

for Television Digital Recording — 12.65-mm Type D-9 Component Format — Video Compression — 525/60 and 625/50



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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 that form the helical records on 12.65-mm tape in cassettes. In addition, it specifies the content, format, and recording method of the longitudinal record containing tracking information for the scanning head associated with the helical records, cue audio, and control tracks.

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

The video channel records and reproduces a component television signal in the 525-line system with a frame frequency of 29.97 Hz (hereafter referred to as the 525/60 system) and the 625-line system with a frame frequency of 25 Hz (hereafter referred to as the 625/50 system).

Intraframe bit-rate reduction is applied to video data prior to recording.

2 Normative references

The following standards, 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.

SMPTE 12M-1999, Television, Audio and Film — Time and Control Code

ITU-R BT.470-7 (02/05), Conventional Analogue Television Systems

ITU-R BT.471-1 (07/86), Nomenclature and Description of Colour Bar Signals

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

3 Acronyms

AAUX	Audio auxiliary data
AP1	Audio application ID
AP2	Video application ID
AP3	Subcode application ID
APT	Track application ID
Arb	Arbitrary
AS	AAUX source pack
ASC	AAUX source control pack
B/W	Black-and-white flag
CGMS	Copy generation management system
DBN	DIF block number
DCT	Discrete cosine transform
DIF	Digital interface
DSF	DIF sequence flag
ECC	Error correction code
EFC	Emphasis channel flag
EOB	End of block
IDP	ID parity
ITI	Initial track information
LF	Locked mode flag
OM	Overwrite margin
QNO	Quantization number
QU	Quantization
Res	Reserved for future use (default value shall be set to 1)
SMP	Sampling frequency
SSA	Start sync area
SSYB	Subcode sync block number
STA	Status of the compressed macro block
Syb (SYB)	Sync block number
TF	Transmitting flag
TIA	Track information area
Trp	Track pair number
VAUX	Video auxiliary data
VLC	Variable length coding
VS	VAUX source pack
VSC	VAUX source control pack
VSM	Vibrating sample magnetometer

4 Environment and test conditions

4.1 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°C ± 1°C
Relative humidity:	(50 ± 2) %
Barometric pressure:	86 kPa to 106 kPa

Tape conditioning:	Not less than 24 h
Tape tension:	0.3 N to 0.45 N (measured at the entrance of the drum)

4.2 Reference tape

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

4.3 Calibration tape

The calibration tapes meeting the requirements of 4.3.1 and clause 5 should be available from manufacturers who produce digital tape recorders and players in accordance with this standard.

4.3.1 Record locations and dimensions

Tolerances shown in table 1 will be reduced by 50%.

4.3.2 Calibration signals

Video, audio, and cue channels shall be recorded on the calibration tape:

Video:	100/0/100/0 color bars
Audio and cue:	1 kHz tone at 20 dB below full scale

5 Video tape

Window and label areas shall be as specified in figures 2 and 3 .

5.1 Base

The base material shall be polyester or its equivalent.

5.2 Width

The tape width shall be $12.650 \text{ mm} \pm 0.010 \text{ mm}$.

5.3 Width fluctuation

Width fluctuation of the video tape shall be less than $6 \text{ }\mu\text{m}$.

5.4 Reference edge straightness

Maximum deviation of the reference edge straightness shall be $6 \text{ }\mu\text{m}$ peak to peak. Edge straightness fluctuation is measured at the edge of a moving tape positioned by three guides all having contact on the same edge of the tape. The distance between guides is 85 mm from the first to second guide, and 85 mm from the second to third guide. Edge measurements are averaged over a 10-mm length of tape. Measurements are made at a point 5 mm in the direction toward the first guide from the midpoint between the first and second guides.

5.5 Tape thickness

The tape thickness shall be $14.4 \text{ }\mu\text{m} \pm 0.5 \text{ }\mu\text{m}$ or $12.4 \text{ }\mu\text{m} \pm 0.4 \text{ }\mu\text{m}$.

5.6 Transmissivity

Transmissivity shall be less than 1.2%, measured over the range of wavelengths 800 nm to 1000 nm.

5.7 Yield strength

The yield strength shall be 18 N or more by the following test method: Fix one end of a sample tape with a length of 200 mm and pull the other end at a speed of 100 mm per minute. The yield strength is the force at which 5% elongation is observed.

5.8 Magnetic coating

The magnetic layer of the tape shall consist of a coating of metal particles or equivalent, and the coercivity shall be class 1800 (approximately 1800 Oe / 143,000 A/m) with an applied field of 800,000 A/m (10,000 Oe) as measured by a vibrating sample magnetometer (VSM).

6 Helical recording — Physical characteristics

6.1 Tape speed

The tape speed shall be 57.737 mm/s for the 525/60 system and 57.795 mm/s for the 625/50 system. The tolerance is $\pm 0.5\%$.

6.2 Sectors

Each recorded track contains ITI sectors, audio sectors, video sectors, and subcode sectors.

6.3 Record location and dimensions

6.3.1 Location and dimensions of recorded tracks

Record location and dimensions for continuous recording shall be as specified in figure 1 and table 1. In recording, sector locations on each helical track shall be contained within the tolerance specified in figure 2 and tables 2 and 3. Sector locations are derived from clause 7, figure 5, and the total length of the helical track (L).

The reference edge of the tape and dimensions specified in this standard shall be the lower edge as shown in figure 1. The magnetic coating, with the direction of tape travel as shown in figure 1, is on the side facing the observer.

6.3.2 Erasure

Full erasure is necessary prior to recording. In addition, flying erasure is also required in insert editing.

6.3.3 Track pitch

As indicated in figure 1, the pitch between helical track pairs shall be 40 μm , with a guard band of a nominal 6 μm between track pairs. Track pairs consist of two nominally equal width tracks.

6.4 Helical track record tolerance zones

The lower edges of the upper heads of any two consecutive track pairs shall be contained within the pattern of the two tolerance zones defined in figure 2. Each zone is defined by two parallel lines which are inclined at an angle of 5.95892° with respect to the tape reference edge. The centerlines of all zones shall be spaced in accordance with figure 2. These zones are established to contain track angle errors and track straightness errors, and maintain vertical head offset tolerance.

6.5 Relative positions of recorded information

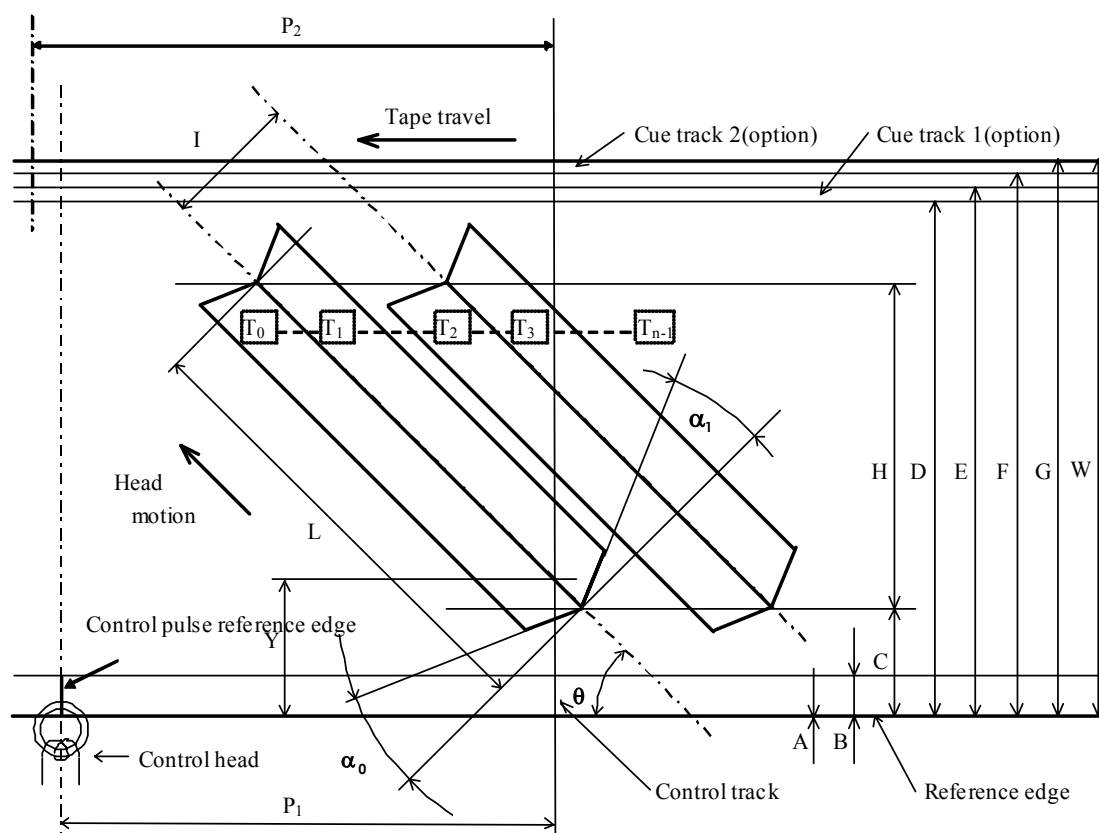
6.5.1 Relative positions of longitudinal tracks

Audio, video, control track, and cue track with information intended to be time coincident shall be positioned as shown in figures 1 and 3. Specifications in figures 1 and 2 are defined in tables 1 and 2.

6.5.2 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 distance Y from the reference edge and the lower leading edge of the odd track (see figure 1).

The relationship between the reference point and the program track data is specified in clause 7.



NOTE – Numbers of tracks in a frame = 10 for 525/60 system, 12 for 625/50 system

Figure 1 – Location and dimensions of recorded tracks

Table 1 – Record location and dimensions

Dimensions			Nominal		Tolerance
			525/60	625/50	
A	Control track lower edge	mm	0	←	Basic
B	Control track upper edge	mm	0.750	←	± 0.050
C	Program area lower edge	mm	1.710	←	Derived
D	Cue track 1 lower edge	mm	11.650	←	± 0.050
E	Cue track 1 upper edge	mm	12.000	←	± 0.050
F	Cue track 2 lower edge	mm	12.300	←	± 0.050
G	Cue track 2 upper edge	mm	12.650	←	See note
H	Program area width	mm	9.244	9.253	Derived
I	Helical track pair pitch	mm	0.040	←	Reference
L	Helical track total length	mm	89.039	89.128	Derived
P ₁	Position of control track record	mm	166.797	166.132	± 0.050
P ₂	Position of cue audio track record	mm	167.350	168.150	± 0.050
Y	Program area reference	mm	1.780	←	± 0.010
W	Tape width	mm	12.650	←	± 0.010
V	Tape speed	mm/s	57.737	57.795	± 0.5%
θ	Track angle	°	5.95892	←	Basic
α_0	Azimuth angle (Even track)	°	14.976	←	± 0.150
α_1	Azimuth angle (Odd track)	°	-15.024	←	± 0.150

Note – Cue track 2 upper edge = to upper edge of tape.

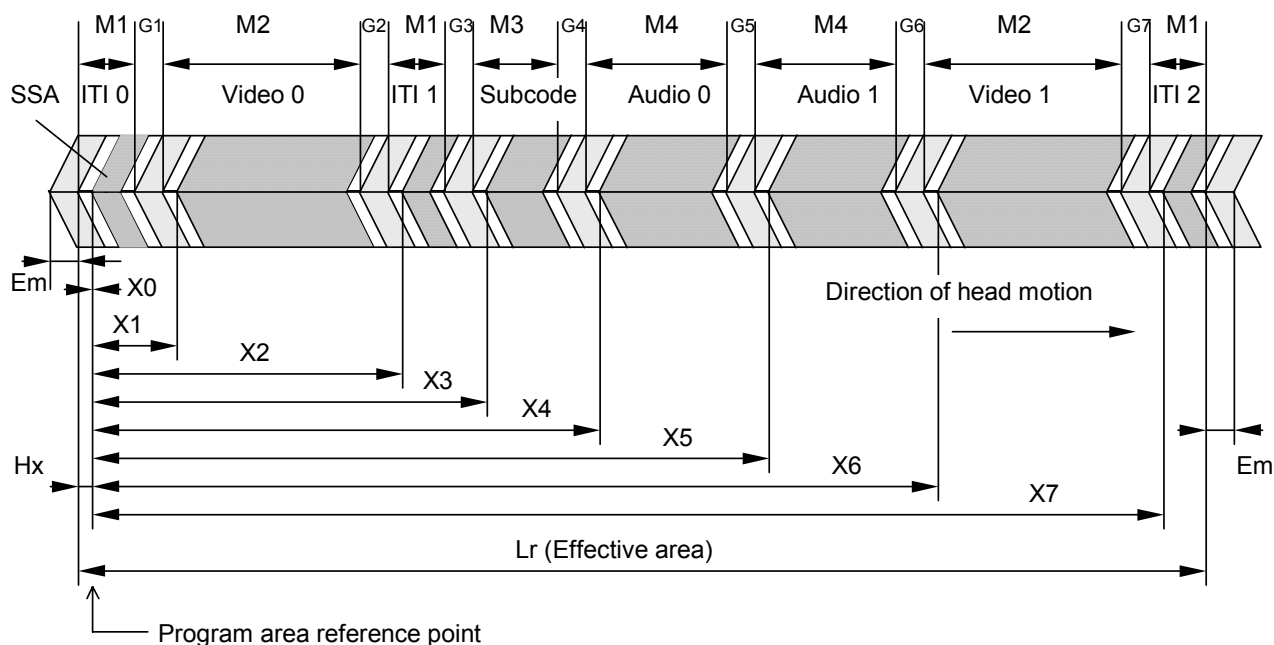


Figure 2 – Sector location from program area reference point

Table 2 – Sector location from program area reference point (525/60 system)

		Dimensions in millimeters	
Dimensions		Nominal	Tolerance
Em	Length of overwrite margin	0.264	—
Hx	Length of ITI pre-amble	1.057	± 0.005
X0	Beginning of SSA	0	—
X1	Beginning of video 0 sync block	2.247	± 0.061
X2	Beginning of SSA of ITI 1	37.325	± 0.237
X3	Beginning of subcode sync block	39.571	± 0.248
X4	Beginning of audio 0 sync block	41.891	± 0.259
X5	Beginning of audio 1 sync block	47.089	± 0.285
X6	Beginning of video 1 sync block	52.316	± 0.312
X7	Beginning of SSA of ITI 2	87.453	± 0.487
M1	Length of ITI sector	1.057	± 0.005
M2	Length of video sector	33.683	± 0.168
M3	Length of subcode sector	1.087	± 0.005
M4	Length of audio sector	3.950	± 0.020

Table 3 – Sector location from program area reference point (625/50 system)

		Dimensions in millimeters	
Dimensions		Nominal	Tolerance
Em	Length of overwrite margin	0.265	—
Hx	Length of ITI pre-amble	1.058	± 0.005
X0	Beginning of SSA	0	—
X1	Beginning of video 0 sync block	2.249	± 0.061
X2	Beginning of SSA of ITI 1	37.362	± 0.237
X3	Beginning of subcode sync block	39.611	± 0.248
X4	Beginning of audio 0 sync block	41.933	± 0.260
X5	Beginning of audio 1 sync block	47.136	± 0.286
X6	Beginning of video 1 sync block	52.369	± 0.312
X7	Beginning of SSA of ITI 2	87.541	± 0.488
M1	Length of ITI sector	1.058	± 0.005
M2	Length of video sector	33.717	± 0.169
M3	Length of subcode sector	1.088	± 0.005
M4	Length of audio sector	3.954	± 0.020

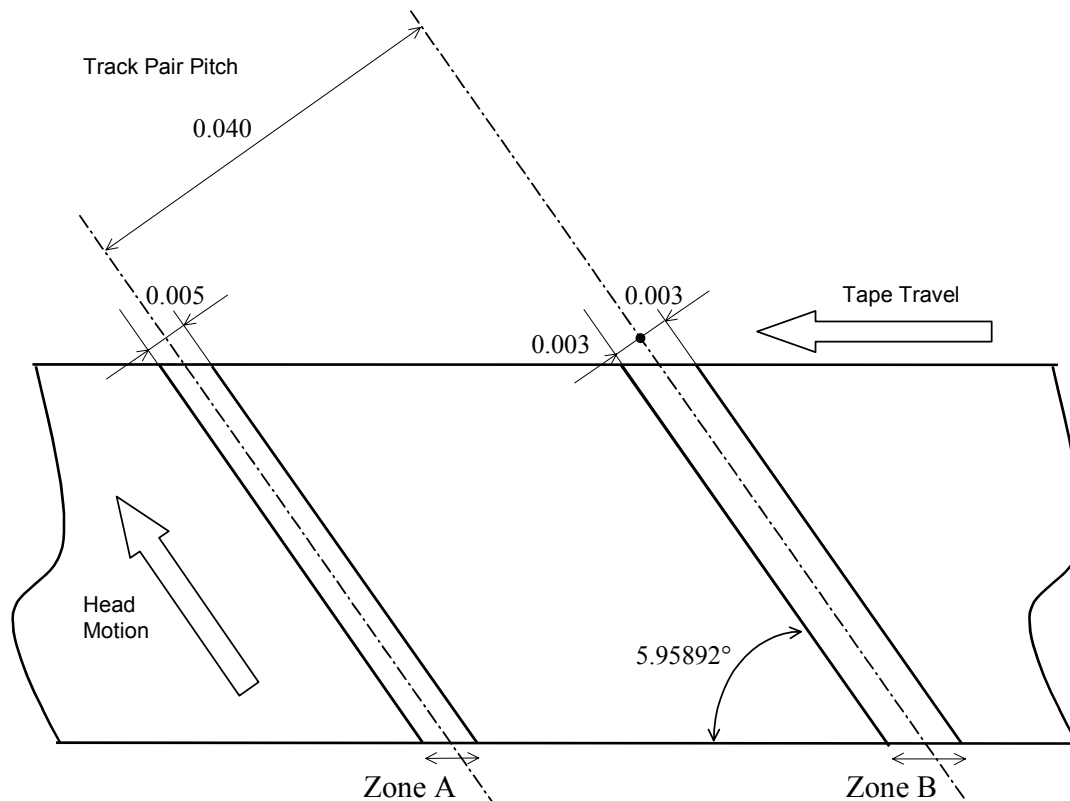


Figure 3 – Location and dimensions of tolerance zone of helical track record

6.6 Gap azimuth

6.6.1 Cue and control track

The azimuth angle of the cue and control track head gaps used to produce longitudinal track recordings shall be perpendicular to the track recording direction.

6.6.2 Helical track

The azimuth of the head gap used for the helical track shall be inclined at angles α_0 and α_1 as specified in table 1, with respect to a line perpendicular to the helical track. The azimuth of the even track of every frame shall be oriented in the clockwise direction with respect to a line perpendicular to the helical track direction when viewed from the face of the tape with a magnetic coating.

6.7 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. A possible configuration of the transport uses a scanner with an effective diameter of 62.00 mm. Scanner rotation is in the same direction as tape motion during normal playback mode. Data are recorded by two groups of heads mounted 180° apart. Figure 4 shows a possible mechanical configuration of the scanner. Table 4 shows the corresponding mechanical parameters. Other mechanical configurations are allowable provided the same footprint of recorded information is produced on the tape.

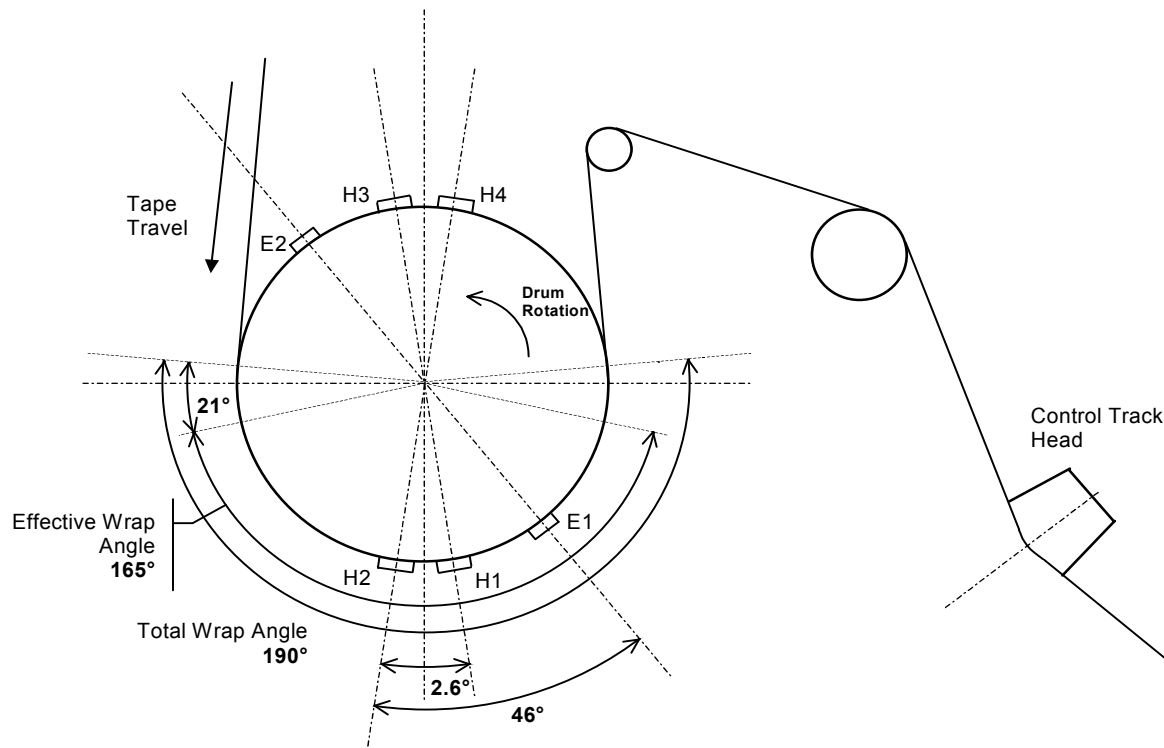


Figure 4a – Overhead view

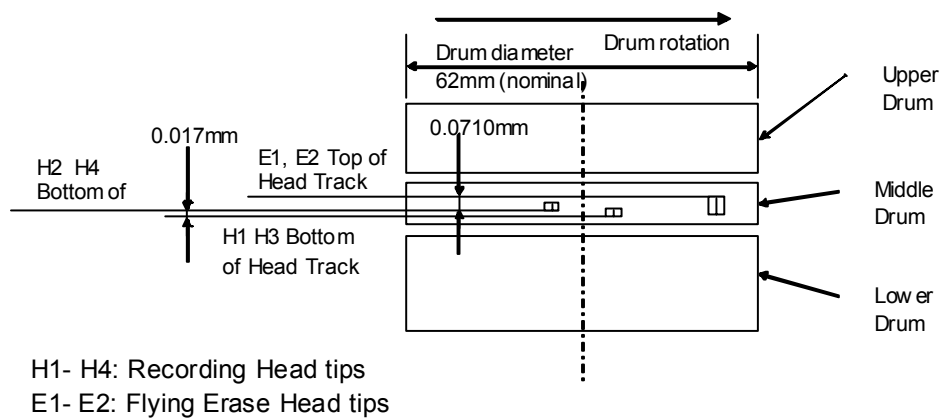


Figure 4b – Side view

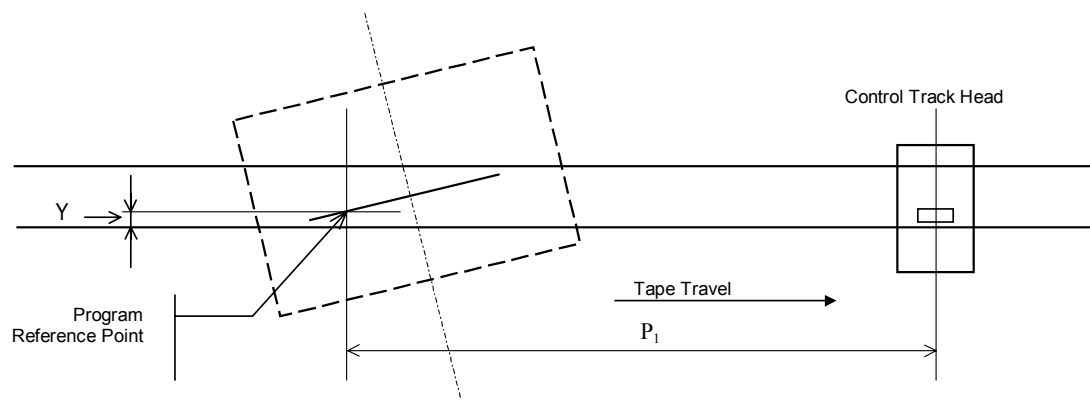


Figure 4c – Side view with control track head

Figure 4 – Possible scanner configuration (525/60 and 625/50 system)

Table 4 – Possible scanner design parameters (525/60 and 625/50 system)

Dimensions		525/60 system	625/50 system
D	Scanner diameter	62.0 mm	62.0 mm
θ_s	Scanner lead angle	5.93539°	5.93539°
R_s	Scanner rotation speed	$(75 / 1.001) \text{ s}^{-1}$	75 s^{-1}
N_t	Tracks / scanner rotation	4	4
θ_e	Effective wrap angle	165.22°	165.22°
T_w	Recording head track width	$17.0 \mu\text{m}$	$17.0 \mu\text{m}$
NOTE – The scanner rotation speed and the tape speed should be changed in proportion to the average frame frequency of the input video signal.			

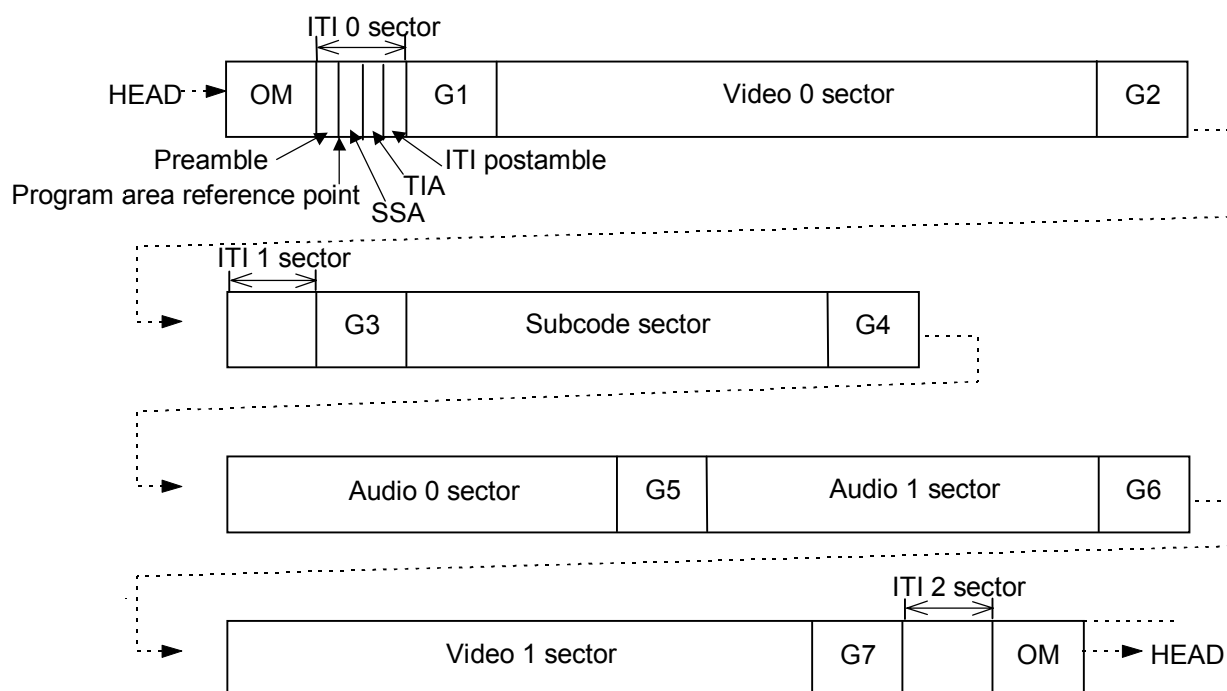
7 Helical recording — Electrical characteristics

7.1 Track contents

7.1.1 Track contents and duration

Each television frame is recorded on 10 tracks for the 525/60 system or 12 tracks for the 625/50 system. The helical tracks contain digital data of the ITI sectors, video sector, audio sector, and subcode sector. The end of the preamble and beginning of SSA in the ITI 0 sector shall be recorded at the program area reference point. The ITI sectors contain the start sync and track information. The subcode sector contains the subcode data.

Edit gaps between all sectors accommodate timing errors during editing. Figure 5 shows the arrangement of the ITI sectors, the video and audio sectors, and the subcode sector on the tape.



Sector	Bits as recorded	Bits from Program area reference point at beginning of sector
OM	900	-2,300
ITI 0	Preamble	-1,400
	SSA + TIA	0
	Postamble	1,920
Gap 1	4,150	2,200
Video 0	114,700	6,350
Gap 2	4,650	121,050
ITI 1	3,600	125,700
Gap 3	4,150	129,300
Subcode	3,700	133,450
Gap 4	4,200	137,150
Audio 0	13,450	141,350
Gap 5	4,250	154,800
Audio 1	13,450	159,050
Gap 6	4,350	172,500
Video 1	114,700	176,850
Gap 7	4,850	291,550
ITI 2	3,600	296,400
OM	900	300,000
Total	303,200	

Figure 5 – Sector arrangement on single helical track (525/60 and 625/50 systems)

7.1.2 Labeling convention

The most 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 hexadecimal value.

7.2 Signal processing

7.2.1 General

The data to be recorded on the program track shall be processed through the following operations:

- Randomization (except for sync patterns)
- Modulation (except for sync patterns and IDO)
- Precoding (except for sync patterns)

All preambles, postambles, edit gaps, overwrite margins, and ITI sectors are defined as the bit streams after those processed in this specification.

7.2.2 Randomization

Bit stream data (except for sync patterns) shall be randomized. The randomizing is equivalent to performing the exclusive-or operation between the serial data stream and the serial stream generated by the polynomial function below:

$$X^7 + X^3 + 1$$

where X^i are place-keeping variables in GF(2), the binary field. The first term is the most significant and the first to enter the division computation. Randomization limits the run length of similar binary values.

7.2.3 24-25 modulation

As shown in figure 6, bit streams of randomized data shall be processed through 24-25 modulation by adding an extra bit at the beginning of previously randomized three consecutive bytes. A total of 25 bits of data is referred to as a codeword. The extra bit shall satisfy three restrictions in a precoded bit stream as follows:

Priority 1 – Avoid duplicating the sync pattern as shown in 8.2.3.1 and 8.4.3.1.

Priority 2 – Both the run length of zeros and ones shall be less than ten. If the maximum run length is greater than nine for the extra bit = 0 and the extra bit = 1, the value of the extra bit shall be chosen to make the maximum run length shorter.

Priority 3 – If priority 2 is satisfied in a precoded bit stream, the value of the extra bit shall be chosen to make the frequency characteristics of the precoded bit stream nearer to being DC free.

7.2.4 Precoding

Precoding of the 24-25 modulated data stream shall be performed by converting it to interleaved NRZI as shown in figure 7.

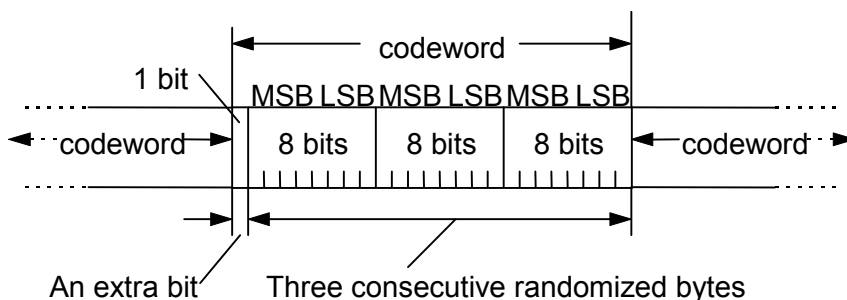


Figure 6 – Bit stream before interleaved NRZI modulation

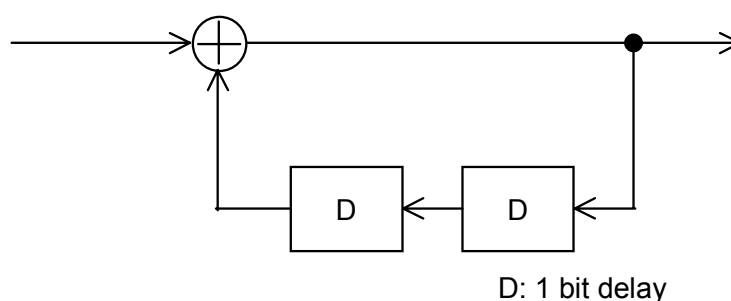


Figure 7 – Precoding

7.3 Magnetization

7.3.1 Polarity

The recorder shall reproduce signals without regard to the polarity of the recorded flux on the helical tracks.

7.3.2 Record equalization

The record current should generate a record head gap flux which is constant within ± 1 dB between 0.55 MHz and 24.75 MHz.

7.3.3 Record level

The optimum recording current that flows through either of the heads should be higher by $3 \text{ dB} \pm 1 \text{ dB}$ than the level necessary to obtain maximum signal output level at 24.75 MHz.

7.3.4 Overwrite margin

In an original recording, the overwrite margin shall be recorded with concatenations of run pattern A and run pattern B defined as follows:

– Run pattern A:

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

- Run pattern B:

MSB LSB

1 1 1 0 0 0 1 1 1 0 0 0 1 1 1 1 1 0 0 0 1 1 1 0 0 0

In overwriting whole sectors including ITI, an overwrite margin (OM) shall be recorded so as to erase old ITI 2 data.

However, the overwrite margin (OM) need not be recorded when insert editing by using the start sync area (SSA). Since the overwrite margin (OM) has no data, it need not be recorded or produced outside the effective area.

8 Program track data

8.1 ITI sector

8.1.1 Structure

The ITI sector contains the following elements:

- ITI preamble
- Start sync area (SSA)
- Track information area (TIA)
- ITI postamble

The ITI sector is not overwritten during insert editing. Figure 8 shows the structure of the ITI sector.

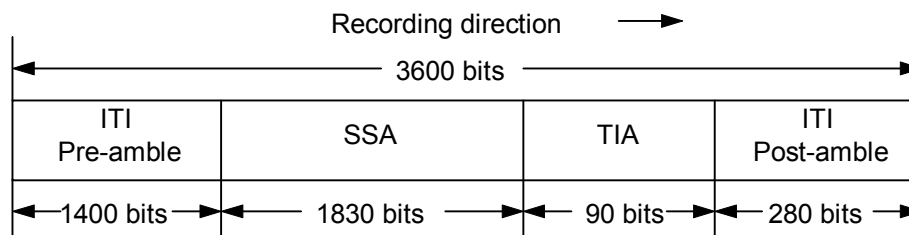


Figure 8 – Structure of ITI sector

8.1.2 ITI preamble

Codeword 1000101110 shall be recorded for 140 words as the ITI preamble.

8.1.3 SSA

The bit stream shown in table 5 shall be recorded as SSA. The bit stream shown in table 5 serves only as the sync start-up pattern and does not carry information.

8.1.4 TIA (track information area)

The bit stream specified in table 6 shall be recorded as TIA. Within each frame, the entire TIA bit stream pattern shall follow either that of table 6a or 6b (but not both).

Table 5 – Bit stream of SSA

Order of recording	Code word MSB LSB	Order of recording	Code word MSB LSB	Order of recording	Code word MSB LSB	Order of recording	Code word MSB LSB
0	0010011101	50	0101010101	100	0110101001	150	0010011101
1	0101010101	51	0010011101	101	0101011001	151	0110010101
2	0101010101	52	0101101001	102	0010011101	152	0101101001
3	0010011101	53	0101011001	103	0110101001	153	0010011101
4	0101010101	54	0010011101	104	0101101001	154	0110010101
5	0101011001	55	0101101001	105	0010011101	155	0101100101
6	0010011101	56	0101101001	106	0110101001	156	0010011101
7	0101010101	57	0010011101	107	0101100101	157	0110010101
8	0101101001	58	0101101001	108	0010011101	158	0110101001
9	0010011101	59	0101100101	109	0110101001	159	0010011101
10	0101010101	60	0010011101	110	0110101001	160	0110011101
11	0101100101	61	0101101001	111	0010011101	161	0110100101
12	0010011101	62	0110101001	112	0110101001	162	0010011101
13	0101010101	63	0010011101	113	0110100101	163	0110010101
14	0110101001	64	0101101001	114	0010011101	164	0110010101
15	0010011101	65	0110100101	115	0110101001	165	0010011101
16	0101010101	66	0010011101	116	0110010101	166	0110010101
17	0110100101	67	0101101001	117	0010011101	167	0110011001
18	0010011101	68	0110010101	118	0110101001	168	0010011101
19	0101010101	69	0010011101	119	0110011001	169	0110011001
20	0110010101	70	0101101001	120	0010011101	170	0101010101
21	0010011101	71	0110011001	121	0110100101	171	0010011101
22	0101010101	72	0010011101	122	0101010101	172	0110011001
23	0110011001	73	0101100101	123	0010011101	173	0101011001
24	0010011101	74	0101010101	124	0110100101	174	0010011101
25	0101011001	75	0010011101	125	0101011001	175	0110011001
26	0101010101	76	0101100101	126	0010011101	176	0101101001
27	0010011101	77	0101011001	127	0110100101	177	0010011101
28	0101011001	78	0010011101	128	0101101001	178	0110011001
29	0101011001	79	0101100101	129	0010011101	179	0101100101
30	0010011101	80	0101101001	130	0110100101	180	0010011101
31	0101011001	81	0010011101	131	0101100101	181	0110011001
32	0101101001	82	0101100101	132	0010011101	182	0110101001
33	0010011101	83	0101100101	133	0110100101		
34	0101011001	84	0010011101	134	0110101001		
35	0101100101	85	0101100101	135	0010011101		
36	0010011101	86	0110101001	136	0110100101		
37	0101011001	87	0010011101	137	0110100101		
38	0110101001	88	0101100101	138	0010011101		
39	0010011101	89	0110100101	139	0110100101		
40	0101011001	90	0010011101	140	0110010101		
41	0110100101	91	0101100101	141	0010011101		
42	0010011101	92	0110010101	142	0110100101		
43	0101011001	93	0010011101	143	0110011001		
44	0110010101	94	0101100101	144	0010011101		
45	0010011101	95	0110011001	145	0110010101		
46	0101011001	96	0010011101	146	0101010101		
47	0110011001	97	0110101001	147	0010011101		
48	0010011101	98	0101010101	148	0110010101		
49	0101101001	99	0010011101	149	0101011001		

Table 6 – Bit stream of TIA

Table 6a			Table 6b		
Order of recording	Code word		Order of recording	Code word	
	MSB	LSB		MSB	LSB
0	0010011101		0	0010011101	
1	0101010101		1	0101010101	
2	0110010101		2	0110011001	
3	0010011101		3	0010011101	
4	0101010101		4	0101010101	
5	0110010101		5	0110011001	
6	0010011101		6	0010011101	
7	0101010101		7	0101010101	
8	0110010101		8	0110011001	

8.1.5 ITI postamble

Codeword 1000101110 shall be recorded 28 times as the ITI postamble.

8.2 Audio sector

8.2.1 Structure

The audio sector contains the following elements:

- Audio preamble
- Audio sync block
- Audio postamble

An audio sync block contains the following elements:

- Presync block
- Data sync block
- Postsync block

Figure 9 shows the structure of an audio sector.

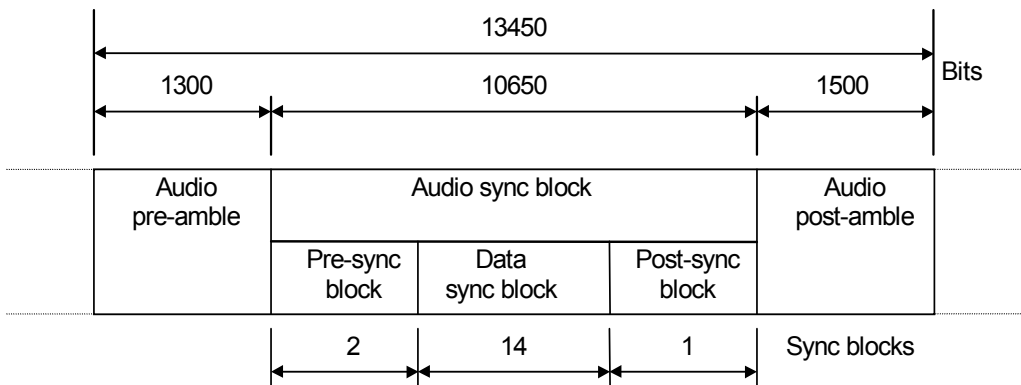


Figure 9 – Structure of audio sector after 24-25 modulation

The two types of audio preamble patterns are defined as shown below:

- MSB LSB
- 0001110001110000011100011

- MSB LSB
1 1 1 0 0 0 1 1 1 0 0 0 1 1 1 1 0 0 0 1 1 1 0 0

8.2.3 Audio sync block

An audio sync block contains 2 presync blocks followed by 14 data sync blocks, followed by one postsync block. Each sync block contains 2 sync bytes, 3 ID bytes (ID0, ID1, IDP), and/or an area that can be composed either of 85 audio data bytes or an ID2 or ID3 byte. Byte position number 5 of presync and postsync are additional ID bytes (ID2, ID3). Figure 10 shows the structure of an audio sync block.

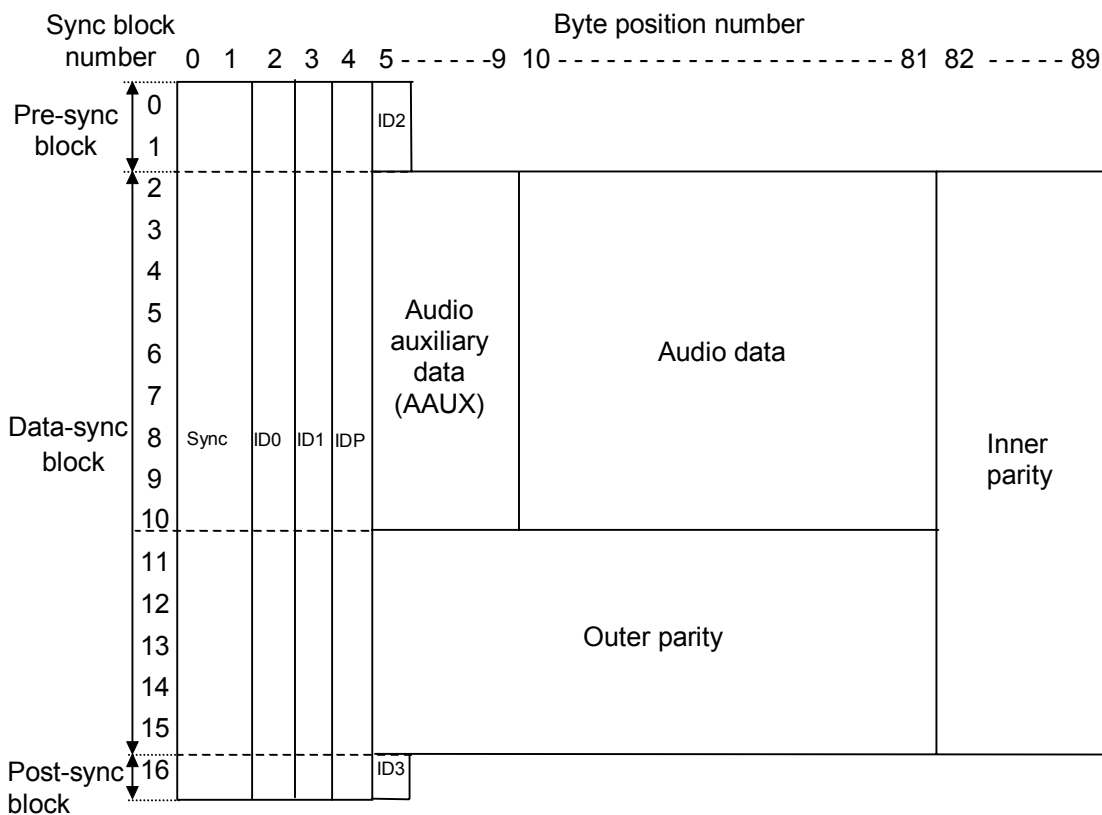


Figure 10 – Structure of sync blocks in audio sector

8.2.3.1 Sync

The two types of sync patterns after precoding are defined as follows:

	MSB	LSB
Sync pattern F :	0 0 0 1 1 1 1 1 1 1 1 1 0 0 0 1	
Sync pattern G :	1 1 1 0 0 0 0 0 0 0 0 0 1 1 1 0	

A sync pattern to be recorded shall be chosen from the above two patterns according to the priority 2 and priority 3 restrictions in 7.2.3. The length of the recorded sync shall be 17 bits.

8.2.3.2 ID

The ID sections consist of 2 ID data bytes (ID0, ID1), and 1 ID parity byte (IDP). ID data consist of application ID (AP12, AP11, AP10), sequence number (Seq3, Seq2, Seq1, Seq0), upper/lower flag (U/L), track pair number (Trp2, Trp1, Trp0), and sync block number (Syb7, Syb6, Syb5, Syb4, Syb3, Syb2, Syb1, Syb0) (see tables 7, 8, and 9).

– ID0

ID0 contains the information defined in table 10.

Table 7 – Audio application ID

Audio application ID			Format type
AP1 ₂	AP1 ₁	AP1 ₀	
0	0	0	D-9 use
0	0	1	Res
0	1	0	
0	1	1	
1	0	0	
1	0	1	
1	1	0	
1	1	1	

Table 8 – Track pair number

			Track pair number	
Trp ₂	Trp ₁	Trp ₀	525/60 system	625/50 system
0	0	0	Tracks 0 and 1	Tracks 0 and 1
0	0	1	Tracks 2 and 3	Tracks 2 and 3
0	1	0	Tracks 4 and 5	Tracks 4 and 5
0	1	1	Tracks 6 and 7	Tracks 6 and 7
1	0	0	Tracks 8 and 9	Tracks 8 and 9
1	0	1	Res	Tracks 10 and 11
1	1	0	Res	Res
1	1	1	Res	Res

Table 9 – Sequence number (525/60 and 625/50 system)

Seq ₃	Seq ₂	Seq ₁	Seq ₀	Meaning
0	0	0	0	Sequence 0
0	0	0	1	Sequence 1
0	0	1	0	Sequence 2
0	0	1	1	Sequence 3
0	1	0	0	Sequence 4
0	1	0	1	Sequence 5
0	1	1	0	Sequence 6
0	1	1	1	Sequence 7
1	0	0	0	Sequence 8
1	0	0	1	Sequence 9
1	0	1	0	Sequence 10
1	0	1	1	Sequence 11
1	1	0	0	Not used
1	1	0	1	Not used
1	1	1	0	Not used
1	1	1	1	No information

Table 10 – ID0 in audio sector

	Sync block number 0,1,11 to 16	Sync block number 2 to 10
Bit 7	AP ₁₂	Seq ₃
Bit 6	AP ₁₁	Seq ₂
Bit 5	AP ₁₀	Seq ₁
Bit 4	Seq ₀	Seq ₀
Bit 3	U/L	U/L
Bit 2	Trp ₂	Trp ₂
Bit 1	Trp ₁	Trp ₁
Bit 0	Trp ₀	Trp ₀

The track pair number shall be defined as given in table 8.

The sequence number shall be kept at the same value during one video frame and is numbered from 0 to 11 sequentially. Table 9 shows the sequence number.

– ID1

ID1 contains the sync block number defined as follows:

MSB				LSB			
Syb ₇	Syb ₆	Syb ₅	Syb ₄	Syb ₃	Syb ₂	Syb ₁	Syb ₀

Sync blocks are numbered 0 to 16 and stored in ID1 in binary notation. Sync block number = FFh means no information.

The length of ID1 shall be 8 bits before modulation.

– IDP

IDP is the parity byte of ID0 and ID1. The length of the IDP shall be 8 bits before modulation.

IDP is defined as (12, 8, 3) BCH code for which the generator polynomial is $X^4 + X + 1$. ID code is divided into two ID codewords (ID - CW0, ID - CW1) as follows:

ID – CW0: C14, C12, C10, C8, C6, C4, C2, C0, P6, P4, P2, P0

ID – CW1: C15, C13, C11, C9, C7, C5, C3, C1, P7, P5, P3, P1

The bit assignment of ID codewords is shown in table 11.

Parity bits P0 to P7 are given by the following equations:

$$\begin{aligned}
 P6 &= C14 + C10 + C6 + C4 \\
 P4 &= C14 + C12 + C8 + C4 + C2 \\
 P2 &= C14 + C12 + C10 + C6 + C2 + C0 \\
 P0 &= C12 + C8 + C6 + C0 \\
 P7 &= C15 + C11 + C7 + C5 \\
 P5 &= C15 + C13 + C9 + C5 + C3 \\
 P3 &= C15 + C13 + C11 + C7 + C3 + C1 \\
 P1 &= C13 + C9 + C7 + C1
 \end{aligned}$$

where + is the symbol of an exclusive-or.

Modulation shall be applied together with ID1, IDP, ID2, or ID3, or first audio data.

Table 11 – Bit assignment of ID code words

Byte position number		
2 ID0	3 ID1	4 IDP
C15	C7	P7
C14	C6	P6
C13	C5	P5
C12	C4	P4
C11	C3	P3
C10	C2	P2
C9	C1	P1
C8	C0	P0

8.2.3.3 Additional ID (ID2, ID3)

Byte position number 5 of presync block (ID2) shall be set to F0h before modulation. Byte position number 5 of postsync block (ID3) shall be set to FFh before modulation. Modulation shall be applied to three-byte sequences to include: ID1, IDP, ID2, and ID1, IDP, ID3.

8.2.3.4 Composed audio data

Composed audio data containing the audio data, audio auxiliary data, inner error code, and outer error code are shown in figure 10.

The length of the composed audio data shall be 85 bytes prior to 24-25 modulation. By including the last two bytes of the ID, the length of the composed audio data shall be 87 bytes, divisible into three-byte length sections for 24-25 modulation.

8.2.4 Audio postamble

Audio postamble shall be the same as the audio preamble described in 8.2.2 (except in length). The recorded length of the audio postamble shall be 1500 bits.

8.3 Video sector

8.3.1 Structure

A video sector contains the following elements:

- Video preamble
- Video sync block
- Video postamble

A video sync block contains the following elements:

- Presync block
- Data sync block
- Postsync block

Figure 11 shows the structure of the video sector.

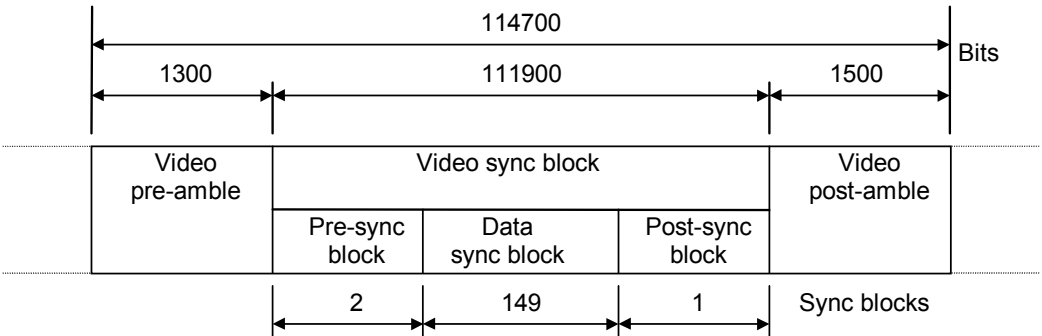


Figure 11 – Structure of video sector after 24-25 modulation

8.3.2 Video preamble

The video preamble pattern shall be the same as the audio preamble described in 8.2.2. The recorded length of the video preamble shall be 1300 bits.

8.3.3 Video sync block

The video sync block contains 2 presync blocks followed by 149 data sync blocks, followed by 1 postsync block. Each sync block contains sync of 2 bytes, ID of 3 bytes, and compressed video data of 77 bytes. Figure 12 shows the structure of a video sync block. Byte position number 5 of presync and postsync is the additional ID (ID2, ID3).

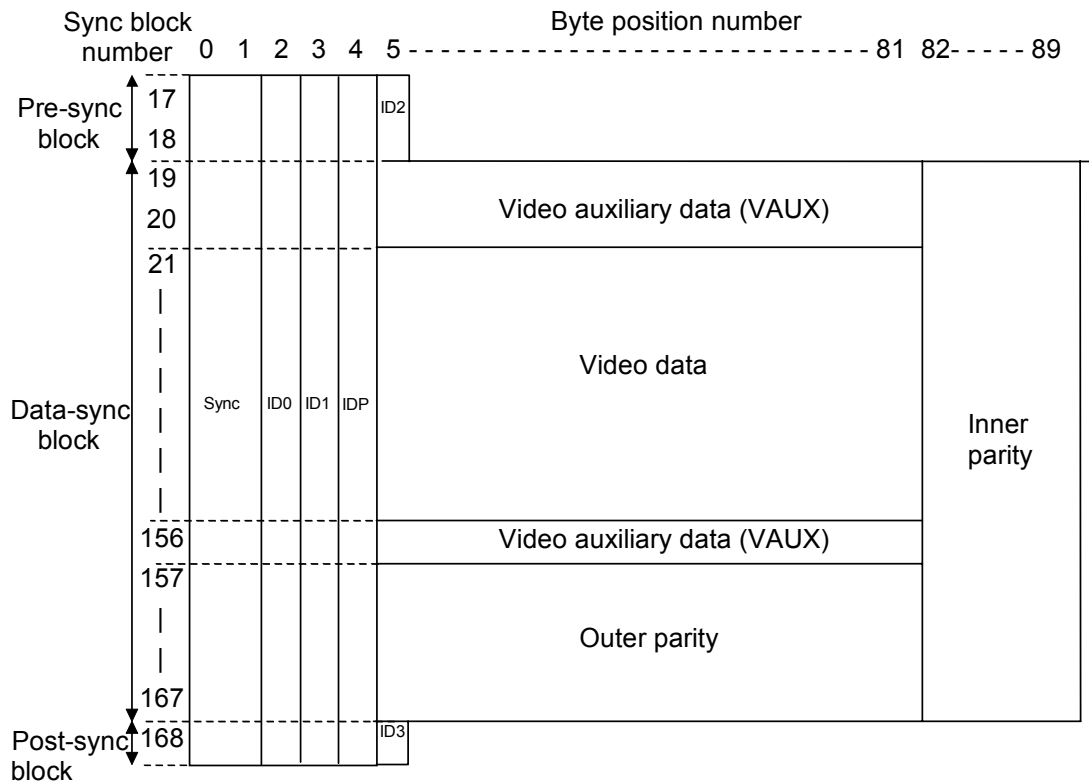


Figure 12 – Structure of sync blocks in video sector

8.3.3.1 Sync

Sync shall be the same as the audio sync described in 8.2.3.1. The recorded length of the sync shall be 17 bits.

The ID consists of 2 data bytes (ID0, ID1), and 1 ID parity byte (IDP). ID data consists of the video application ID (AP22, AP21, AP20), sequence number (Seq3, Seq2, Seq1, Seq0), track pair number (Trp3, Trp2, Trp1, Trp0), and sync block number (Syb7, Syb6, Syb5, ..., Syb0).

– ID0

ID0 contains the information defined in table 12.

The video application ID is defined in table 13. The track pair number shall be the same as in table 8. The sequence number is defined in table 9.

– ID1

ID1 contains the sync block number defined as follows:

MSB						LSB	
Syb ₇	Syb ₆	Syb ₅	Syb ₄	Syb ₃	Syb ₂	Syb ₁	Syb ₀

Sync blocks are numbered 17 to 168 and are stored in ID1 in binary notation. Sync block = FFh means no information.

– IDP

IDP shall be the same as that in 8.2.3.2.

Table 12 – ID data in video sector

Bit position	Sync block number 17 to 18 and 157 to 168		Sync block number 19 to 156	
	ID0	ID1	ID0	ID1
b7	AP2 ₂	Syb ₇	Seq ₃	Syb ₇
b6	AP2 ₁	Syb ₆	Seq ₂	Syb ₆
b5	AP2 ₀	Syb ₅	Seq ₁	Syb ₅
b4	Seq ₀	Syb ₄	Seq ₀	Syb ₄
b3	U / L	Syb ₃	U / L	Syb ₃
b2	Trp ₂	Syb ₂	Trp ₂	Syb ₂
b1	Trp ₁	Syb ₁	Trp ₁	Syb ₁
b0	Trp ₀	Syb ₀	Trp ₀	Syb ₀

Table 13 – Video application ID

Video application ID			Format type
AP2 ₂	AP2 ₁	AP2 ₀	
0	0	0	D9 use
0	0	1	Res
0	1	0	
0	1	1	
1	0	0	
1	0	1	
1	1	0	
1	1	1	

8.3.3.3 Additional ID (ID2, ID3)

Byte position number 5 of presync block (ID2) shall be set to F0_h before modulation. Byte position number 5 of postsync block (ID3) shall be set to FF_h before modulation.

8.3.3.4 Composed video data

Composed video data containing the video data, video auxiliary data, inner error code, and outer error code are shown in figure 12. The length of the composed video data shall be 85 bytes before modulation.

8.3.3.5 Video postamble

Video postamble shall be the same as the audio postamble described in 8.2.4. The recorded length of the video postamble shall be 1500 bits.

8.4 Subcode sector

8.4.1 Structure

The subcode sector contains the following elements:

- Subcode preamble
- Subcode sync block
- Subcode postamble

Figure 13 shows the structure of the subcode sector.

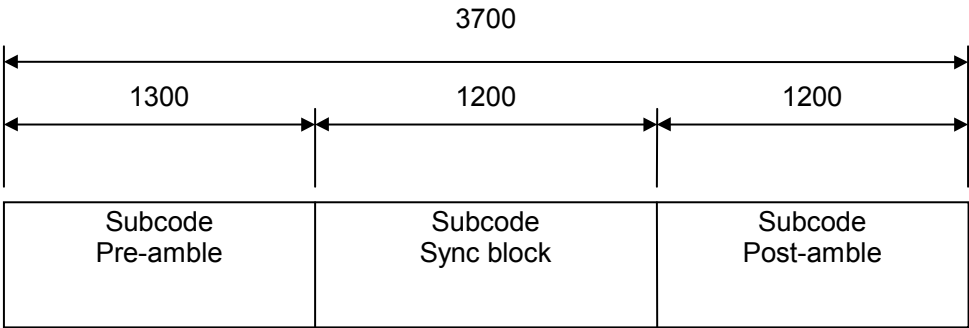


Figure 13 – Structure of subcode sector after 24-25 modulation

8.4.2 Subcode preamble

The subcode preamble pattern shall be the same as the audio preamble described in 8.2.2. The recorded length of the subcode preamble shall be 1300 bits.

8.4.3 Subcode sync block

The subcode sync block contains 12 sync blocks. Each sync block consists of a 2 byte sync word, 3 ID bytes, 5 bytes of subcode data, followed by 2 parity bytes. Figure 14 shows the structure of the subcode sync block.

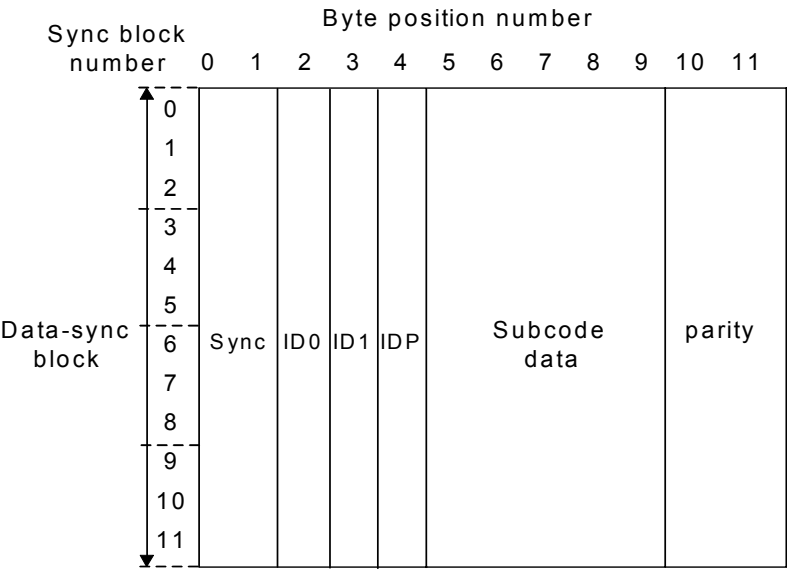


Figure 14 – Structure of sync blocks in subcode sector

8.4.3.1 Sync

The two types of sync patterns after precoding are defined as follows:

	MSB	LSB
Sync pattern D :	0 0 0 0 0 1 1 1 1 1 1 1 1 1 0 1	
Sync pattern E :	1 1 1 1 1 0 0 0 0 0 0 0 0 0 0 1 0	

A sync pattern to be recorded shall be chosen from the above two patterns according to the restrictions of priority 2 and 3 described in 7.2.3. The length of the recorded sync shall be 17 bits.

8.4.3.2 ID

The ID consists of 2 data bytes (ID0, ID1), and 1 ID parity byte (IDP). They are placed in sync block byte positions 2, 3, and 4. ID parity is the same as for the audio and video sectors. ID data consist of the subcode application ID (AP32, AP31, AP30), application ID for track (APT2, APT1, APT0), first half ID (FR ID), and sync block number (Syb3, Syb2, Syb1, Syb0).

Figure 15 shows the structure of the ID data.

Sync
block
number

	ID0								ID1							
	MSB				LSB				MSB				LSB			
0	FR	AP3 ₂	AP3 ₁	AP3 ₀	0	0	0	0	0	0	0	0	Syb ₃	Syb ₂	Syb ₁	Syb ₀
1	FR	0	0	0	0	0	0	0	0	0	0	0	Syb ₃	Syb ₂	Syb ₁	Syb ₀
2	FR	0	0	0	0	0	0	0	0	0	0	0	Syb ₃	Syb ₂	Syb ₁	Syb ₀
3	FR	0	0	0	0	0	0	0	0	0	0	0	Syb ₃	Syb ₂	Syb ₁	Syb ₀
4	FR	0	0	0	0	0	0	0	0	0	0	0	Syb ₃	Syb ₂	Syb ₁	Syb ₀
5	FR	0	0	0	0	0	0	0	0	0	0	0	Syb ₃	Syb ₂	Syb ₁	Syb ₀
6	FR	AP3 ₂	AP3 ₁	AP3 ₀	0	0	0	0	0	0	0	0	Syb ₃	Syb ₂	Syb ₁	Syb ₀
7	FR	0	0	0	0	0	0	0	0	0	0	0	Syb ₃	Syb ₂	Syb ₁	Syb ₀
8	FR	0	0	0	0	0	0	0	0	0	0	0	Syb ₃	Syb ₂	Syb ₁	Syb ₀
9	FR	0	0	0	0	0	0	0	0	0	0	0	Syb ₃	Syb ₂	Syb ₁	Syb ₀
10	FR	0	0	0	0	0	0	0	0	0	0	0	Syb ₃	Syb ₂	Syb ₁	Syb ₀
11	FR	APT ₂	APT ₁	APT ₀	0	0	0	0	0	0	0	0	Syb ₃	Syb ₂	Syb ₁	Syb ₀

Where AP3: Subcode application
 Syb: Sync block number
 APT: Application ID for track

Figure 15 – Structure of ID data

8.4.3.2.1 ID0

FR ID (first half ID)

FR ID is an identification for the first half or the second half of the video frame data:

- FR = 1: The first half of the video frame data
- FR = 0: The second half of the video frame data

AP3: Subcode application ID

The subcode application ID is defined in table 14.

APT_n: Application ID for track

APT_n shall be defined in table 15. If the signal source is unknown, all bits for these data shall be set to 1. AP1, AP2, and AP3 shall be identical with APT.

8.4.3.2.2 ID1

Sync block number (Syb): The sync blocks are numbered 0 to 11, and stored in Syb in binary notation. A sync block number = Fh means no information.

8.4.3.2.3 IDP

IDP shall be the same as in 8.2.3.2.

Table 14 – Application ID of area 3

Area 3 application ID			Format type
AP3 ₂	AP3 ₁	AP3 ₀	
0	0	0	D9 use
0	0	1	Res
0	1	0	
0	1	1	
1	0	0	
1	0	1	
1	1	0	
1	1	1	No information

Table 15 – Application ID for track

Application ID for track			Format type
APT ₂	APT ₁	APT ₀	
0	0	0	D-9 use
0	0	1	Res
0	1	0	
0	1	1	
1	0	0	
1	0	1	
1	1	0	
1	1	1	No information

8.4.4 Subcode postamble

The subcode postamble shall be the same as the audio postamble described in 8.2.4. The recorded length of the subcode postamble shall be 1200 bits.

8.5 Edit gap

The space between areas on a track, reserved for accommodation of timing errors during editing, is referred to as the edit gap. In an original recording, the edit gap records concatenations of run pattern A and run pattern B defined as follows:

- Run pattern A:

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

- Run pattern B:

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

During an edit, the edit gap may be partially rewritten with the above concatenations. The preamble and postamble of adjacent unedited areas shall not be overwritten.

The choice of a run pattern between run patterns A and B depends only on the minimization of DC constants.

9 Longitudinal tracks

9.1 Control track

9.1.1 Method of recording

The control track shall be recorded using the hysteresis (direct recording) method.

9.1.2 Flux polarity and control pulse reference edge

The polarities of the flux shall be as shown in figure 16.

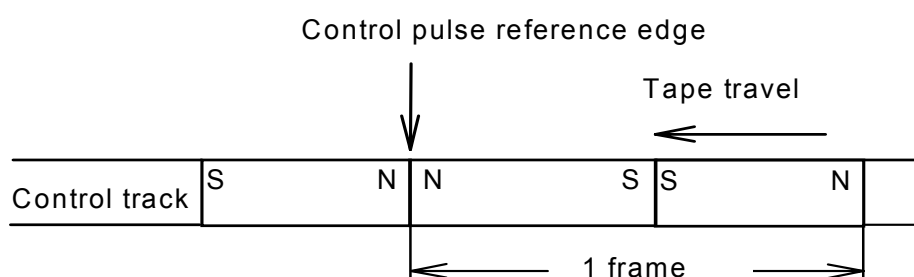


Figure 16 – Flux polarity of control track

9.1.3 Flux level

The control signal shall be recorded on the control track with sufficient current for saturation. The playback circuit shall not be impaired when the residual control signal is up to -10 dB compared with the new (overwritten) control signal, as shown in figure 17.

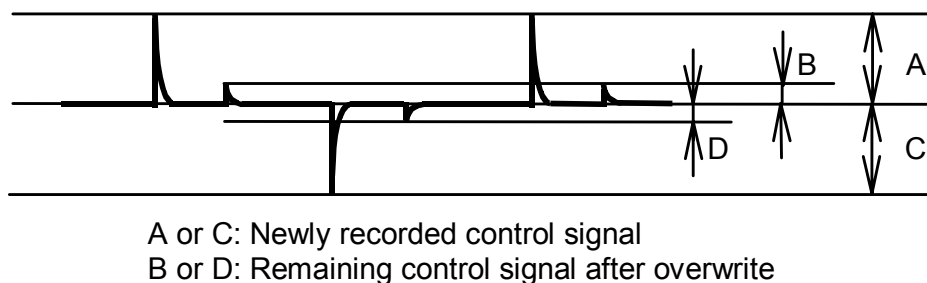


Figure 17 – Flux levels

9.1.4 Pulse width

The period of the whole cycle of the recorded pulse shall be 33.37 ms (nominal) for the 525/60 system and 40 ms (nominal) for the 625/50 system. The rise time (10%, 90%) shall be less than 200 μ s.

9.1.5 Color frame indication by nonsymmetrical duty factor

525/60 system

When color frame indication is required, the control track pulse duty factor shall be modified as indicated below:

- Color frame A – $67.5\% \pm 0.5\%$
- Color frame B – $52.5\% \pm 0.5\%$

When color frame indication is not required, the control track pulse duty factor shall be $62.5\% \pm 0.5\%$ or $57.5\% \pm 0.5\%$. A pulse with a duty factor of $20\% \pm 0.5\%$ can be used as the 0 frame pulse, indicating the last frame of a recorded cut.

625/50 system

When color frame indication is required, the control track pulse duty factor shall be modified as indicated below:

- Fields 1 and 2 – $70\% \pm 0.5\%$
- Fields 3 and 4 – $50\% \pm 0.5\%$
- Fields 5 and 6 – $65\% \pm 0.5\%$
- Fields 7 and 8 – $55\% \pm 0.5\%$

When color frame indication is not required, the control track pulse duty factor shall be $60\% \pm 0.5\%$. A pulse with a duty factor of $20\% \pm 0.5\%$ can be used as the 0 frame pulse, indicating the last frame of a recorded cut.

9.1.6 Servo reference pulse timing

The control pulse reference edge and the program area reference point shall have the relation shown in figure 1.

9.2 Cue track

9.2.1 Method of recording

The signals shall be recorded using the nonhysteresis (AC bias) method.

9.2.2 Flux level

The recorded reference audio level shall correspond to an rms magnetic short circuit flux level of 70 nWb/m (± 20 nWb/m) of track width at 1000 Hz.

9.2.3 Relative timing

Cue information shall be recorded on the tape at a point referenced to the program area reference point as defined by dimension P2 of figure 1 and table 1.

10 Audio processing

10.1 Introduction

Four channels of audio data, each of which corresponds to one video frame period, are recorded in four audio blocks respectively. Each audio block is processed identically but independently. The audio block is composed of five audio sectors in five consecutive tracks for the 525/60 system, and six audio sectors in six consecutive tracks for the 625/50 system.

Each audio sector consists of audio data, audio auxiliary data (AAUX), and inner and outer parity data as shown in figure 10. Each audio sector is processed in a product block of 77 columns by 9 rows. Audio data are shuffled prior to the addition of AAUX and after the addition of AAUX data, error correction data are added to the product block.

10.2 Encoding mode

One channel of audio signal shall be recorded in an audio block with a sampling frequency of 48 kHz. The encoded data are expressed by twos complement representation with 16 linear bits.

10.2.1 Emphasis

Audio encoding is carried out with linear frequency characteristics or with first-order preemphasis of 50/15 μ s.

NOTE – For analog-input recording, emphasis should be off in the default state.

10.2.2 Audio error code

In audio encoded data, 8000_h shall be assigned as the error code to indicate an invalid audio sample. This code corresponds to negative full-scale value in ordinary twos complement representation. When the encoded data includes 8000_h, 8000_h shall be converted to 8001_h.

10.2.3 Sample to data-byte conversion

Samples of 16 bits are defined as D_n (n = 0, 1, 2, ...) and are shuffled by each D_n unit. The 16 bit encoded data are divided into two bytes as shown in figure 18.