SMPTE STANDARD

Time Code for High Frame Rate Signals and Formatting in the Ancillary Data Space

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Foreword

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SMPTE Engineering Documents are drafted in accordance with the rules given in its Standards Operations Manual.

SMPTE ST 12-3 was prepared by Technology Committee 32NF.

Intellectual Property

At the time of publication no notice had been received by SMPTE claiming patent rights essential to the implementation of this Engineering Document. However, attention is drawn to the possibility that some of the elements of this document may be the subject of patent rights. SMPTE shall not be held responsible for identifying any or all such patent rights.

Introduction

This section is entirely informative and does not form an integral part of this Engineering Document.

This standard forms a portion of one of the oldest SMPTE Standards for Television. SMPTE Time Code was developed originally for analog television recording systems and thus dealt only with interlaced television systems operating with frame rates up to 30 frames per second. It is, however, flexible enough in design to be used in digital television systems, either standard definition, high definition, and ultra-high definition.

The other parts of this suite of documents (SMPTE ST 12-1 and SMPTE ST 12-2) do not support time code operating at system rates higher than 60 frames per second, even though high frame rate (HFR) devices are already coming into use. This standard is intended to support such devices.

This standard defines the time code for HFR and its data structure in the ancillary data space in a way that is extensible to cover frame rates of up to 960 frames per second. To facilitate a simple approach that is consistent with existing implementations, the time address and ancillary data space formats are inherited from the existing time code standards (SMPTE ST 12-1, SMPTE ST 12-2).

1 Scope

This standard specifies time code formats with the frame counts 72, 96, 100 and 120 and the frame count 120 with drop-frame compensation. This standard also specifies a transmission format for conveyance of the time code and frame count in the ancillary data space of serial digital interfaces.

2 Conformance Notation

Normative text is text that describes elements of the design that are indispensable or contains the conformance language keywords: "shall", "should", or "may". Informative text is text that is potentially helpful to the user, but not indispensable, and can be removed, changed, or added editorially without affecting interoperability. Informative text does not contain any conformance keywords.

All text in this document is, by default, normative, except: the Introduction, any section explicitly labeled as "Informative" or individual paragraphs that start with "Note:”

The keywords "shall" and "shall not" indicate requirements strictly to be followed in order to conform to the document and from which no deviation is permitted.

The keywords, "should" and "should not" indicate that, among several possibilities, one is recommended as particularly suitable, without mentioning or excluding others; or that a certain course of action is preferred but not necessarily required; or that (in the negative form) a certain possibility or course of action is deprecated but not prohibited.

The keywords "may" and "need not" indicate courses of action permissible within the limits of the document.

The keyword “reserved” indicates a provision that is not defined at this time, shall not be used, and may be defined in the future. The keyword “forbidden” indicates “reserved” and in addition indicates that the provision will never be defined in the future.

A conformant implementation according to this document is one that includes all mandatory provisions ("shall") and, if implemented, all recommended provisions ("should") as described. A conformant implementation need not implement optional provisions ("may") and need not implement them as described.

Unless otherwise specified, the order of precedence of the types of normative information in this document shall be as follows: Normative prose shall be the authoritative definition; Tables shall be next; then formal languages; then figures; and then any other language forms.

3 Normative References

The following standards contain provisions which, through reference in this text, constitute provisions of this engineering document. At the time of publication, the editions indicated were valid. All standards are subject to revision, and parties to agreements based on this engineering document are encouraged to investigate the possibility of applying the most recent edition of the standards indicated below.

SMPTE ST 12-2:2014, Transmission of Time Code in the Ancillary Data Space

SMPTE ST 291-1:2011, Ancillary Data Packet and Space Formatting

4 Terms and Definitions

For the purposes of this document, the following terms and definitions apply.

4.1 Ancillary Time Code – ATC

Ancillary data packets carried in the Ancillary space (VANC or HANC) of a digital television data stream, as defined in SMPTE ST 12-2 and this standard, and payloads of these packets convey LTC or VITC as well as the “time code” defined in this standard.

4.2 Ancillary Time Code for High Frame Rate Time Code – ATC_HFRTC

ATC that carries high frame rate time code codewords as defined in this standard.

4.3 Binary Coded Decimal System – BCD

A means for encoding decimal numbers as groups of binary bits. Each decimal digit (0-9) is represented by a unique four-bit code. The four bits are weighted with the digit’s decimal weight multiplied by successive powers of two.

Note: For example, the bit weights for a “units” digit would be 1×2^0, 1×2^1, 1×2^2, and 1×2^3, while the bit weights for a “tens” digit would be 10×2^0, 10×2^1, 10×2^2, and 10×2^3.

4.4 Codeword

Time address, the flag bit (i.e. drop frame flag) and a binary group for user-defined data codes comprise the codeword, commonly abbreviated as simply “time code” (note that some users spell this “timecode”).

4.5 Drop Frame – DF

Fractional system rate compensated mode as defined in Section 6.4.3.

4.6 Frame

A frame is a complete image unit of a video sequence.

4.7 Mod

An abbreviated name of the modulo operator. The expression “$n \equiv k \bmod m$” would be equivalent to: ‘n’ is the remainder from the division of ‘k’ by ‘m’.

4.8 Time address

An address consisting of hours, minutes, seconds, super-frames, and frame identifier bits. It is intended as a label to identify discrete frames.

5 Overview (Informative)

This standard defines time code formats with the frame counts 72, 96, 100 and 120 and the frame count 120 with drop-frame compensation and also defines the formatting structure of the ancillary data space for the HFR time code. Implementation of a variable frame count is out of scope of this standard. These frame counts are needed to support the type of HFR equipment already in use. The ancillary data packet defined in this standard can be conveyed in serial digital interfaces or other applications, e.g., MXF (SMPTE ST 436-1). Reserved bits are assigned for possible future extended frame counts, i.e. counts greater than 120 frames up to 960 frames.

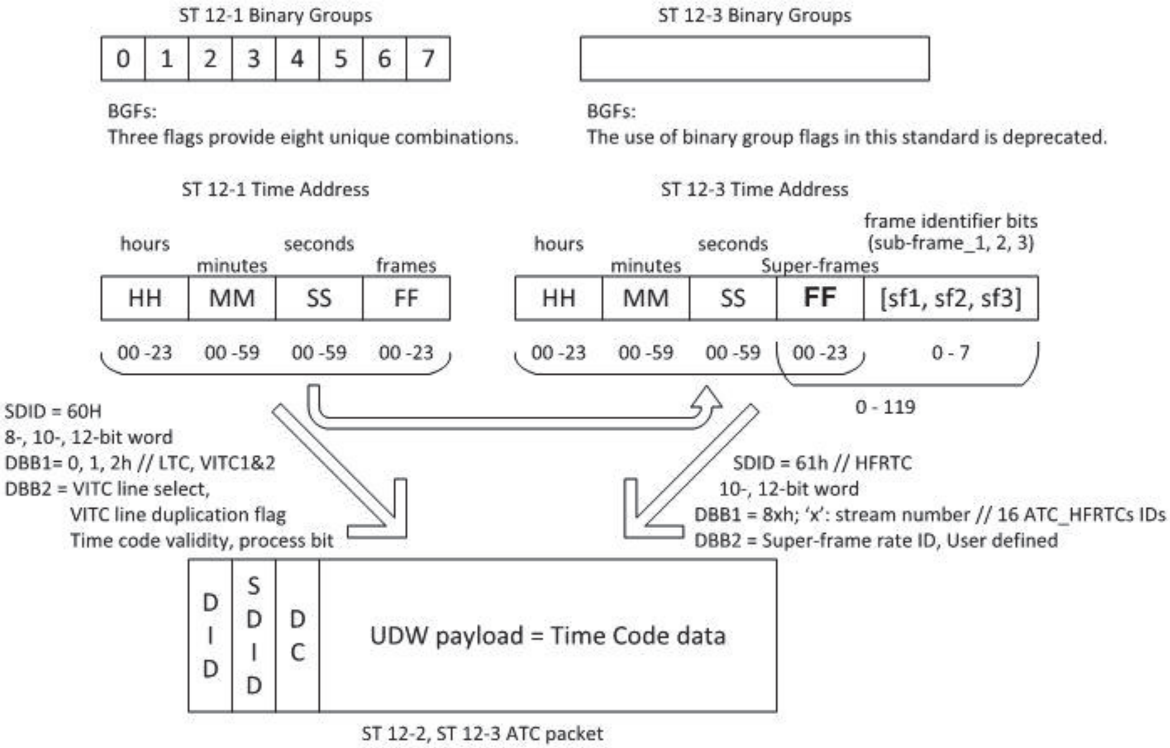

Figure 1 – Overview – e.g. 120 (24x5) frames

This figure illustrates the time code defined in SMPTE ST 12-1 and in this standard, together with an outline of the structure of the ATC packet defined in SMPTE ST 12-2. SMPTE ST 12-3 inherits the time address structure from SMPTE ST 12-1 and defines the frame identifier bits (sub-frame_1, sub-frame_2, sub-frame_3, sub-frame_4 and sub-frame_5, see Section 6.2) to extend the frame counts. Use is made of a 'super-frame' (defined Section 6.1) that comprises an integer multiple of frames at conventional (non-HFR) frame counts of 24, 25, 30 frames or 30 frames with drop-frame compensation. In SMPTE ST 12-3 the binary group flags are replaced with the frame identifier bits. These flags provide eight unique combinations which signify the use of the binary groups in SMPTE ST 12-1, whereas the use of binary group flags in this standard is deprecated.

SMPTE ST 12-3 defines three differences so as to be able to embed the HFR time code onto the ATC defined in SMPTE ST 12-2. Firstly, SDID code is defined as 61h to indicate a HFR ancillary time code packet. Secondly, DBB1 is defined as 8xh where 'x' identifies a HFR time code from up to 16 ATCs. Thirdly, DBB2 identifies the particular super-frame count associated with each HFR frame count as well as the value of N, the multiple of the super-frame count that gives the HFR frame count. Section 9.2.2 describes the details.

6 Representation of Time Address in Time Code

6.1 Super-Frame

A super-frame shall be a group of N frames such that the super-frame count is compatible with SMPTE ST 12-1 as defined in Table 1.

Table 1 – Super-frame counts

N	HFR Frame Count	Super-frame Count	Count Mode
4	120	30	Non-drop frame
4	120	30	Drop frame
4	100	25	Non-drop frame
5	120	24	Non-drop frame
4	96	24	Non-drop frame
3	72	24	Non-drop frame

Application formats can define the representation of N. Section 9.2.2 DBB2 defines the representation of N in DBB2.

6.2 Frame Identifier Bits

The frame identifier bits shall be sub-frame_1, sub-frame_2 , sub-frame_3, sub-frame_4 and sub-frame_5 as defined in Table 2. The frame identifier bits comprise the frame identifier number which identifies a count for a frame within a super-frame.

Table 2 shows the positions of the frame identifier bits within the codeword (see also Table 3 and Table 4). For comparison, it also shows how the corresponding bits are used in SMPTE ST 12-1.

Table 2 – Frame identifier bit positions

120, 120DF frames (30, 30DF x 4)	100 frames	120 frames (24 x 5)	96, 72 frames	ST 12-1 definition (informative)
11: Sub-frame_2	11: Sub-frame_2	11: Sub-frame_2	11: Sub-frame_2	Color frame flag
27: Sub-frame_1	59: Sub-frame_1	27: Sub-frame_1	27: Sub-frame_1	Field identification flag
43: Sub-frame_3*	27: Sub-frame_3*	43: Sub-frame_3	43: Sub-frame_3*	Binary group flag BGF0
58: Sub-frame_4*	58: Sub-frame_4*	58: Sub-frame_4*	58: Sub-frame_4*	Binary group flag BGF1
59: Sub-frame_5*	43: Sub-frame_5*	59: Sub-frame_5*	59: Sub-frame_5*	Binary group flag BGF2

Bits b43, b58 and b59 shall be zero in codewords for 120(30x4), 120DF(30DFx4), 96 and 72 frames.

Bits b27, b43 and b58 shall be zero in codewords for 100 frames.

Bits b58 and b59 shall be zero in codewords for 120(24x5) frames.

The combination of super-frame and the frame identifier bits identifies the frame number (see Section 6.3).

Note 1: *Sub-frame_3 (except 24x5), sub-frame_4 or sub-frame_5 are not used in this version of this standard, but are intended to enable future extension to higher frame counting beyond 120 frames and are zero.

Note 2: Sub-frame_1 is the MSB of the count of the frame identifier number, in a position consistent with the "field identification flag" of SMPTE ST 12-1. Sub-frame_n is intended to follow a cycle whose frame rate is 2^n times the super-frame rate. This structure allows a subset of the frame identifier bits to be used for a proxy time code of the original. For example, 60-frame count time code can be used as a proxy of 120 to 960 frame count time code in an off-line edit environment. Thus an edit list based on 60 frame time code is applied to any television systems operating at a system rate that is multiple of 60, i.e. 120, 180, 240… up to 960 frames per second.

6.3 Frame Number

The frame number shall be calculated as follows. The frame number shall be incremented every frame.

For the case of N = 3, 4, that is, 120, 120DF (as a multiple of 30, 30DF), 100, 96 and 72 frame time codes

$$\text{frame number} = \{10 \times (\text{Tens of super-frames}) + (\text{Units of super-frames})\} \times N + (\text{sub-frame\_1 bit} \times 1/2^1 + \text{sub-frame\_2 bit} \times 1/2^2) \times 2^2$$

For the case of N = 5, that is, 120 frame time code (as a multiple of 24)

$$\text{frame number} = \{10 \times (\text{Tens of super-frames}) + (\text{Units of super-frames})\} \times N + (\text{sub-frame\_1 bit} \times 1/2^1 + \text{sub-frame\_2 bit} \times 1/2^2 + \text{sub-frame\_3 bit} \times 1/2^3) \times 2^3$$

In 120, 120DF (as a multiple of 30, 30DF), 100, 96 and 72 frame time codes, the frame identifier bits consist of two bits: the sub-frame_1 bit and the sub-frame_2 bit. In 120 frame time code (as a multiple of 24), the frame identifier bits consists of three bits: the sub-frame_1 bit, the sub-frame_2 bit and the sub-frame_3 bit.

frame identifier number ≡ frame number mod N,

where N = (Time Code Frame Count) / (Super-frame Count)

i.e., N = 3 for 72 frame time code

N = 4 for 120, 120DF (as a multiple of 30, 30DF), 100 and 96 frame time codes

N = 5 for 120 (as a multiple of 24) time code

The frame identifier number shall be incremented as follows.

If N = 3 the frame identifier bits shall be set in accordance with the following repeating sequence of [sub-frame_1, sub-frame_2] on successive frames: is [0,0], [0,1], [1,0].

If N = 4 the frame identifier bits shall be set in accordance with the following repeating sequence of [sub-frame_1, sub-frame_2] on successive frames: [0,0], [0,1], [1,0], [1,1].

If N = 5 the frame identifier bits shall be set in accordance with the following repeating sequence of [sub-frame_1, sub-frame_2, sub-frame_3] on successive frames: [0,0,0], [0,0,1], [0,1,0], [0,1,1], [1,0,0].

6.4 Time Address with Frame Counting of 120 (30x4) and 120 with Drop-Frame Compensation

6.4.1 Time Address of a Frame

Each frame shall be identified by a complete address consisting of an hour, minute, second and frame number.

The hours, minutes, and seconds follow the ascending progression of a 24-hour clock beginning with 00 hours, 00 minutes, and 00 seconds to 23 hours, 59 minutes, and 59 seconds. The frames shall be numbered successively according to the counting mode (drop frame or non-drop frame) as defined as the “frame number” in Section 6.3.

6.4.2 Non-drop frame – Uncompensated mode

Frames shall be successively numbered 0 through 119, with no omissions.

Note: When non-drop frame time code is used in a television system operating at a frame rate multiple of 30/1.001 frames per second, monotonically counting at 30 super-frames per second will yield a deviation of approximately +3.6 seconds in one hour of elapsed time.

6.4.3 Drop frame – fractional system rate compensated mode

To minimize fractional time deviation from real time, the first two super-frame numbers (00 and 01) shall be omitted from the count at the start of each minute except minutes 00, 10, 20, 30, 40, and 50. Thus the first eight frame numbers (0 through 7) are omitted from the count at the start of each minute except minutes 00, 10, 20, 30, 40, and 50.

Note: When drop-frame compensation is applied to a fractional television time code, the total deviation accumulated after one hour is reduced to approximately –3.6 ms. The total deviation accumulated over a 24-hour period is approximately –2.6 super-frames (–86 ms).

6.5 Time Address with Frame counting of 100

Each frame shall be identified by a complete address consisting of an hour, minute, second and frame number.

The hours, minutes, and seconds follow the ascending progression of a 24-hour clock beginning with 00 hours, 00 minutes, and 00 seconds to 23 hours, 59 minutes, and 59 seconds. The frames shall be successively numbered 0 through 99 as described in Sectiion 6.3.

6.6 Time Address with Frame counting of 72, 96 and 120 (24x5)

Each frame shall be identified by a complete address consisting of an hour, minute, second and frame number.

The hours, minutes, and seconds follow the ascending progression of a 24-hour clock beginning with 00 hours, 00 minutes, and 00 seconds to 23 hours, 59 minutes, and 59 seconds. The frames shall be successively numbered 0 through 71, 95 and 119, respectively, as described in Section 6.3.

Note: Drop frame mode (which is applicable only to a multiple of 30-frame counting) is not applicable to a multiple of 24-frame counting.

7 Structure of the Time Code

7.1 Numeric Code

The numeric code consists of nine groups, eight four-bit groups containing time address and flag bits and a binary group for user-defined data.

7.2 Time Address

The basic structure of the time address is based upon the BCD system, using units and tens in digit pairs for hours, minutes, seconds, and super-frames; together with a binary representation of the frame number using the sub-frame_1 bit, the sub-frame_2 bit and the sub-frame_3 bit (if applicable) as per Section 6.3.

Decimal digit (0-2) shall be used for a "tens" digit of hours.
Decimal digit (0-9) shall be used for a "units" digit of hours.
Decimal digit (0-5) shall be used for a "tens" digit of minutes.
Decimal digit (0-9) shall be used for a "units" digit of minutes.
Decimal digit (0-5) shall be used for a "tens" digit of seconds.
Decimal digit (0-9) shall be used for a "units" digit of seconds.
Decimal digit (0-2) shall be used for a "tens" digit of super-frames.
Decimal digit (0-9) shall be used for a "units" digit of super-frames.

Thus some of the digits are limited to values that do not require all four bits to be significant. These bits are omitted from the time address and include the “80’s” and “40’s” of hours, “80’s” of minutes, “80’s” of seconds, and the “80’s” and “40’s” of super-frames. Thus the decimal digits of each time address are coded into 26 bits.

The bit positions of the time address are listed in Table 3.

Table 3 – Time address and a flag bit positions

Bit	Definition			
	120, 120DF frames (30, 30DF x 4),	100 frames	120 frames (24 x 5)	96, 72 frames
0 - 3	Units of super-frames			
8 - 9	Tens of super-frames			
10	Drop frame flag Zero: non drop frame One: drop frame	Set to zero		
11	Sub-frame_2			
16 - 19	Units of seconds			
24 - 26	Tens of seconds			
27	Sub-frame_1	Sub-frame_3*	Sub-frame_1	
32 - 35	Units of minutes			
40 - 42	Tens of minutes			
43	Sub-frame_3*	Sub-frame_5*	Sub-frame_3	Sub-frame_3*
48 - 51	Units of hours			
56 - 57	Tens of hours			
58	Sub-frame_4*			
59	Sub-frame_5*	Sub-frame_1	Sub-frame_5*	

Note: *Sub-frame_3 (except 24x5), sub-frame_4 or sub-frame_5 are not used in this version of this standard, but are intended to enable future extension to higher frame counting beyond 120 frames and are zero.

7.3 Drop frame flag

This flag shall be set to logical one when drop-frame compensation is being performed as defined in Section 6.4.3 When the count is not drop-frame compensated, this flag bit shall be set to logical zero.

The drop frame flag position is bit 10.

7.4 Use of the Binary Group

The data contained in the binary group may be defined by the users, and is out of scope for this standard.

7.5 Codeword Format

Each codeword shall consist of 64 bits numbered 0 through 63. Each codeword shall be associated with one television frame

7.6 Codeword Data Content

Each codeword shall consist of the time address, the flag bit and the binary group as listed in Table 4.

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Table 4 – Codeword bit positions

Bit	Definition		
	120, 120DF frames (30, 30DF x 4)	100 frames	120 (24 x 5), 96, 72 frames
0 - 3	Units of super-frames [1,2,4,8]		
4 - 7	Binary group		
8 - 9	Tens of super-frames [10,20]		
10	Drop frame flag	Set to zero	
11	Sub-frame_2		
12 - 15	Binary group		
16 - 19	Units of seconds [1,2,4,8]		
20 - 23	Binary group		
24 - 26	Tens of seconds [10,20,40]		
27	Sub-frame_1	Sub-frame_3*	Sub-frame_1
28 - 31	Binary group		
32 - 35	Units of minutes [1,2,4,8]		
36 - 39	Binary group		
40 - 42	Tens of minutes [10,20,40]		
43	Sub-frame_3*	Sub-frame_5*	Sub-frame_3
44 - 47	Binary group		
48 - 51	Units of hours [1,2,4,8]		
52 - 55	Binary group		
56 - 57	Tens of hours [10,20]		
58	Sub-frame_4*		
59	Sub-frame_5*	Sub-frame_1	Sub-frame_5*
60 - 63	Binary group		

Note: *Sub-frame_3 (except 24x5), sub-frame_4 or sub-frame_5 are not used in this version of this standard, but are intended to enable future extension to higher frame counting beyond 120 frames and are zero.

8 Format of Ancillary Time Code Packets

The format of Ancillary Time Code Packet shall be as defined in SMPTE ST 12-2 with the exception that the DID and SDID shall be set to:

DID 60h

SDID 61h

9 Format of User Data Words in Ancillary Time Code Packets

9.1 General

The format of User Data Words shall be as defined in SMPTE ST 12-2 with the exception of the Distributed Binary Bits and the mapping of Time Code data into Ancillary Data Packets.

9.2 Distributed Binary Bits (DBB)

DBB1 and DBB2 shall be as defined in SMPTE ST 12-2. Information coded in the DBB1 and DBB2 distributed binary bit groups are defined in Table 5 and Table 7.

9.2.1 DBB1 – Payload Type

ATC_HFRTC shall have the distributed binary bit group 1 (DBB1) value of 8xh as defined in Table 5. The bitstream number is given by the notation 'x' and is used to identify different ATC_HFRTC. The bitstream number shall have a value in the range 0h to fh and the default value of the bitstream number shall be zero.

Table 5 – DBB1 (payload type) Distributed binary bit group coding

Bit 3 of UDW	Distributed binary bit (DBB1) MSB LSB	Definition
UDW-8 through UDW-1	1 0 0 0 0 0 0 0 through 1 0 0 0 1 1 1 1	High frame rate time code (ATC_HFRTC)
	1 0 0 1 0 0 0 0 through 1 1 1 1 1 1 1 1	Reserved

9.2.2 DBB2

The assignments of DBB2 are defined in Table 7.

Bit b7 is reserved and shall be set to zero.

Bits b6 and b5 shall be used to identify the frame count of the super-frame defined in Section 6.1 and shall be set as follows:

Table 6 – Super-frame count identifier bits

b6	b5	Super-frame count
0	0	24 frames
0	1	25 frames
1	0	30 frames
1	1	reserved

Bits b4 through b0 shall be used to identify the value of 'N'.

$$N = b4 \times 2^4 + b3 \times 2^3 + b2 \times 2^2 + b1 \times 2^1 + b0 \times 2^0$$

Table 7 – DBB2 (payload type) Distributed binary bit group coding

Bit3 of UDW	Distributed binary bit (DBB2)	Definition
UDW-16	B7	Reserved
UDW-15	b6 through b5	Super-frame count as per Table 6
UDW-14		
UDW-13	b4 through b0	N as per equation above
UDW-12		
UDW-11		
UDW-10		
UDW-9		

9.3 Mapping of the Time Code Data into Ancillary Data Packets

Mapping of the time code data into the UDW 1 through UDW 16 of the ancillary time code data packet shall be as shown in Table 8.

Table 8 – Mapping of Time Code Data into UDW

ATC		Time Code Data			
UDW	Bit	Codeword bit	Time code bit definitions		
			120-frames (30 x 4)	100-frames	120 (24 x 5), 96, 72-frames
1	4	0	Units of super-frames 1		
	5	1	Units of super-frames 2		
	6	2	Units of super-frames 4		
	7	3	Units of super-frames 8		
2	4-7	4-7	Binary group		
3	4	8	Tens of super-frames 10		
	5	9	Tens of super-frames 20		
	6	10	Drop frame flag	Set to zero	
	7	11	Sub-frame_2		
4	4-7	12-15	Binary group		
5	4	16	Units of seconds 1		
	5	17	Units of seconds 2		
	6	18	Units of seconds 4		
	7	19	Units of seconds 8		
6	4-7	20-23	Binary group		
7	4	24	Tens of seconds 10		
	5	25	Tens of seconds 20		
	6	26	Tens of seconds 40		
	7	27	Sub-frame_1	Sub-frame_3*	Sub-frame_1
8	4-7	28-31	Binary group		
9	4	32	Units of minutes 1		
	5	33	Units of minutes 2		
	6	34	Units of minutes 4		
	7	35	Units of minutes 8		
10	4-7	36-39	Binary group		
11	4	40	Tens of minutes 10		
	5	41	Tens of minutes 20		
	6	42	Tens of minutes 40		
	7	43	Sub-frame_3*	Sub-frame_5*	Sub-frame_3*
12	4-7	44-47	Binary group		
13	4	48	Units of hours 1		
	5	49	Units of hours 2		
	6	50	Units of hours 4		
	7	51	Units of hours 8		
14	4-7	52-55	Binary group		
15	4	56	Tens of hours 10		
	5	57	Tens of hours 20		
	6	58	Sub-frame_4*		
	7	59	Sub-frame_5*	Sub-frame_1	Sub-frame_5*
16	4-7	60-63	Binary group		

Note : *Sub-frame_3 (except 24x5), sub-frame_4 or sub-frame_5 are not used in this version of this standard, but are intended to enable future extension to higher frame counting beyond 120 frames and are zero.

10 Transmission of Ancillary Time Code Packets

10.1 Transmission of Multiple ATC Packets

Transmissions of multiple ancillary time code packets with a different instance identification per video frame are permissible under the provisions of this standard. The bitstream number (see Section 9.2.1) is used to identify different ATC_HFRTC.

10.2 ATC Packet Transmission Rate

Transmission of ancillary time code packets with a particular instance identification shall take place once per frame.

11 Ancillary Time Code Packet Location

11.1 Permissible Insertion Locations

Insertion of ancillary time code (ATC) packets into any available location in the digital data stream is permitted under the provisions of this standard.

11.2 Preferred Locations for Placement of ATC

Preferred locations for insertion of ancillary time code (ATC) packets are video format-dependent and shall be based on the applicable standard for the format. ATC may be inserted within the available ancillary space located within vertical blanking after the vertical interval switching point and before the beginning of active video.

Annex A Bibliography (Informative)

SMPTE ST 12-1:2014, Time and Control Code

SMPTE RP 291-2:2013, Ancillary Data Space Use — 4:2:2 SDTV and HDTV Component Systems and 4:2:2 2048 ×1080 Production Image Formats

SMPTE ST 436-1:2013, MXF Mappings for VI Lines and Ancillary Data Packets