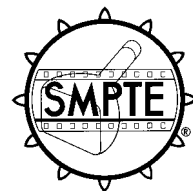


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SMPTE STANDARD

for Television Digital Recording — 19-mm Type D-6 — Content of Helical Data and Time and Control Code Records



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1 Scope

1.1 This standard specifies the content of the data blocks which form the helical records as specified in ANSI/SMPTE 277M on 19-mm tape in cassettes as specified in SMPTE 226M. Part of this standard is the specification of the time and control code record, which forms the longitudinal index track, as specified in ANSI/SMPTE 277M.

1.2 Digital video and audio data derived from various image standards are recorded with a data rate of approximately 1 Gbit/s. All image standards recorded by this format employ the identical track pattern, inner and outer block structure, and modulation code.

2 Normative references

The following standards contain provisions which, through reference in this text, constitute provisions of this standard. At the time of publication, the editions indicated were valid. 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.

ANSI S4.40-1992, Digital Audio Engineering — Serial Transmission Format for Two-Channel Linearly Represented Digital Audio Data (AES-3)

ANSI/SMPTE 12M-1995, Television, Audio and Film — Time and Control Code

ANSI/SMPTE 277M-1996, Television Digital Recording — 19-mm Type D-6 — Helical Data, Longitudinal Index, Cue and Control Records

3 Helical record content

3.1 Recorded data

Eight tracks form a cluster. Each cluster is divided into 3 sectors as shown in figure 1. The A and C sectors contain audio data, and the B sectors contain the video data.

Each segment starts with the B sector, followed by the C sector of the same cluster, and ends with the A sector of the next recorded cluster as shown in figure 2. The segment counting cycle starts with cluster 0 which is identified by the program reference point (see ANSI/SMPTE 277M).

One data field as defined in ANSI/SMPTE 277M is the minimum edit distance for video and audio. The data field is formed by a group of segments. The number of segments per data field is a parameter depending on the recorded video standard as defined in table 1. For a video standard with 30 frames/s, the arrangement for video and audio data within one data field is shown in figure 3.

Video data are distributed over the 8 tracks of a cluster as shown in table 2. The audio data are recorded twice and placed at the beginning and at the end of each track. Before recording, all data are submitted to a modulation code.

3.2 Track structure

All recorded blocks along a slant track have the same size regardless of content. The basic structure of a track is shown in figure 4.

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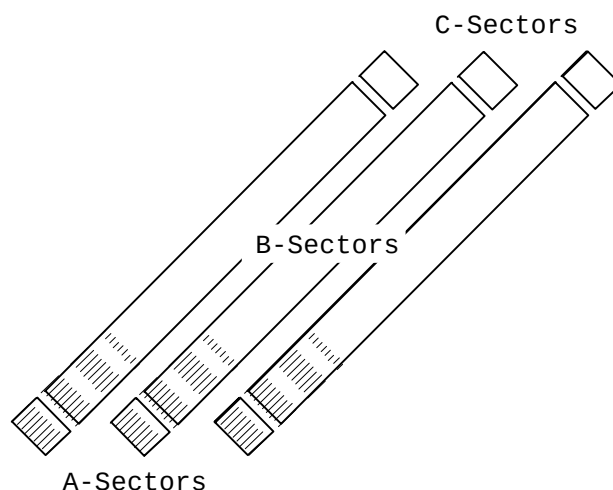


Figure 1 – Sector arrangement for all video standards

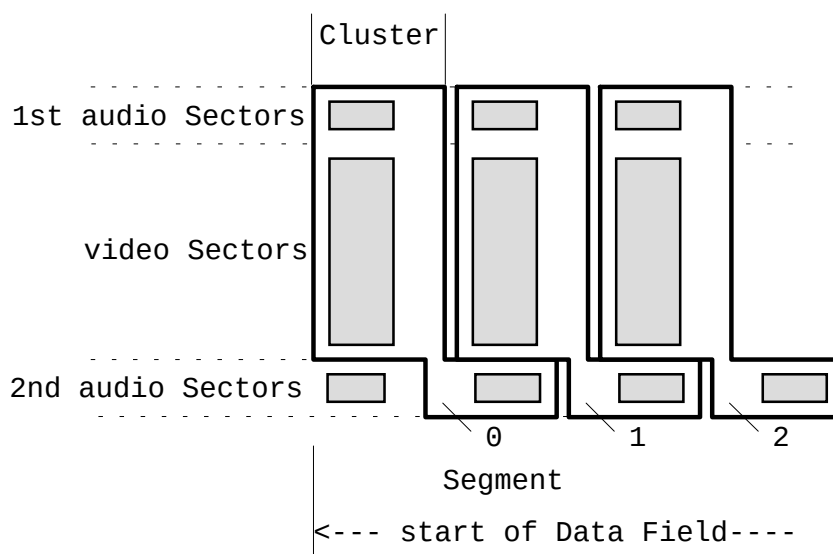


Figure 2 – Segment numbering

Table 1 – Number of segments per data field as parameter of the video standard

No. of active samples/line	No. of active lines/frame	Frames/s	Data fields/frame	Segments/data field SDF
1920	1035	30 ¹⁾	2	5
1920	1080	30 ¹⁾	2	5
1920	1152	25	2	6
1920	1080	24	2	6
1280	720	60	1	5

¹⁾ All figures in the table related to 30 frames/s are valid as well for a possible recording based on 29.97 frames/s, if not otherwise specified.

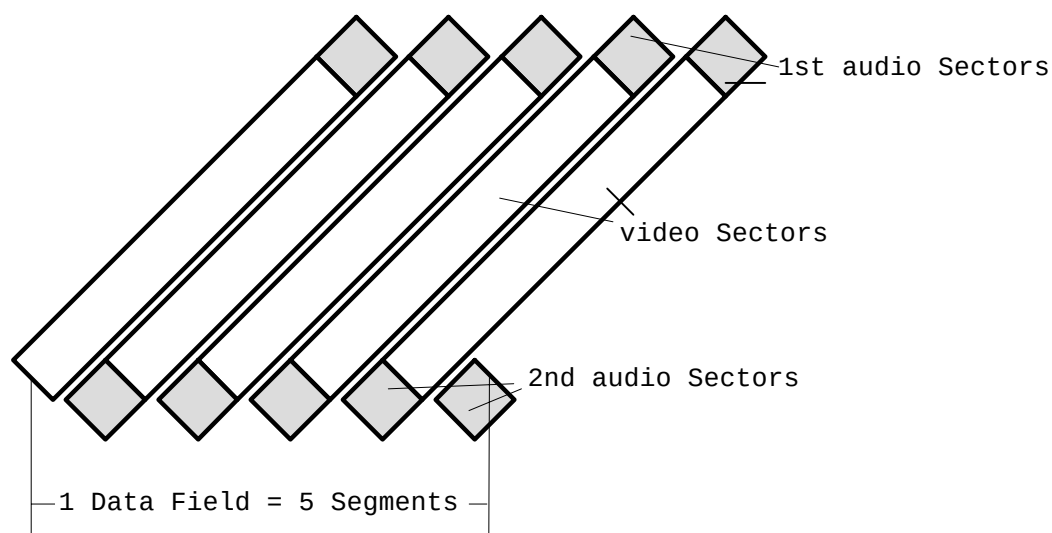


Figure 3 – Location of video and audio for television standards based on 30 frames/s

**Table 2 – Distribution of video data within a cluster
(numbering of tracks as shown in ANSI/SMPTE 277M)**

Track 0	Luminance
Track 1	Chrominance
Track 2	Luminance
Track 3	Chrominance
Track 4	Luminance
Track 5	Chrominance
Track 6	Luminance
Track 7	Chrominance

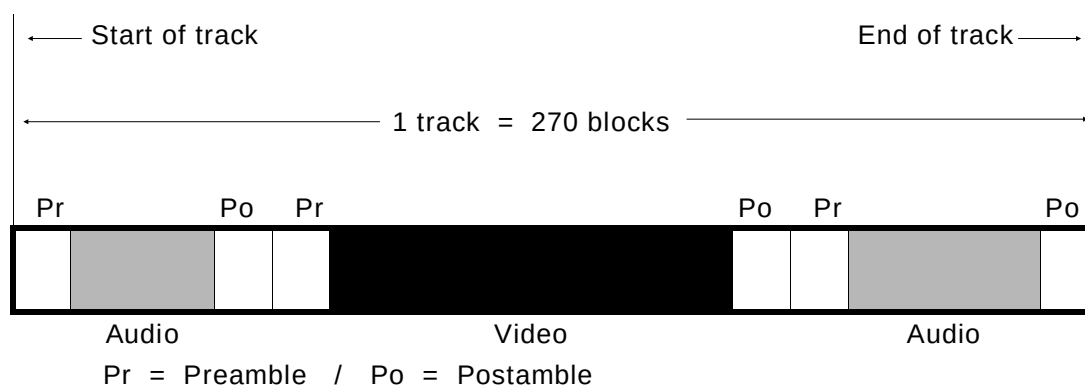


Figure 4 – Track structure

The first and second records of audio are identified by the identification bytes ID 1 and ID 2 (see SMPTE 277M). The numbering of ID 1 along the track and the associated state of bit 0 of byte ID 2 is shown in figure 5. The definition for the remaining seven bits of identification byte ID 2 is given in table 3.

3.3 Synchronization pattern (SYNC)

Each block starts with a synchronization pattern. The SYNC is not subject to channel modulation and is 24 bits on tape. This is equivalent to the length of two data bytes before 8–12 channel modulation (see figure 6). Their task is to synchronize the channel decoder as well as to control word and block synchronization. There are two synchronization patterns. The selection depends on the last modulation bit (numbered '-1' in figure 6).

3.4 Inner error correction

The error correction system is based on a Reed-Solomon product code formed by inner and outer codes. The outer error correction is described in 4.4 and 5.4.

The inner code blocks contain the RData bytes and the preceding block identification (ID), both protected by 16 check bytes (see figure 7).

3.4.1 Check bytes

Parameters:

- field generator polynomial: $x^8 + x^4 + x^3 + x^2 + 1$
- code generator polynomial: $(x+1)(x+a)(x+a^2)(x+a^3)(x+a^4)(x+a^5)(x+a^6)(x+a^7)(x+a^8)(x+a^9)(x+a^{10})(x+a^{11})(x+a^{12})(x+a^{13})(x+a^{14})(x+a^{15})$, where $a = 02_h$ in GF(256)

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

See annex A for examples of check byte patterns.

3.5 Randomization sequences

The randomization of data bytes is based on a randomization table as described in clause 7 of SMPTE 277M. Eight randomizing sequences are used. These sequences are created by using eight different (row/column) addresses for the start of the sequence within that randomization table. The start

address will be determined by bits 0, 1, and 2 of the identification byte ID1 (see table 4).

4 Video and data processing

4.1 Processing structure

The block diagrams of the record and playback data processing are shown in figures 8 and 9.

4.2 Intertrack shuffling

The pixels of each video line are distributed equally over all 8 tracks of a cluster. A distribution cycle repeats every eight luminance pixels and eight chrominance pixels. The sequence of tracks within a cycle is varied from line to line and is dependent on the data field number. An example of a distribution cycle is given in figure 10.

4.2.1 Program for track distribution

```
For DFIELD = 0 to 3
  For RLINE = 0 to MAXRLINE
    For PIXEL = 0 to MAXPIXEL
      Track = 2 * ( ( P0 + (PIXEL MOD 4) ) MOD 4 )
              + CHROMA
    Next PIXEL
  Next RLINE
Next DFIELD
```

4.2.2 Input parameters

CHROMA: = 0 for Y signal, = 1 for Cr/Cb signal

RLINE: Number of recorded line ($0 \leq \text{RLINE} \leq \text{MAXRLINE}$)

PIXEL: Sample number within a line ($0 \leq \text{PIXEL} \leq \text{MAXPIXEL}$)

DFIELD: Number of data field ($0 \leq \text{DFIELD} \leq 3$)

The relationship of recorded lines (RLINE) to video lines at the video interface is given in table 5.

4.2.3 Auxiliary parameters

The cyclic counting of the data fields is synchronized by the two data field pulse doublet of the control track as described in 9.2.8 of SMPTE 277M. The television standard dependent parameters MAXRLINE and MAXPIXEL are given in table 6. The auxiliary parameter P0 is given in table 7.

Block number			ID 1	bit 0 of ID 2
270	Postamble		85h	1
269	Audio		84h	1
268			83h	1
267			82h	1
266			81h	1
265			80h	1
264	Preamble		7Fh	1
263	Postamble		FEh	0
262	Video		FDh	0
261			FCh	0
260			FBh	0
.			.	.
.			.	.
11			02h	0
10			01h	0
9			00h	0
8	Preamble		FFh	0
7	Postamble		05h	1
6	Audio		04h	1
5			03h	1
4			02h	1
3			01h	1
2			00h	1
1	Preamble		FFh	1

Figure 5 – IDs within one track

Table 3 – Definition of bits 1 to 7 of identification byte ID 2

No. of active lines/frame	Frames/s	Bit 1	Bit 2	Bit 3	Bit 4	Bit 5	Bit 6	Bit 7
1035	30/29.97	1/0	1	1	0	0	0	0
1080	30/29.97	1/0	1	1	1	0	0	0
1152	25	1	0	0	1	0	0	0
1080	24	0	0	1	1	1	0	0
720	60	1	1	0	0	1	0	0

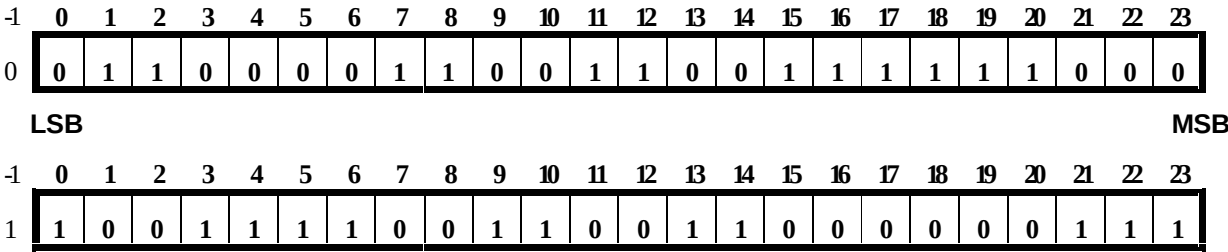


Figure 6 – Synchronization pattern

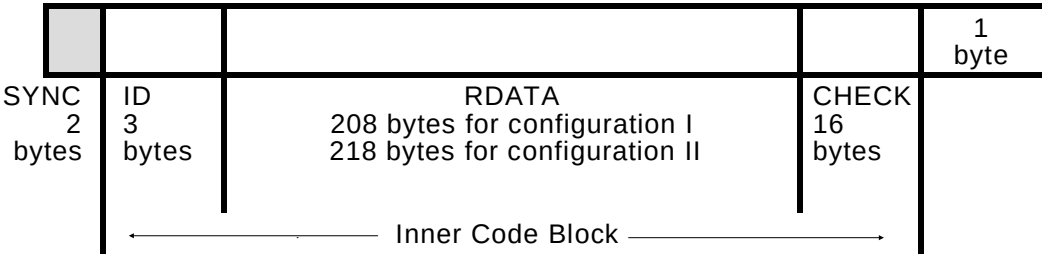


Figure 7 – Structure of the inner code block before channel modification

Table 4 – Relationship between randomizing sequences and ID1
(for row/column see clause 6 of ANSI/SMPTE 277M)

ID1 bit			Start address (row/column)
0	1	2	
0	0	0	00/0
1	0	0	D0/0
0	1	0	A0/1
1	1	0	70/2
0	0	1	40/3
1	0	1	10/4
0	1	1	E0/4
1	1	1	B0/5

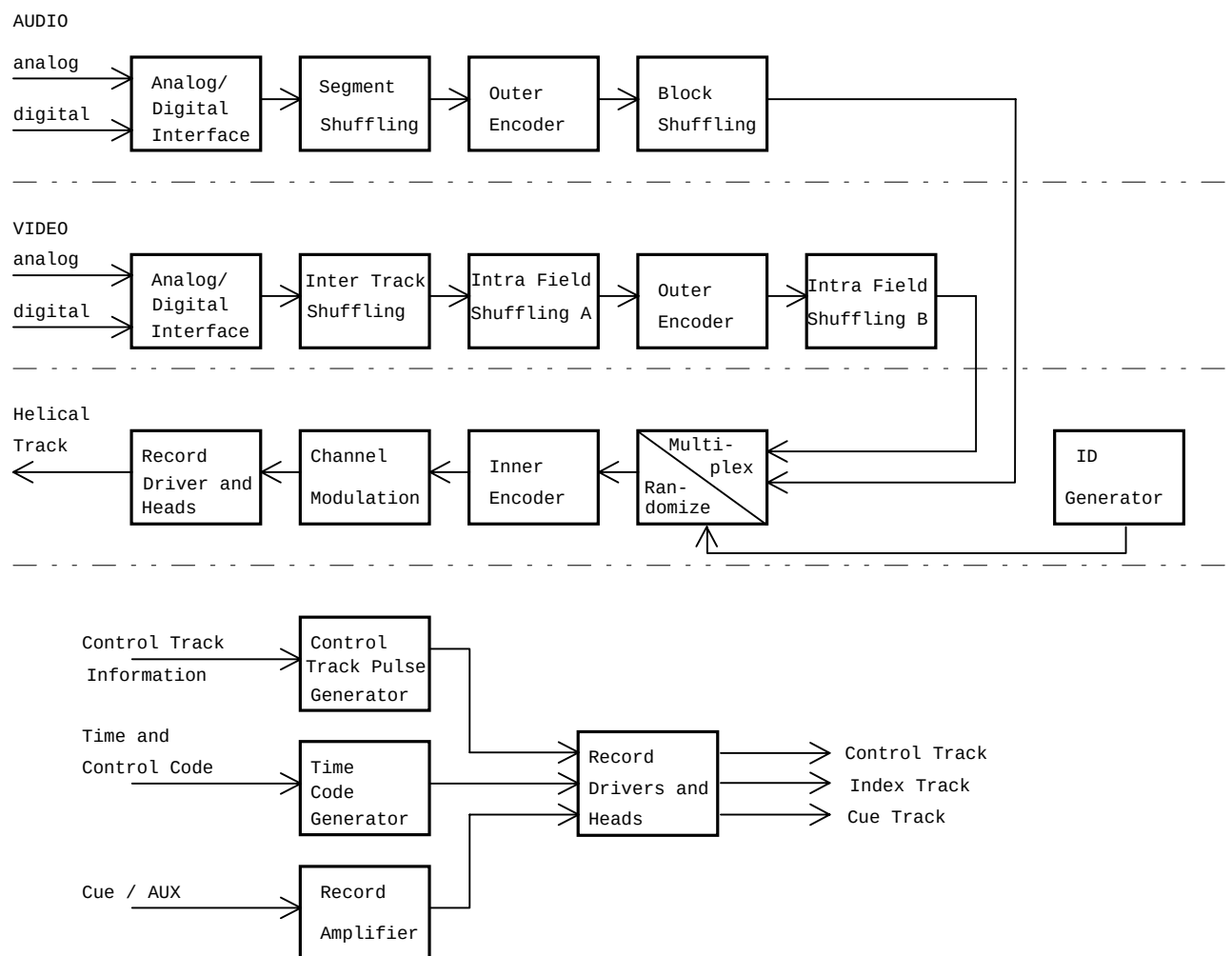


Figure 8 – Record signal processing

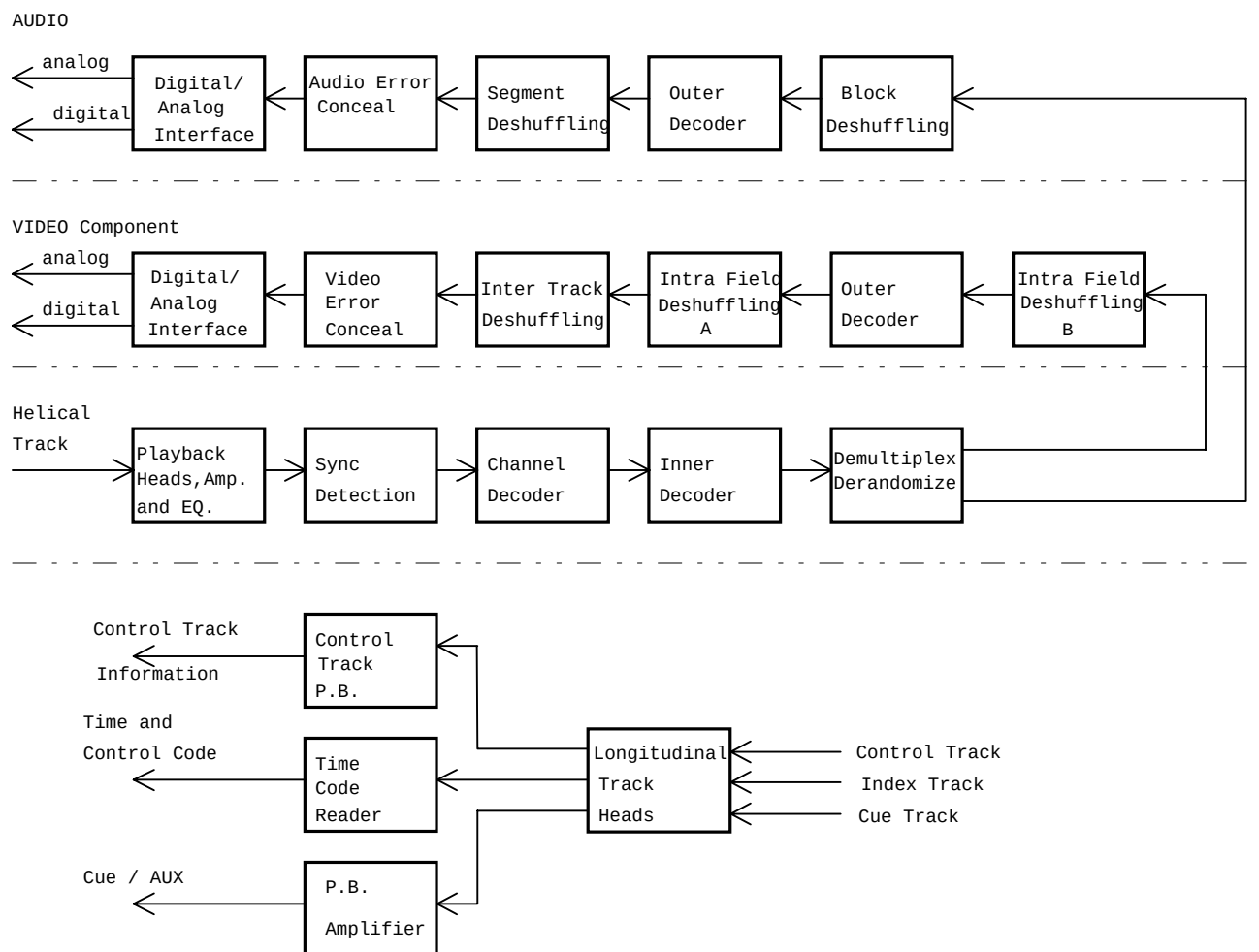


Figure 9 – Playback signal processing