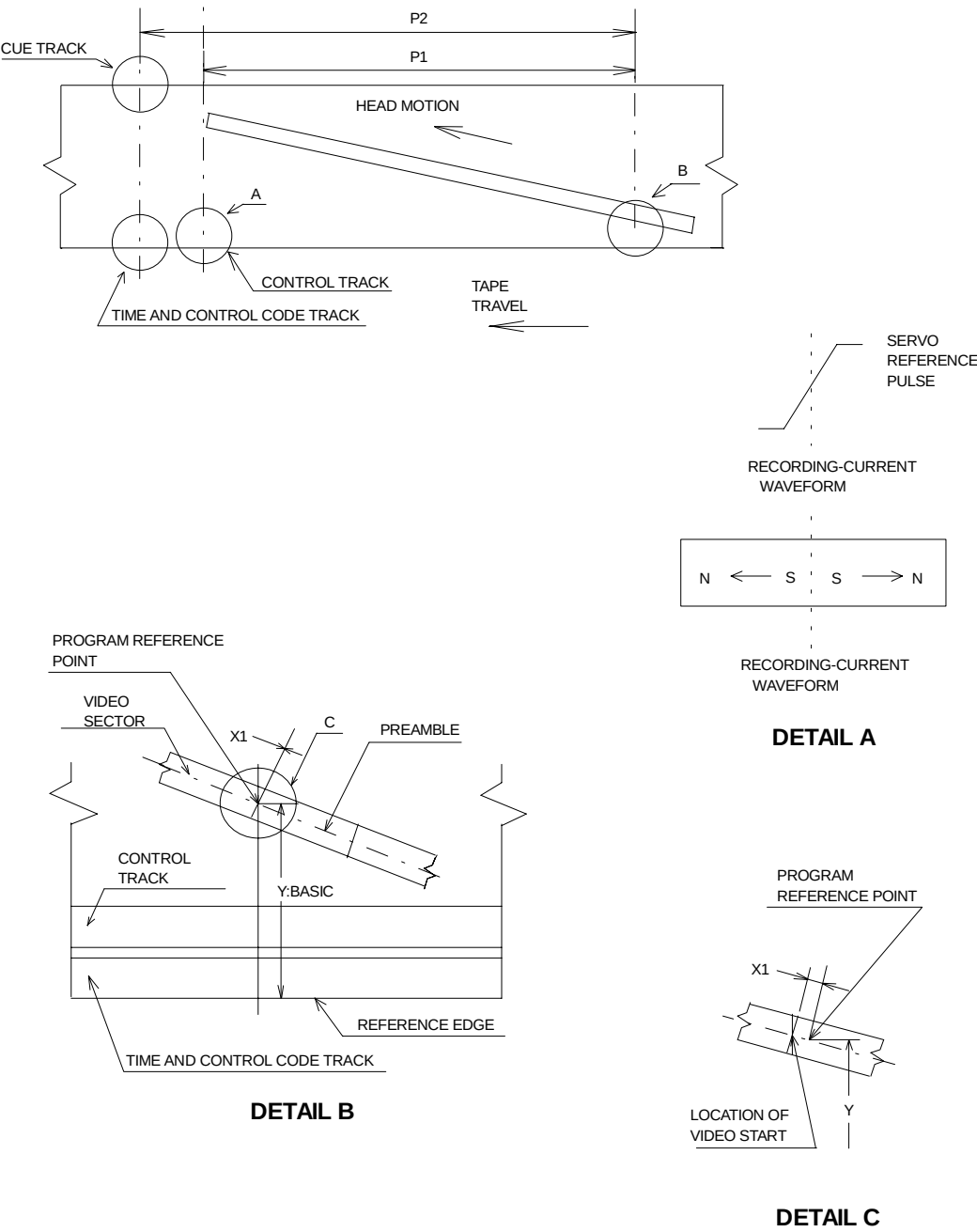
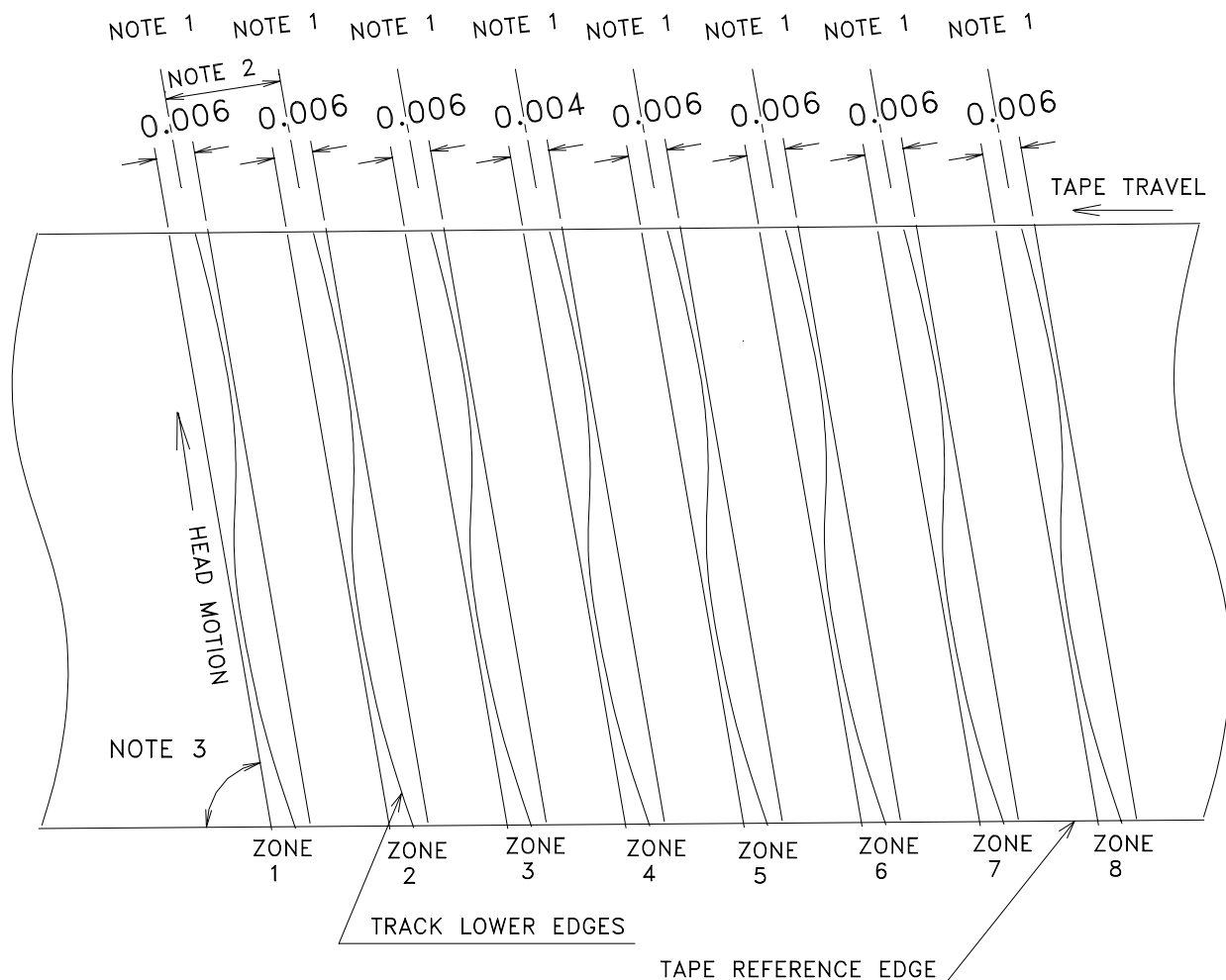


Figure 4 – Location of cue and time and control code track record



NOTES

- 1 Tolerance zone centerlines.
- 2 0.0200 (525/60 system); 0.0180 (625/50 system).
- 3 4.9384° (525/60 system); 4.9345° (625/50 system).
- 4 All dimensions are in millimeters.

Figure 5 – Location and dimensions of tolerance zones of helical track record

The centerlines of all zones shall be spaced apart 0.0200 mm basic (525/60 system) or 0.018 mm basic (625/50 system). The width of zones 1 to 3 and 5 to 8 shall be 0.006 mm basic. The width of zone 4 shall be 0.004 mm basic. These zones are established to contain track angle errors, track straightness errors, and vertical head offset tolerance (measuring technique is shown in annex B).

5.4 Relative positions of recorded information

5.4.1 Relative positions of longitudinal tracks

Audio, video, control track, time and control code, and cue track with information intended to be time coincident shall be positioned as shown in figures 3 and 4.

5.4.2 Program area reference point

The program area reference point is determined by the intersection of a line parallel to the reference edge of the tape at a distance Y from the reference edge and the centerline of the first track in each video field (segment 0, track 0). (See figures 3 and 4.)

The end of the preamble and start of the video sector are located at the program area reference point, and the tolerance is dimension $X1$. The locations are shown in figures 3 and 4; dimensions $X1$ and Y are in tables 1 and 2. The relationship between sectors and contents of each sector are specified in clause 6.

5.5 Gap azimuth

5.5.1 Cue track, control track and time code track

The azimuth angle of the cue, control track, and time and control code head gaps used to produce longitudinal track records shall be perpendicular to the track record.

5.5.2 Helical track

The azimuth of the head gaps used for the helical track shall be inclined at angles α_0 and α_1 , as specified in tables 1 and 2, with respect to a line perpendicular to the helical track. The azimuth of the first track of every field (segment 0, track 0) shall be oriented in the counterclockwise direction with respect to a line perpendicular to the helical track direction when viewed from the side of the tape containing the magnetic record.

5.6 Transport and scanner

The effective drum diameter, tape tension, helix angle, and tape speed taken together determine the track angle. Different methods of design and/or variations in drum diameter and tape tension can produce equivalent recordings for interchange purposes.

One possible configuration of the transport uses a scanner with an effective diameter of 76.000 mm. Scanner rotation is in the same direction as tape motion during normal playback mode. Data are recorded by two groups of four heads mounted 180° apart. Figures 6 (525/60 system) and 7 (625/50 system) show one possible mechanical configuration of the scanner, and table 3 shows the corresponding mechanical parameters. Figures 8 (525/60 system)

and 9 (625/50 system) show the relationship between the longitudinal heads and the scanner.

Other mechanical configurations are allowable provided the same footprint of recorded information is produced on tape. Erase heads are described in 5.2.1 and figures 6 and 7.

6 Program track data

6.1 Introduction

Each television field is recorded on 12 tracks (525/60 system) or 16 tracks (625/50 system).

The helical tracks contain digital data from the video channel and four audio channels. Each track contains a video sector followed by four audio sectors corresponding to four audio channels and followed by a second video sector, recorded in that order. An edit gap between sectors accommodates timing errors during editing. Figure 10 shows the arrangement of video and audio sectors on the tape.

6.2 Labeling convention

The least significant bit is written on the left and first recorded to tape.

The lowest numbered byte is shown at the left/top and is the first encountered in the input data stream.

Byte values are expressed in hexadecimal notation unless otherwise noted. An h subscript indicates a hexadecimal value.

6.3 Sector details

Each sector (audio or video) is divided into the following elements:

- Preamble containing clock run-up sequence, sync pattern, identification pattern, and fill pattern;
- Sync blocks containing sync pattern and identification pattern, followed by a fixed-length data block with error control;
- Postamble containing sync pattern and identification pattern.

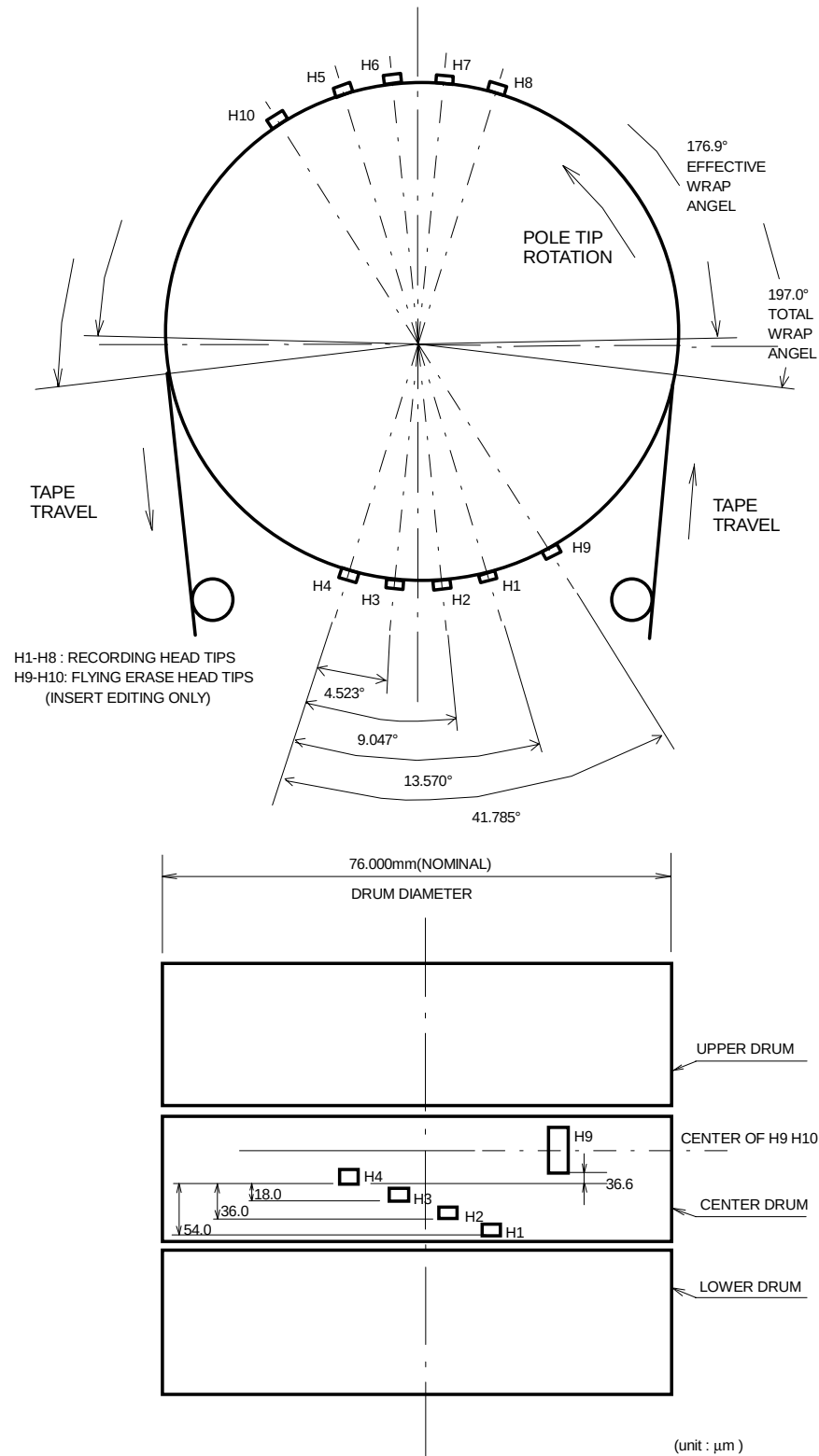


Figure 6 – A possible scanner configuration (525/60 system)

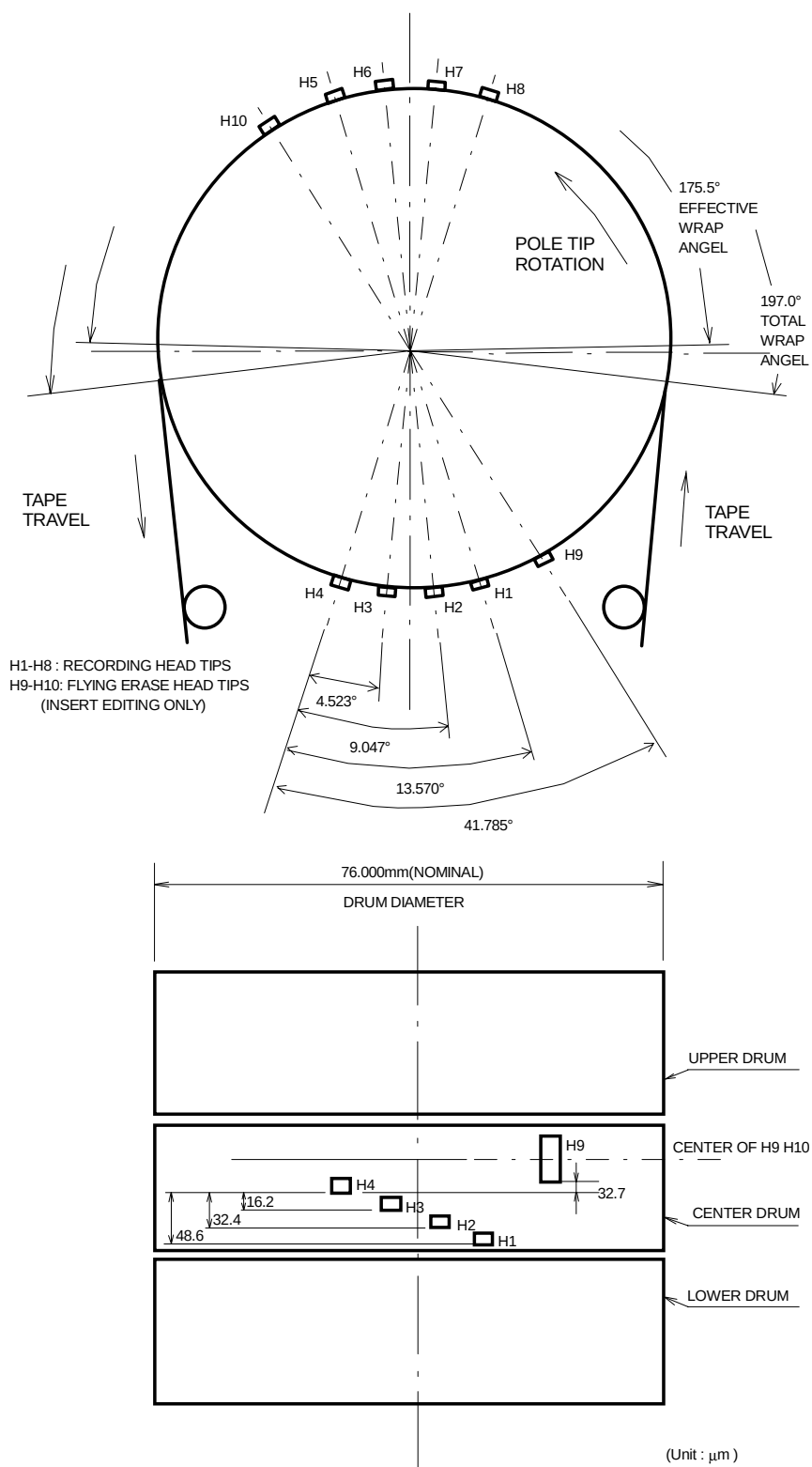
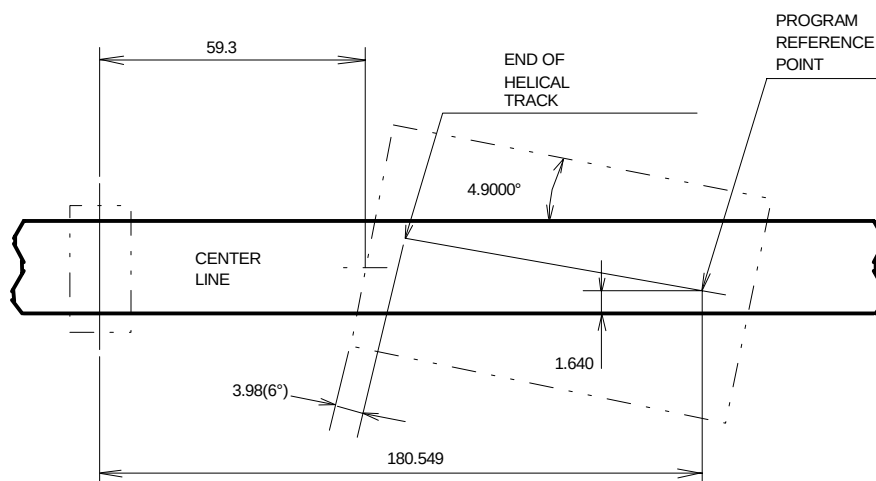
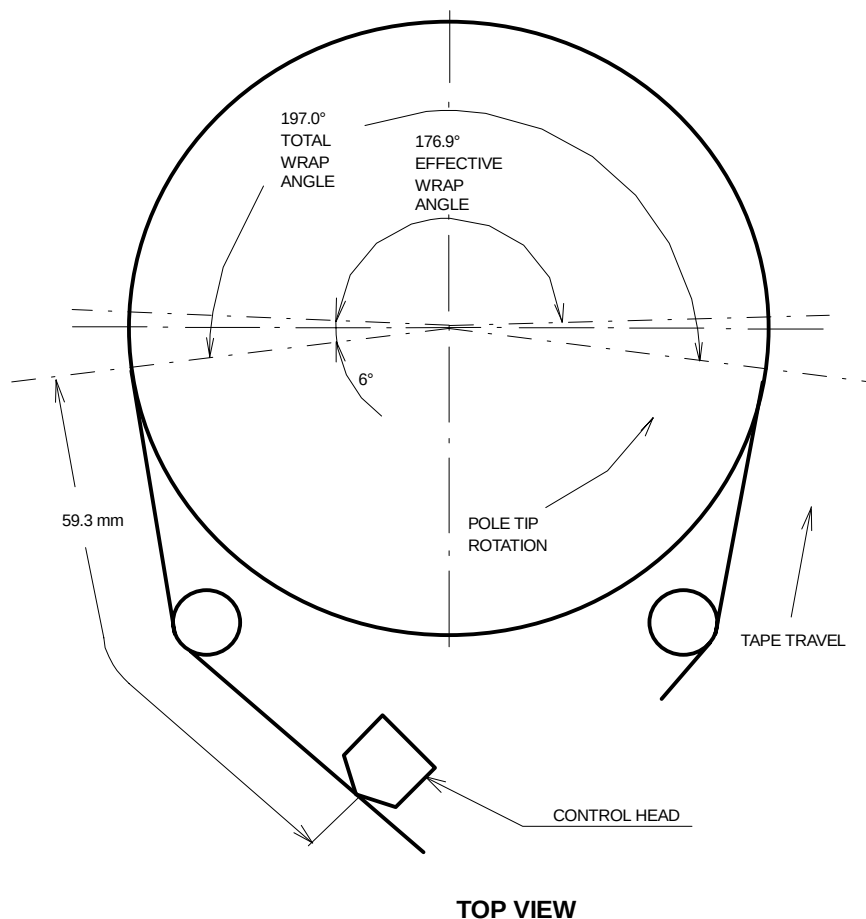
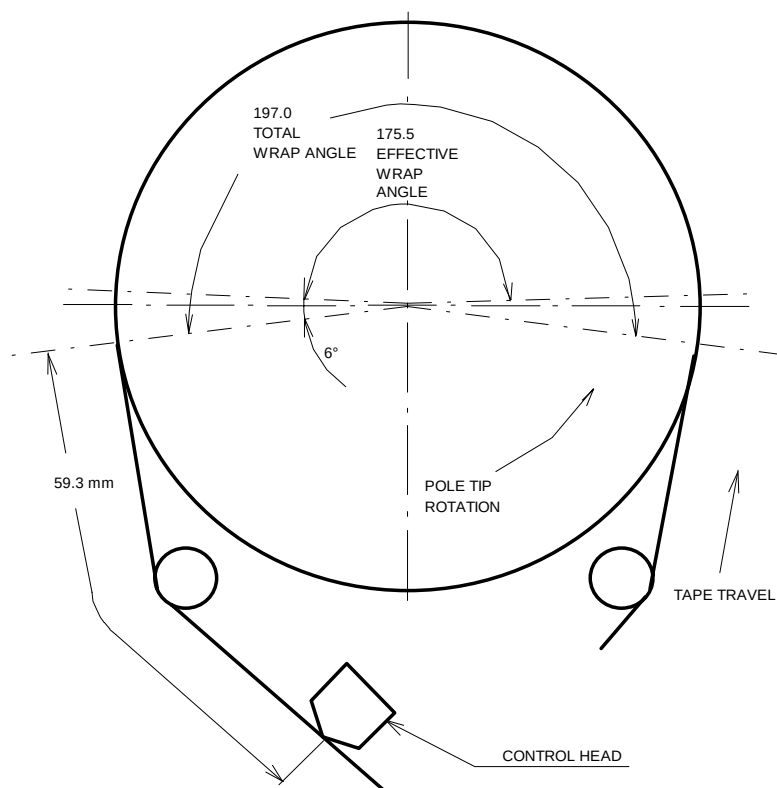


Figure 7 – A possible scanner configuration (625/50 system)

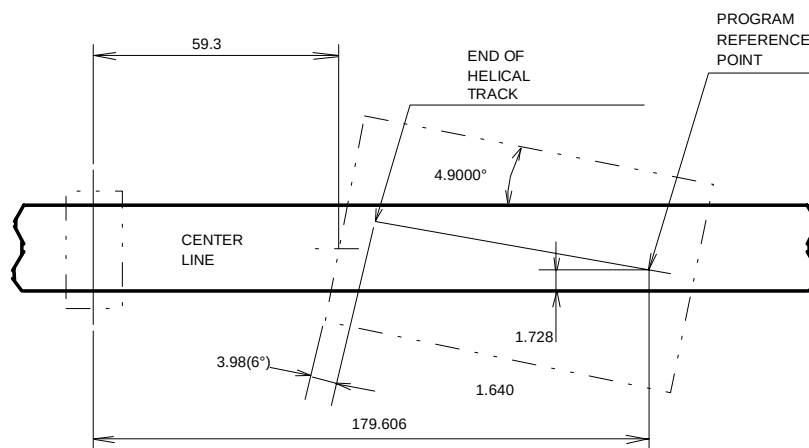


NOTE – Unwrapped; viewed magnetic coating side.

Figure 8 – A possible longitudinal head location and tape wrap (525/60 system)



TOP VIEW



NOTE - Unwrapped, viewed magnetic coating side.

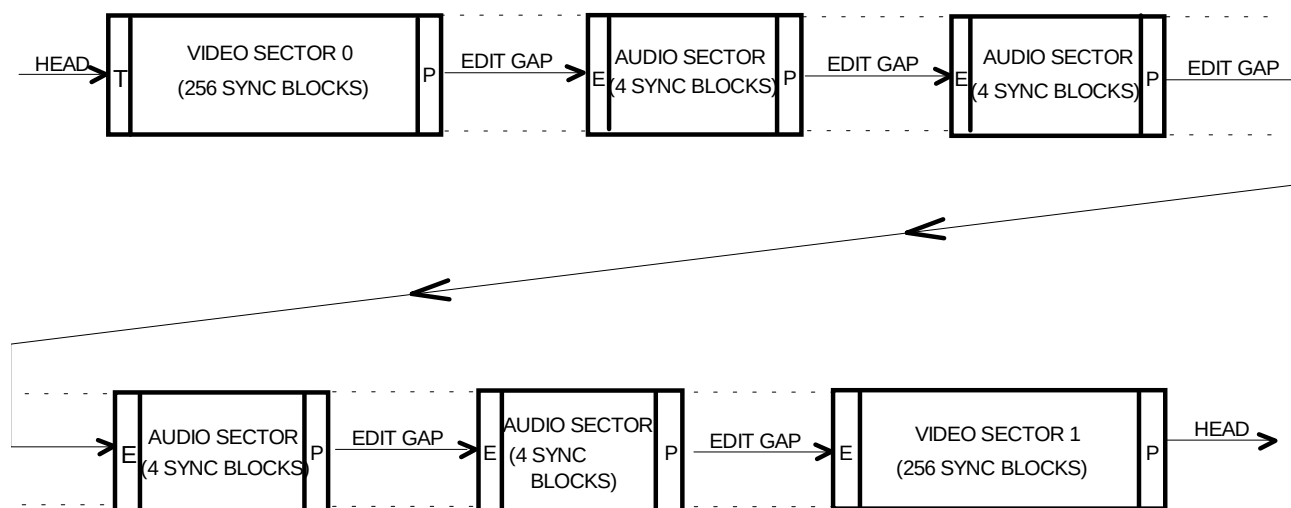
cation and tape wrap.
tem)

NOTE – Unwrapped; viewed magnetic coating side.

Figure 9 – A possible longitudinal head location and tape wrap (625/50 system)

Table 3 – Parameters for a possible scanner design

Parameters		525/60 system	625/50 system
Scanner rotation speed (rps)		90/1.001	100
Number of tracks per rotation		8	
Drum diameter (mm)		76.000	
Center span tension (N)		0.31	
Helix angle (degrees)		4.9000	
Effective wrap angle (degrees)		176.9	175.5
Scanner circumferential speed (m/s)		21.5	23.9
H1, H3 overwrap head entrance (degrees)		14.1	15.5
H1, H3 overwrap head exit (degrees)		6	
Angular relationship (degrees)	H1 – H4:	13.570	
	H2 – H4:	9.047	
	H3 – H4:	4.523	
	H5 – H8:	13.570	
	H6 – H8:	9.047	
	H7 – H8:	4.523	
	H4 – H8:	180.000	
Vertical displacement (mm)	H1 – H4:	0.054	0.0486
	H2 – H4:	0.036	0.0324
	H3 – H4:	0.018	0.0162
	H5 – H8:	0.054	0.0486
	H6 – H8:	0.036	0.0234
	H7 – H8:	0.018	0.0162
Maximum tip projection (μm)		42.0	
Record head track width (μm)		20	18

**NOTES**

- 1 T = track preamble (58 bytes).
- 2 E = in-track preamble.
- 3 P = postamble (4 bytes).
- 4 Sync block: 97 bytes (525/60 system); 88 bytes (625/50 system).
- 5 Edit gap: 162 bytes nominal (525/60 system); 144 bytes nominal (625/50 system).

Figure 10 – Sector arrangement on helical track

6.3.1 Sync block

The sync block format is common to both audio and video sectors. Each sync block contains a sync pattern (2 bytes) and an inner code block. Each inner block contains an identification pattern (2 bytes) and 85 (525/60 system) or 76 (625/50 system) data bytes of video, audio, or outer check bytes followed by 8 inner check bytes.

The inner code block contains the two bytes of the identification pattern together with 85 data bytes (525/60 system) or 76 data bytes (625/50 system). Figures 11 (525/60 system) and 12 (625/50 system) show the sync block format.

6.3.2 Sync pattern

- a) Length: 16 bits (2 bytes).
- b) Pattern: 97F1 (in hexadecimal notation).

	LSB								MSB							
Byte 0	1	1	1	0	1	0	0	1	1	1	1	0	0	1	0	0
Byte 1	1	0	0	0	1	1	1	1	1	1	1	0	0	1	0	0

- c) Protection: None.
- d) Randomization: None.

6.3.3 Identification pattern

As illustrated in figures 13 (525/60 system) and 14 (625/50 system), the first two bytes of each inner block are used for identification of sync block, television field, segment (group of helical tracks scanned simultaneously), sector (portion of a track), and helical track. Bits 1 to 6 of the second byte (byte 3 of sync block) of the identification pattern identify the track. Bit 7 of the second byte (byte 3) identifies a sector on the helical track (see figures 15 and 16).

- a) Length: 16 bits (2 bytes).
- b) Arrangement: The sync block number (byte 2 and bit 0 of byte 3) follows a coded sequence along the track. Figure 17 shows the sequence of the sync block numbers.

The sector ID (bits 1-7 of byte 3) identifies a particular sector.

The segment count is modulo 3 (525/60 system) or modulo 4 (625/50 system). For the 525/60 system, the field count for video sectors is modulo 4 ($VF_2 = 0$ in byte 3). The field count for audio sectors is modulo 4 (for AF_0 and AF_1 in byte 3) and AF_2 (in byte 3) is used for the identification of the five field sequences. For the 625/50 system, the field count for video sectors is modulo 8 and the field count for audio sectors is modulo 4 ($AF_2 = 0$).

c) Video field identification: The field address VF_0 , VF_1 , VF_2 (bits 4, 5, and 6 of byte 3) for video sync blocks shall identify the field sequence as shown below. In the case of composite signal input, the field address shall identify the four-field color sequences (525/60 system) or eight-field color sequences (625/50 system), as defined in ITU-R BT.470-6 and have the values as shown below:

525/60 system:

Component signal input	Composite signal input	VF_0	VF_1	VF_2
Field 1	Color frame A, field I	0	0	0
Field 2	Color frame A, field II	1	0	0
Field 1	Color frame B, field III	0	1	0
Field 2	Color frame B, field IV	1	1	0

NOTE – Composite recording requires detection of a color field sequence while for component recording this is not required. If a component recorder (as for example D-5) in its implementation allows a recording of composite signals as well, it is necessary to detect and maintain proper color field sequence during editing sessions. Such a relationship between odd/even fields of a component recording and color fields of a composite recording therefore must be defined as shown in 6.3.3.

625/50 system:

Component signal input	Composite signal input	VF_0	VF_1	VF_2
Field 1	Color field I	0	0	0
Field 2	Color field II	1	0	0
Field 1	Color field III	0	1	0
Field 2	Color field IV	1	1	0
Field 1	Color field V	0	0	1
Field 2	Color field VI	1	0	1
Field 1	Color field VII	0	1	1
Field 2	Color field VIII	1	1	1

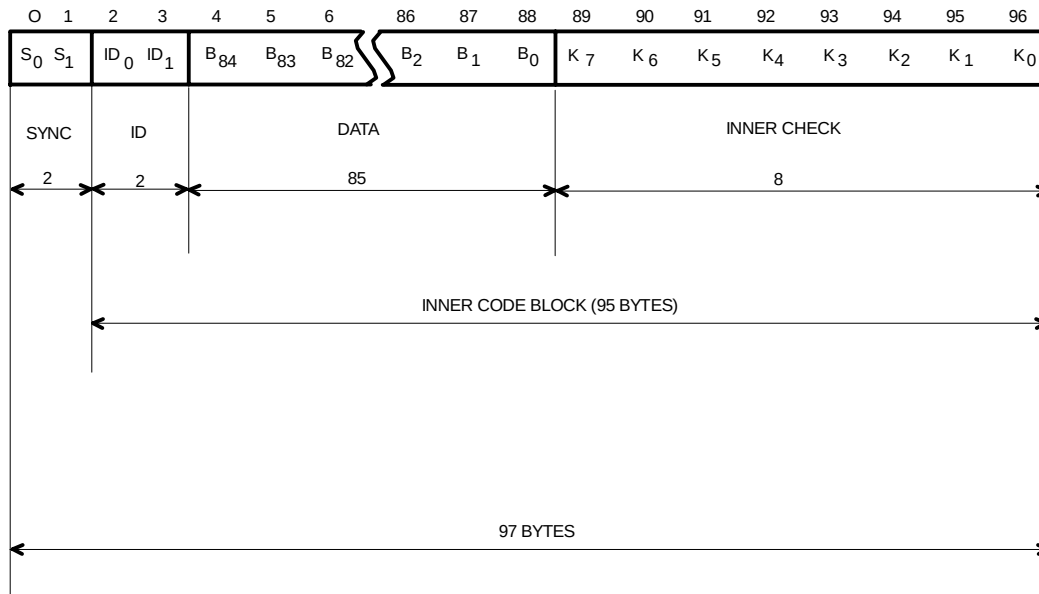


Figure 11 – Sync block format (525/60 system)

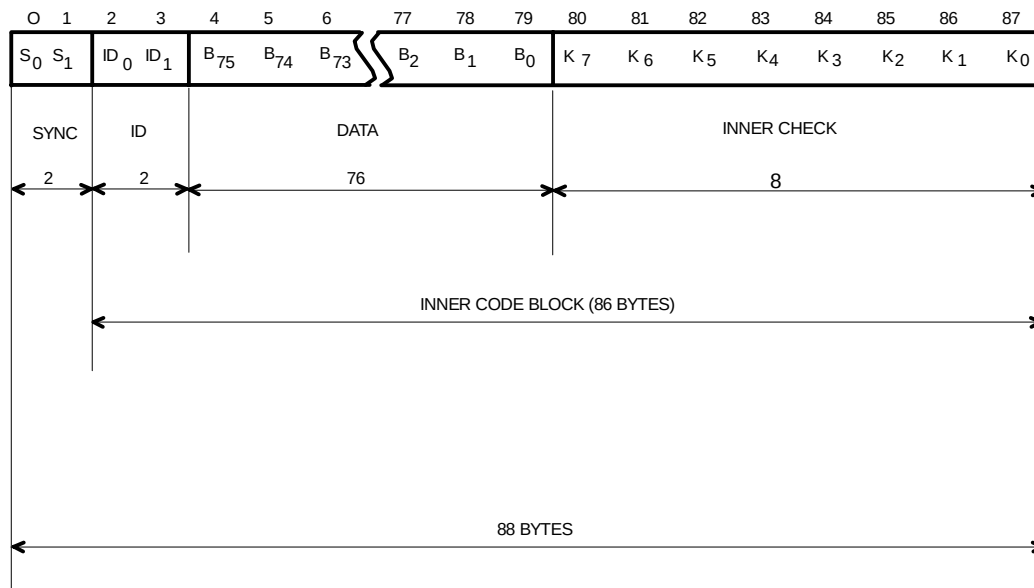
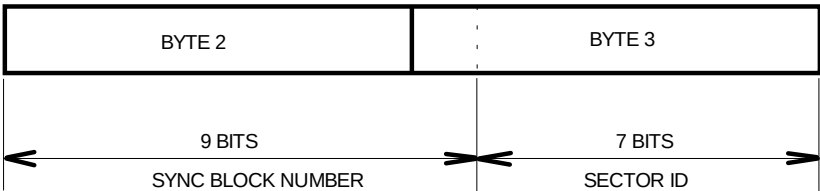
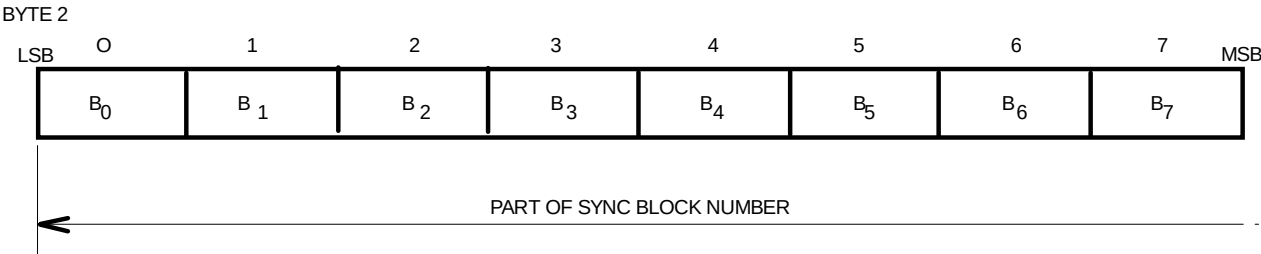


Figure 12 – Sync block format (625/50 system)

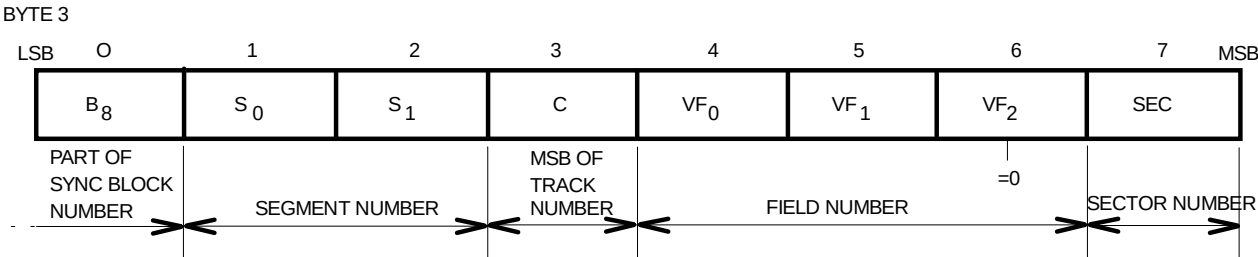
ARRANGEMENT



SYNC BLOCK NUMBER



SECTOR ID FOR VIDEO SYNC BLOCKS



SECTOR ID FOR AUDIO SYNC BLOCKS

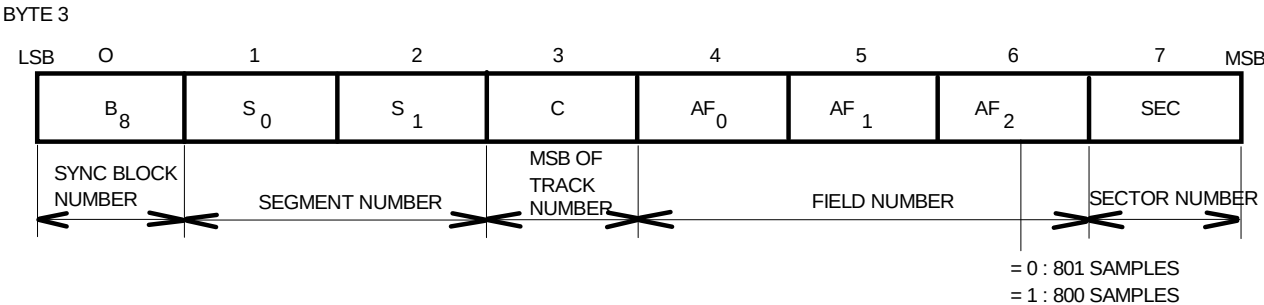
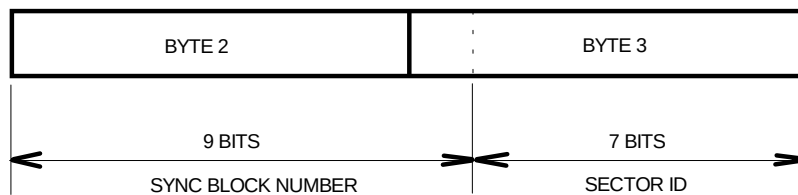


Figure 13 - Sync block identification format. (525/60 system)

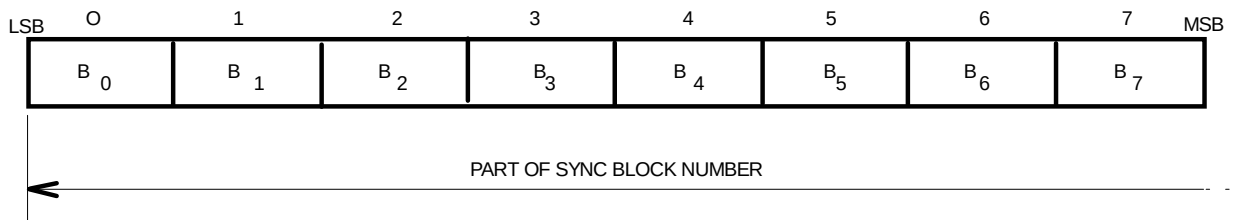
Figure 13 – Sync block identification format (525/60 system)

ARRANGEMENT



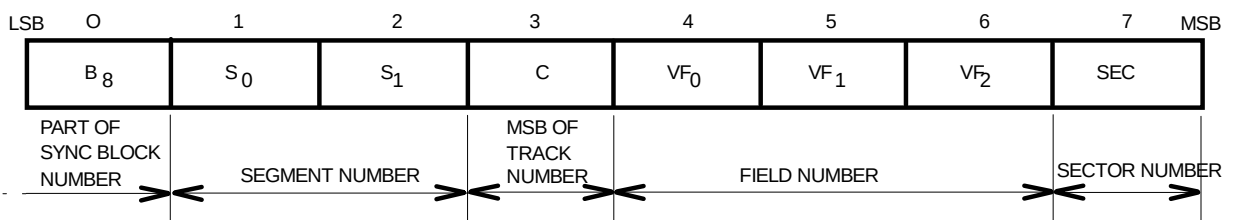
SYNC BLOCK NUMBER

BYTE 2



SECTOR ID FOR VIDEO SYNC BLOCKS

BYTE 3



SECTOR ID FOR AUDIO SYNC BLOCKS

BYTE 3

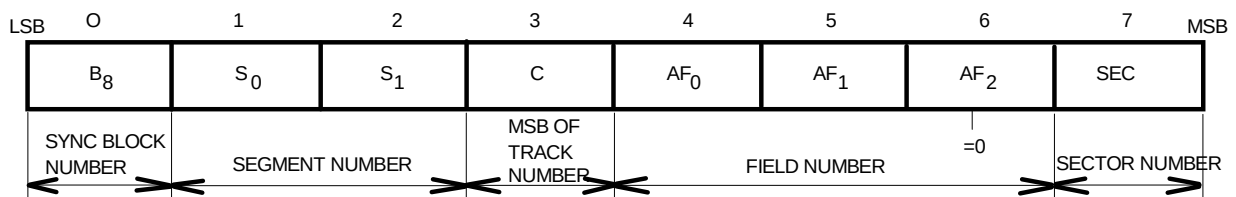
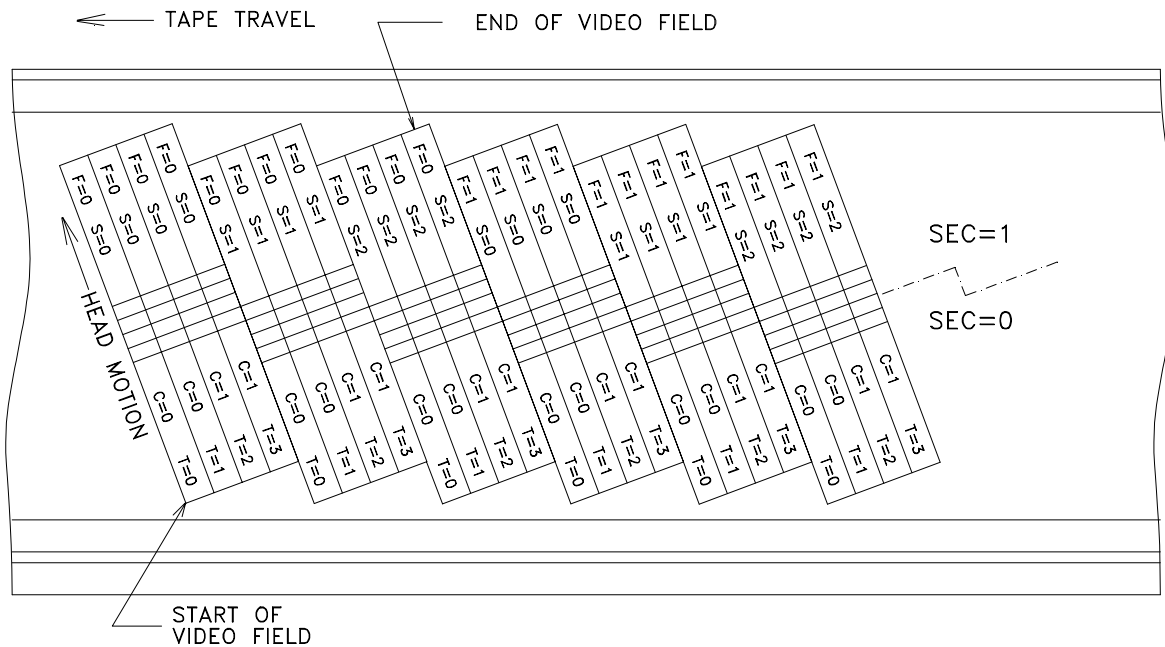


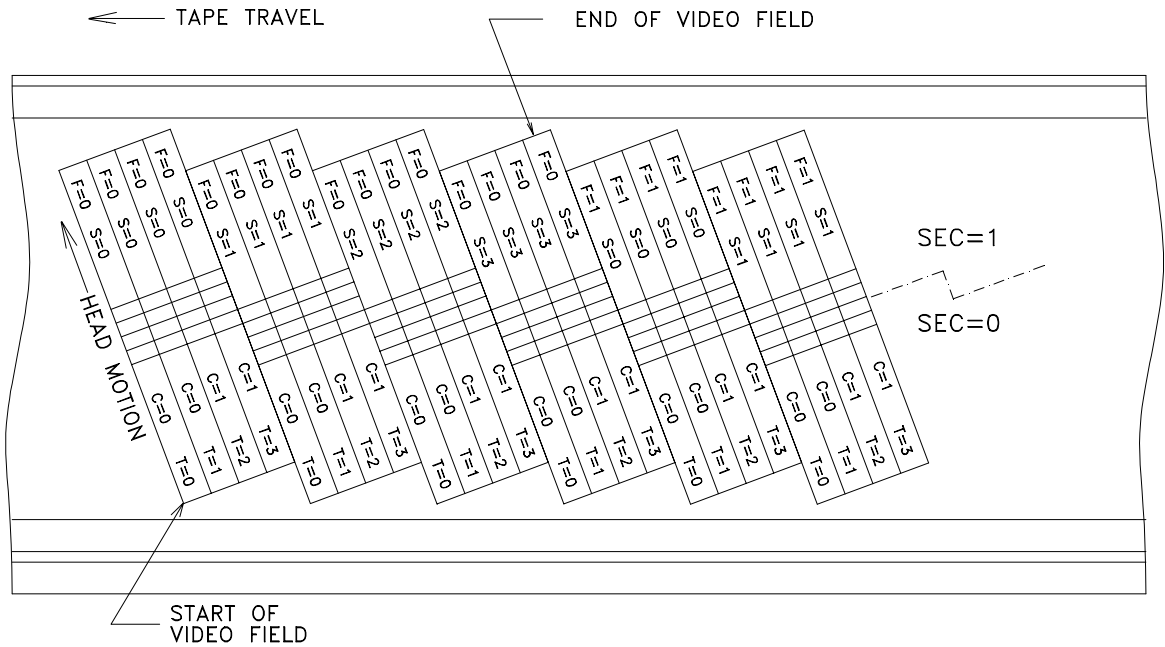
Figure 14 - Sync block identification format. (625/50 system)

Figure 14 – Sync block identification format (625/50 system)



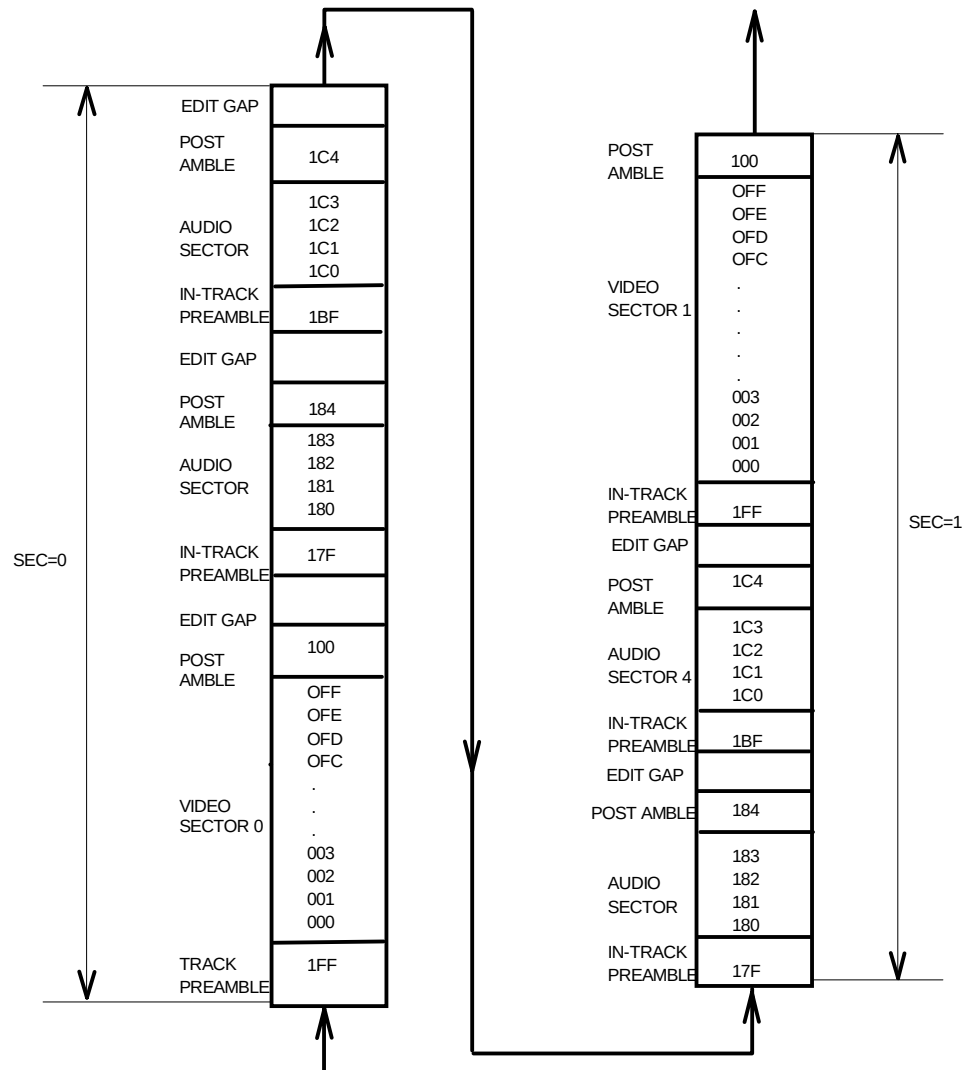
- NOTES
- 1 F = field number (0, 1, 2, 3).
 - 2 S = segment number (0, 1, 2).
 - 3 SEC = sector number; C = MSB of track number (0, 1).
 - 4 T = track number (0, 1, 2, 3). The LSB of the track number is identified by the azimuth angle.
 - 5 Audio sectors are not shown.

Figure 15 – Track, segment and field numbers (525/60 system)



- NOTES
- 1 F = field number (0, 1, 2, 3, . . . 7).
 - 2 S = segment number (0, 1, 2, 3).
 - 3 SEC = sector number; C = MSB of track number (0, 1).
 - 4 T = track number (0, 1, 2, 3). The LSB of the track number is identified by the azimuth angle.
 - 5 Audio sectors are not shown.

Figure 16 – Track, segment and field numbers (625/50 system)



NOTE – Sync block number shown in hexadecimal notation.

Figure 17 – Sync block number

d) Audio field identification: The field addresses AF_0 and AF_1 of the audio sync block (bits 4 and 5 of byte 3) shall identify a four-field sequence as shown below. The sequence shall be identical for the 525/60 system and the 625/50 system. When audio sectors are edited, the four-field sequence shall be maintained.

Field	AF_0	AF_1
m	0	0
m+1	0	1
m+2	1	0
m+3	1	1

For the 525/60 system, the field address AF_2 of the audio sync block (bit 6 of byte 3) shall identify a five-field sequence for the number of audio samples in the current field as shown below. When audio sectors are edited, the five-field sequence shall be maintained (see 10.3.6 d)). For the 625/50 system, the field address AF_2 of the audio sync block (bit 6 of byte 3) shall be set always to 0.

525/60 system			625/50 system		
Field	AF_2	Number of audio samples	AF_2	Number of audio samples	
n	0	801	0	960	
n+1	0	801	0	960	
n+2	0	801	0	960	
n+3	0	801	0	960	
n+4	1	800	0	960	

e) Protection: The identification pattern is protected by an inner code block.

f) Randomization: The identification pattern is randomized before being channel coded. The randomizing is equivalent to performing the exclusive-OR operation between the serial data stream and the serial stream generated by the polynomial function

$$x^8 + x^4 + x^3 + x^2 + 1 \text{ (in GF(2))}$$

The first term is the most significant and the first to enter the division computation. The polynomial generator noted above is preset to 15h (525/60 system) or 0Ch (625/50 system) at the first byte of the identification pattern and continues to cycle until the end of the sync block.

6.3.4 Data field

This block is used for all video and audio data and the associated error correction data.

a) Length: 1 inner code block. For the 525/60 system, the inner code block contains 95 bytes consisting of two identification pattern bytes, 85 data bytes (outer ECC check bytes are considered data), plus 8 inner ECC check bytes. For the 625/50 system, the inner code block contains 86 bytes consisting of two identification pattern bytes, 76 data bytes (outer ECC check bytes are considered data), plus 8 inner ECC check bytes.

b) Arrangement: See figures 11 and 12.

c) Interleaving: None.

d) Protection: Inner ECC code.

Type: Reed-Solomon.

Galois field: GF(256).

Field generator polynomial: $x^8 + x^4 + x^3 + x^2 + 1$, where x^i are place-keeping variables in GF(2), the binary field.

Order of use: Left-most term is most significant, oldest in time computationally, and written to tape first.

Code generator polynomial in GF(256):

$G(x) = (x+1)(x+a)(x+a^2)(x+a^3)(x+a^4)(x+a^5)(x+a^6)(x+a^7)$, where a is given by 02h in GF(256).

Check characters: $K_7, K_6, K_5, K_4, K_3, K_2, K_1, K_0$ in $K_7x^7 + K_6x^6 + K_5x^5 + K_4x^4 + K_3x^3 + K_2x^2 + K_1x + K_0$ obtained as the remainder after dividing $x^8D(x)$ by $G(x)$, where

$D(x) = ID_0x^{86} + ID_1x^{85} + B_{84}x^{84} + \dots + B_2x^2 + B_1x + B_0$ (525/60 system);

$D(x) = ID_0x^{77} + ID_1x^{76} + B_{75}x^{75} + \dots + B_2x^2 + B_1x + B_0$ (625/50 system).

Polynomial of full code:

$ID_0x^{94} + ID_1x^{93} + B_{84}x^{92} + B_{83}x^{91} + \dots + B_1x^9 + B_0x^8 + K_7x^7 + K_6x^6 + \dots + K_2x^2 + K_1x + K_0$ (525/60 system);

$$ID_0X^{85} + ID_1X^{84} + B_{75}X^{83} + B_{72}X^{82} + \dots + B_1X^9 + B_0X^8 + K_7X^7 + K_6X^6 + \dots + K_2X^2 + K_1X + K_0 \text{ (625/50 system).}$$

e) Randomization: All data and error correction check characters are randomized before being channel coded. The randomization is equivalent to randomization as defined in 6.3.3 f).

6.3.5 Sector preamble

All sectors are preceded by a preamble consisting of a clock run-up sequence, sync pattern (2 bytes), identification pattern (2 bytes), and fill pattern (4 bytes). The clock run-up sequence varies in length depending on the sector. The remaining elements of the preamble have the same format for all sectors. When a sector is edited, the appropriate preamble, including the run-up sequence, shall be recorded.

6.3.5.1 Track preamble (T)

The track preamble precedes the first sector of every track. The total length of the track preamble is 58 bytes and contains 50 bytes of run-up pattern $2C_h$ which is followed by two bytes of sync pattern, two bytes of identification pattern, and four bytes of fill pattern 00_h .

LSB				MSB			
0	0	1	1	0	1	0	0

a) Arrangement: See figure 18 (a).

b) Total length: 58 bytes.

c) Run-up pattern: $2C_h$.

d) Sync pattern: See 6.3.2.

e) Identification pattern: See 6.3.3.

f) Fill pattern: 00_h .

g) Protection: None.

h) Randomization: Only the identification pattern and fill pattern are randomized before being channel coded. The randomization is equivalent to randomization as defined in 6.3.3 f).

6.3.5.2 In-track preamble (E)

An in-track preamble precedes every sector except the first sector of a track. The total length is 28 bytes long and contains 20 bytes of run-up pattern $2C_h$ followed by two bytes of sync pattern, two bytes of identification pattern, and four bytes of fill pattern 00_h .

a) Arrangement: See figure 18 (b).

b) Total length: 28 bytes.

c) Run-up pattern: $2C_h$.

LSB				MSB			
0	0	1	1	0	1	0	0

d) Sync pattern: See 6.3.2.

e) Identification pattern: Refer to figures 13 and 14.

f) Fill pattern: 00_h .

g) Protection: None.

h) Randomization: Only the identification pattern and fill pattern are randomized before being channel coded. The randomization is equivalent to randomization as defined in 6.3.3 f).

6.3.6 Sector postamble (P)

All sectors are followed by a postamble. The total length is four bytes and contains two bytes of sync pattern and two bytes of identification pattern.

a) Arrangement: See figure 18c.

b) Total length: 4 bytes.

c) Sync pattern: See 6.3.2.

d) Identification pattern: See 6.3.3.

e) Protection: None.

f) Randomization: Only the identification pattern is randomized before being channel coded. The randomization is equivalent to randomization as defined in 6.3.3 f).

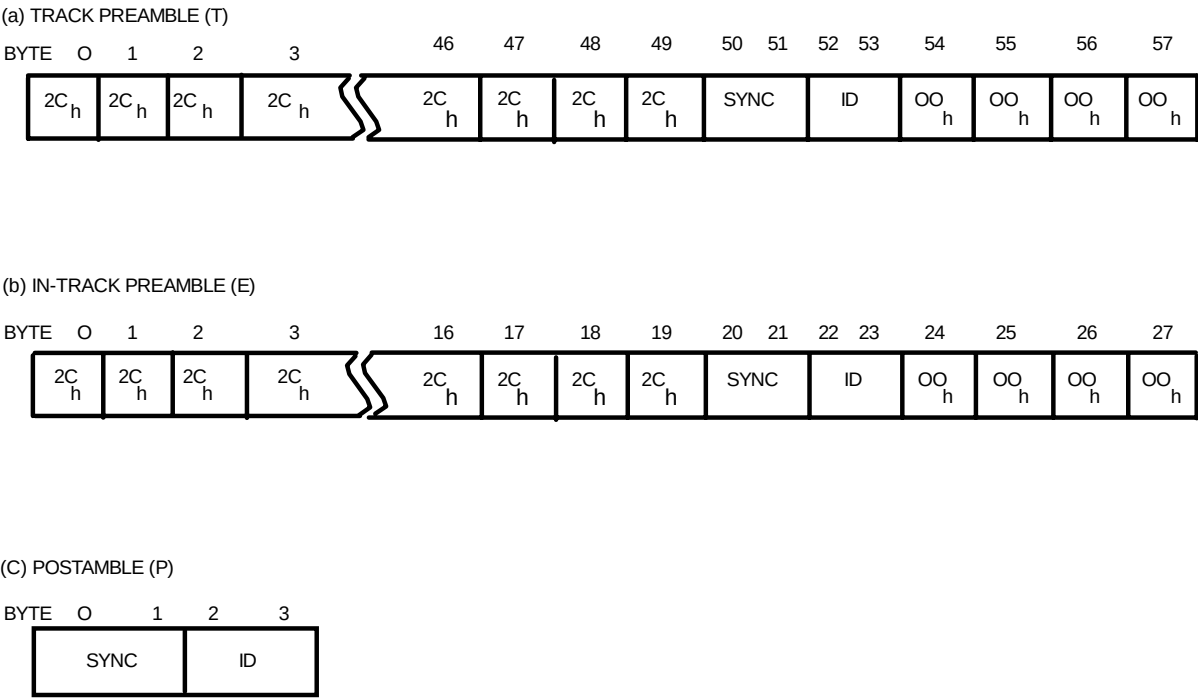


Figure 18 – Sector preamble and postamble

6.4 Edit gaps

The space between the individual sectors of a track, exclusive of preamble and postamble, is nominally 167 bytes long in the 525/60 system and 144 bytes long in the 625/50 system.

The edit gap is used to accommodate timing errors during editing. In an original recording, the edit gap shall contain the pattern 2C_h. During an edit, the edit gap may be partially overwritten with the 2C_h code provided that the preamble and/or postamble of the adjacent unedited track sectors are not overwritten.

- a) Protection: None.
- b) Randomization: None.

6.5 Channel code

The channel code shall be an 8-14 modulation code which is defined by the following code rules:

NOTES

1 DSV is an acronym for digital sum variation and indicates the integral value which is counted from the beginning of the 8-14 modulated waveform, taking high level as 1 and low level as -1.

2 CDS is an acronym for codeword digital sum and indicates the DSV of one symbol modulation code.

3 Eight-bit data entries in tables 4 and 5 are in hexadecimal notation.

Selecting the current 14-bit code, the following steps shall be taken:

- 1) Select a 14-bit code satisfying the following conditions of (A) and (B) from tables 4 and 5:
 - a) The number of consecutive identical bits at the joint portion with the preceding 14-bit code is two to seven.
 - b) The absolute value of the DSV at the end of the code (called end DSV hereafter) is equal to or less than two.

2) When two or more 14-bit codes are selected at step (1), choose a 14-bit code that gives the smallest absolute value of the end DSV.

3) When two or more 14-bit codes are still chosen in step (2), select a 14-bit code by calculating the DSV for each bit of the code (called bit DSV hereafter), determining the bit DSV the absolute value of which is minimum for each code, and choosing the code with the bit DSV whose minimum absolute value is smallest.

4) When two or more 14-bit codes are further found in step (3), select a 14-bit code by finding the maximum absolute value of the bit DSV of each code, and choosing a code with the bit DSV whose maximum absolute value is equal to or less than six.

5) When two or more codes are still found in step (4), select a 14-bit code satisfying the condition that the number of consecutive identical bits at the joint portion with the preceding 14-bit code is equal to or less than six.

6) When any codes selected in step (4) do not satisfy step (5), or two or more modulation codes satisfy step (5), select a 14-bit code satisfying the condition that the number of consecutive identical bits in that code is equal to or less than six.

7) When any codes selected at step (4) do not satisfy step (5) and step (6), or when any codes selected at step (5) do not satisfy step (6), or when two or more codes are further found at step (6), the following two steps shall be taken:

a) When the end DSV of the code is -2 , select a code of higher priority (corresponding to a smaller number in table 6) according to table 6. Likewise, when the end DSV of the code is $+2$, select a code of higher priority (corresponding to a smaller number in table 7) according to table 7.

b) When two or more codes belonging to the equal highest priority are found in step (a), select all of them temporarily. When the end DSV is zero, select a code satisfying the last six bits except when 111111 or 000000 are in the code.

8) When any codes selected at step (4) do not satisfy steps (5), (6), and (7), or when any codes selected at step (5) do not satisfy step (6) and step (7), or when any codes selected at step (6) do not satisfy step (7), or when two or more codes are further found at step (7), select a code with the bit DSV whose maximum absolute value is smallest.

9) When two or more codes are still found at step (8), select a 14-bit code with the bit DSV whose minimum absolute value appears earliest in the bit string of the code.

10) When two or more codes are further found at step (9), select a 14-bit code whose bit will be reversed earliest after the joint portion with the preceding code.

The recorded data rate (for the scanner configuration defined in 5.6) and shortest recorded wavelength are given in table 8, provided for reference only.

6.6 Magnetization

6.6.1 Polarity

Reproduction of the tape record shall be without regard to the polarity of the recorded flux on the helical tracks.

6.6.2 Recorded equalization

The record head current applied to a head should generate a constant magnetic flux level within a gap from the lowest recorded frequency (i.e., approximately one-third the Nyquist frequency) to the Nyquist frequency.

6.6.3 Record level

The level of the record head current applied to a head with a gap should be optimized for best reproduced signal-to-noise ratio at the highest constant recorded frequency (i.e., the Nyquist frequency of the channel). Other methods of setting the record level are permitted, providing they achieve the same results.

Table 4 – 4-18 modulation (CDS $\geq$ 0)

Class	8-bit data	Modulation codes beginning with "0"	CDS	Class	8-bit data	Modulation codes beginning with "1"	CDS
1(A)	00	01111110000001	0	1(B)	00	1000001111110	0
	01	01111100110000	0		01	1000011001111	0
	02	01111100011000	0		02	1000001110011	0
	03	01111100001100	0		03	1000001111001	0
	04	01111100000110	0		04	1000001111100	0
	05	01111100000011	0		05	10000011111100	0
	06	01111001110000	0		06	10000110001111	0
	07	01111001100001	0		07	10000110011110	0
	08	01111000111000	0		08	10000111000111	0
	09	01111000110001	0		09	10000111001110	0
	0A	01111000011100	0		0A	10000111100011	0
	0B	01111000011001	0		0B	10000111100110	0
	0C	01111000001110	0		0C	10000111110001	0
	0D	01111000000111	0		0D	10000111111000	0
	0E	01110011110000	0		0E	10001100001111	0
	0F	01110011100001	0		0F	10001100011110	0
	10	01110011001100	0		10	10001100110011	0
	11	01110011000110	0		11	10001100111001	0
	12	01110011000011	0		12	10001100111100	0
	13	01110001111000	0		13	10001110000111	0
	14	01110001110001	0		14	10001110001110	0
	15	01110001100110	0		15	10001110011001	0
	16	01110001100011	0		16	10001110011100	0
	17	01110000111100	0		17	10001111000011	0
	18	01110000111001	0		18	10001111000110	0
	19	01110000110011	0		19	10001111001100	0
	1A	01110000011110	0		1A	10001111100001	0
	1B	01110000001111	0		1B	10001111110000	0
	1C	01100111110000	0		1C	10011000001111	0
	1D	01100111100001	0		1D	10011000011110	0
	1E	01100111001100	0		1E	10011000110011	0
	1F	01100111000110	0		1F	10011000111001	0
	20	01100111000011	0		20	10011000111100	0
	21	01100110011100	0		21	10011001100011	0
	22	01100110011001	0		22	10011001100110	0
	23	01100110001110	0		23	10011001110001	0
	24	01100110000111	0		24	10011001111000	0
	25	01100011111000	0		25	10011100000111	0
	26	01100011110001	0		26	10011100001110	0
	27	01100011100110	0		27	10011100011001	0
	28	01100011100011	0		28	10011100011100	0
	29	01100011001110	0		29	10011100110001	0
	2A	01100011000111	0		2A	10011100111000	0
	2B	01100001111100	0		2B	10011110000011	0
	2C	01100001111001	0		2C	10011110000110	0
	2D	01100001110011	0		2D	10011110001100	0
	2E	01100001100111	0		2E	10011110011000	0
	2F	01100000111110	0		2F	10011111000001	0
	30	01100000011111	0		30	10011111100000	0
	31	01111111001100	4		31	10000011111110	2
	32	01111111000110	4		32	10000110011111	2
	33	01111111000011	4		33	10000111001111	2
	34	01111111001100	4		34	10000111100111	2
	35	011111110011001	4		35	10000111110011	2
	36	011111110001110	4		36	10000111111001	2
	37	011111110000111	4		37	10000111111100	2
	38	011111001111100	4		38	10001100011111	2

(continued)