# International Telecommunication Union

# ITU-R
## Radiocommunication Sector of ITU

**Recommendation  ITU-R  BT.1366-3**
(07/2018)

# Time code format definitions and transport in the ancillary data space of a digital television interface according to Recommendations ITU-R BT.656, ITU-R BT.799, ITU-R BT.1120 and ITU-R BT.2077

**BT Series**

**Broadcasting service (television)**

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RECOMMENDATION ITU-R BT.1366-3*

# Time code format definitions and transport in the ancillary data space of a digital television interface according to Recommendations ITU-R BT.656, ITU-R BT.799, ITU-R BT.1120 and ITU-R BT.2077

(Question ITU-R 42/6)

(1998-2007-2008-2018)

## Scope

Part 1 of this Recommendation defines a time and control code for use in television, film and accompanying audio systems operating at 60, 59.94, 50, 30, 29.97, 25, 24 and 23.98 frames/s (fps). Section 5 describes the structure of the time address and control bits of the code and sets guidelines for storage of user data in the code. Defined in this Recommendation is the modulation method for LTC, and the modulation method for inserting the time code into the vertical interval of a television signal.

Part 2 of this Recommendation defines a transmission format for conveyance of linear (LTC) or vertical interval (VITC) time code data formatted according to Part 1 in 8- or 10-bit serial digital interfaces according to Recommendations ITU-R BT.656, ITU-R BT.799, ITU-R BT.1120 and ITU-R BT.2077.

Part 3 of this Recommendation specifies time code formats with the frame counts 72, 96, 100 and 120 and the frame count 120 with drop-frame compensation, commonly known as High Frame Rates (HFR). This also specifies a transmission format for conveyance of the time code and frame count in the ancillary data space of serial digital interfaces.

## Keywords

Drop Frame, Linear Tine Code (LTC), Ancillary Data, High frame Rate (HFR), Time Code, Super Frames, Binary bits, Sub Frame, Ancillary Time Code (ATC)

The ITU Radiocommunication Assembly,

*considering*

*a)* that the use of time code signals is well-established in the area of production and post-production;

*b)* that digital television production facilities based on the use of digital video components conforming to Recommendations ITU-R BT.601, ITU-R BT.709, ITU-R BT.2020 or ITU-R BT.2100 are in widespread use;

*c)* that there exists ancillary data capacity within a serial digital interface conforming to Recommendations ITU-R BT.656, ITU-R BT.799, ITU-R BT.1120 and ITU-R BT.2077 for additional ancillary data signals to be carried;

*d)* that there are operational benefits to be achieved by the multiplexing of ancillary data signals within the serial digital interface;

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\* Compliance with this Recommendation is voluntary. However, the Recommendation may contain certain mandatory provisions (to ensure e.g. interoperability or applicability) and compliance with the Recommendation is achieved when all of these mandatory provisions are met. The words "shall" or some other obligatory language such as "must" and the negative equivalents are used to express requirements. The use of such words shall in no way be construed to imply partial or total compliance with this Recommendation.

*e)*          that the operational benefits are increased if a minimum of different formats are used for ancillary data signals;

*f)*          that the exchange of programme material between and within organizations is facilitated if a common format of time code is used;

*g)*          that extension of the capacity of the time code signal to carry additional information is desirable;

*h)*          that progressive image production beyond 30 Hz frame rate requires the use of ancillary time code packets;

*i)*          that image production beyond 60 Hz frame rates requires an extended time code mapped into Ancillary Time Code (ATC) packets,

  *recommends*

**1**          that when time code is required for production and related applications for frame rates up to 60 Hz, the time code parameters defined in Part 1 of this Recommendation should be used;

**2**          that when time code ancillary data is required for production and related applications for frame rates up to 60 Hz, the ancillary data signal format described in Part 2 of this Recommendation should be used for the interfaces defined in Recommendations ITU-R BT.656, ITU-R BT.799 and ITU-R BT.1120 and ITU-R BT.2077;

**3**          that when time code and its ancillary data are required for production and related applications for frame rates greater than 60 Hz, the time code and its ancillary data signal format defined in Part 3 of this Recommendation should be used for the interfaces defined in Recommendation ITU-R BT.2077.

**Overview**

Part 1 of this Recommendation replaces Recommendation ITU-R BR.780. Part 1 of this Recommendation further updates current (2018) operational practices that, in some cases, may not support all the options originally defined in Recommendation ITU-R BR.780. In addition, support for frame rates beyond 60 Hz are defined in Part 3.

The time code signal may be required to perform different functions depending upon the application. In some applications the time code signal will be a label to identify discrete frames and may not indicate real time, or time of day. In other applications real time may be indicated, with the caveat that accuracy of the displayed time may not meet all requirements.

**Normative references**

Recommendation ITU-R BT.1700 – Conventional Television Systems.

Recommendation ITU-R BT.601 – Studio encoding parameters of digital television for standard 4:3 and wide-screen aspect ratios.

Recommendation ITU-R BT.709 – Parameter values for the HDTV standards for production and international programme exchange.

Recommendation ITU-R BT.2020 – Parameter values for ultra-high definition television systems for production and international programme exchange.

Recommendation ITU-R BT.2100 – Image parameter values for high dynamic range television for use in production and international programme exchange.

Recommendation ITU-R BT.1364 – Format of ancillary data signals carried in digital component studio interfaces.

Recommendation ITU-R BT.656 – Interface for digital component video signals in 525-line and 625-line television systems operating at the 4:2:2 level of Recommendation ITU-R BT.601.

Recommendation ITU-R BT.799 – Interface for digital component video signals in 525-line and 625-line television systems operating at the 4:4:4 level of Recommendation ITU-R BT.601.

Recommendation ITU-R BT.1120 – Digital interfaces for HDTV studio signals.

Recommendation ITU-R BT.2077 – Real-time serial digital interfaces for UHDTV signals.

**For the purpose of this Recommendation the following nomenclature applies**

*Ancillary Time Code (ATC)*

ATC refers to ancillary data packets carried in the Ancillary space (VANC or HANC) of a digital television interface, packets may convey LTC or VITC codeword data.

*Ancillary Time Code for High Frame Rate Time Code (ATC_HFRTC)*

ATC that carries high frame rate time code codewords as defined in Part 3.

*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 in some cases the term "timecode" is used).

*Linear time code (LTC)*

LTC refers to the linear time code modulation system (referred to as the longitudinal track application of time and control code).

*Vertical interval time code (VITC)*

VITC refers to the modulation system used to insert the time code signal in the vertical blanking interval of a television signal.

*Binary coded decimal (BCD)*

The binary coded decimal (BCD) system is 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. For example, the bit weights for a units digit would be $1 \times 2^0$, $1 \times 2^1$, $1 \times 2^2$ and $1 \times 2^3$, while the bit weights for a tens digit would be $10 \times 2^0$, $10 \times 2^1$, $10 \times 2^2$ and $10 \times 2^3$.

*Real time*

In a system running at an integer number of $N$ fps, exactly one second of real time elapses during the passage of $N$ frames.

*Drop frame time (DFT)*

In a television system running at a frame rate of $N/1.001$ fps, one second of time elapses during the scanning of $N$ television frames. Because of the difference in frame rates, the relationship between real time and drop frame time is:

$$1 \ sec_{DFT} = 1.001 \ sec_{REAL}$$

*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 '$m$'.

PART 1

# Time code (up to 60 Hz)

## 1 Time address representation in 30 and 30/1.001 frame systems

### 1.1 Time address of a frame

Each TV frame shall be identified by a unique and complete address consisting of an hour, minute, second and frame number. The hours, minutes, and seconds follow the ascending progression of a 24 h clock beginning with 0 h 0 min 0 s to 23 h 59 min 59 s. The frames shall be numbered successively according to the counting mode (drop frame or non-drop frame) as described in the following sections.

### 1.2 Non-drop frame

Frames numbers shall increment 0 through 29, successively.

When the non-drop frame mode is active the drop frame flag contained in the time code signal shall be set to zero.

### 1.3 Drop frame – DFT time

The field rate of an 60/1.001 television signal is 30/1.001 fps, counting at 30 ($\approx 29.97$) fps will yield an error of approximately 108 frames (3.6 s) in 1 h of true clock time (i.e. time address lags clock time). Drop frame time code, is a technique to minimize the drift between clock time and the time indicated by the time code.

To minimize the time error introduced by the 60/1.001 field rate , the first two frame numbers (00 and 01) shall be omitted from the frame count at the start of each minute except minutes 00, 10, 20, 30, 40 and 50.

When drop-frame compensation is applied to a 30/1.001 fps time code, the total error accumulated after one hour is reduced to 3.6 ms. The total error accumulated over a 24 h period is nominally plus 86 ms. (i.e. time address leads clock time).

When drop frame compensation is being performed the drop frame flag shall be set to one as specified in § 5.3.1.

### 1.4 Colour frame identification in NTSC 525/59.94 television system

When colour frame identification in the time code is required, the even units of frame numbers shall identify colour fields I and II, and the odd units of frame numbers shall identify colour fields III and IV as defined by Recommendation ITU-R BT.1700. The colour frame flag shall be set to one when the colour frame relationship to the time code is in effect.

## 2 Time address representation in 25-frame systems

### 2.1 Time address of a frame

Each frame shall be identified by a unique and complete address consisting of an hour, minute, second and frame number. The hours, minutes, and seconds follow the ascending progression of a 24 h clock beginning with 0 h 0 min 0 s to 23 h 59 min 59 s. The frames shall be numbered successively 0 through 24.

## 2.2 Colour frame identification in PAL 625/50 television systems

If identification of the eight-field colour sequence in the time code is required, the time address shall bear a predictable relationship with the eight-field colour sequence as specified in Recommendation ITU-R BT.1700. This relationship can be expressed using either logical or arithmetic notations. The colour frame flag shall be set to one when the colour frame relationship to the time code is in effect.

## 2.3 Logical relationship

Given that the frame and second numbers of the time address are expressed as BCD digit pairs, the value of the logical expression $(A|B) \wedge C \wedge D \wedge E \wedge F$ shall be:

> 1 for fields 1, 2, 3 and 4;
>
> 0 for fields 5, 6, 7 and 8.

where:

> $A$ = value of the 1's bit of the frame number;
>
> $B$ = value of the 1's bit of the second number;
>
> $C$ = value of the 2's bit of the frame number;
>
> $D$ = value of the 10's bit of the frame number;
>
> $E$ = value of the 2's bit of the second number;
>
> $F$ = value of the 10's bit of the second number;
>
> $|$ represents the logical OR operation;
>
> $\wedge$ represents the logical Exclusive OR operation.

## 2.4 Arithmetic relationship

The remainder of the quotient of the division $(S + P)/4$-

> 0 for fields 7 and 8;
>
> 1 for fields 1 and 2;
>
> 2 for fields 3 and 4;
>
> 3 for fields 5 and 6.

where:

> $S$ = decimal value of the seconds digits of the time address and
>
> $P$ = decimal value of the frames digits of the time address.

## 3 Time address representation in 24-frame systems

## 3.1 Time address of a frame

Each TV or film frame shall be identified by a unique and complete address consisting of an hour, minute, second and frame number. The hours, minutes, and seconds follow the ascending progression of a 24 h clock beginning with 0 h 0 min 0 s to 23 h 59 min 59 s. The frames shall be numbered successively 0 through 23.

## 3.2      Operation at 24/1.001 (23.98) Hz (24/1.001 Hz)

There is no drop frame mode for 24/1.001 applications. Where it is desired to maintain a correspondence with 30-frame systems during a conversion to 30 frames, the 30 non-drop frame count mode should be used. For additional details refer to Annex 2 to Part 1, § 2.

## 3.3      Operation at 24.0 Hz

For systems where the TV and film frame rate is 24.0 Hz there is no systematic drift of the time code address relative to clock time.

Where it is desired to maintain a correspondence with 25 frame systems the techniques described in Annex 2 to Part 1, § 2 mode should be used.

## 4         Time address representation in 50 and 60 frame progressive systems

## 4.1      Time address of a frame

Since the frame rate of 50/60 progressive systems exceeds the frame count capacity of the time code address, the count is constrained to increment every second frame.

Each pair of progressive frames shall be identified by a unique and complete address consisting of an hour, minute, second and frame number. Figure 1-1 shows an example of frame labelling for these systems.

FIGURE 1-1

**Example of frame labelling for 50 and 60 fps systems**
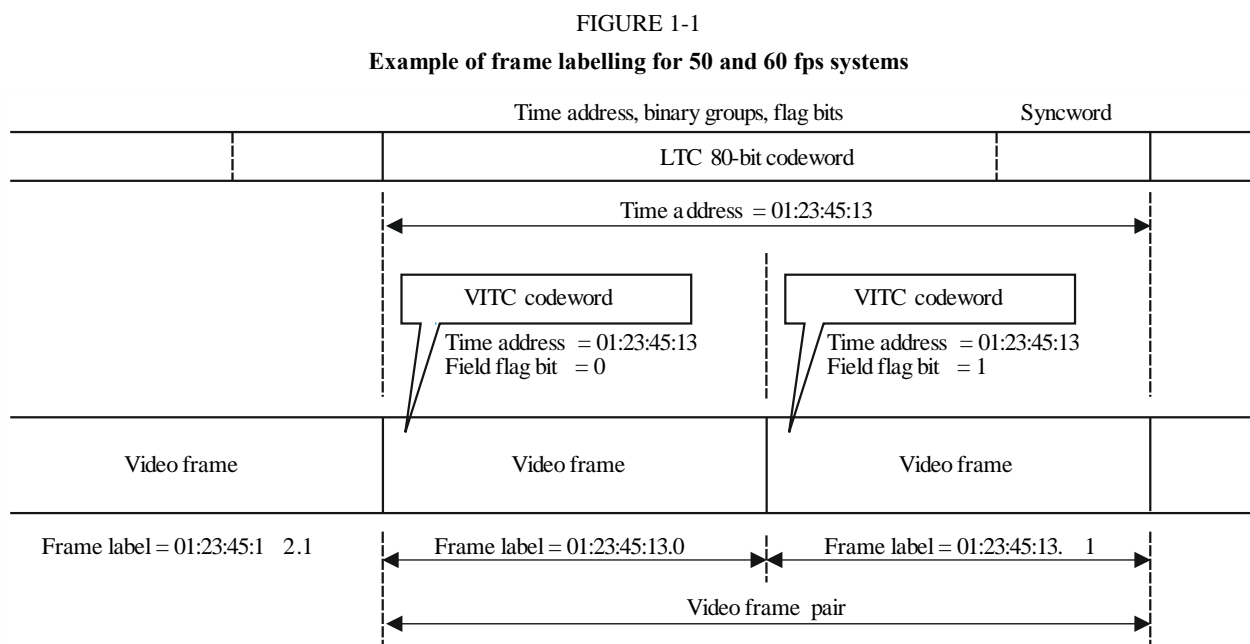


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Where the time code is VITC the field mark flag shall be used to identify each of the frames as described in § 6.16.4.

Where the time code is modulated as LTC, the time code shall be aligned to start at the beginning of the first frame of the pair of frames and to finish at the end of the second frame. The individual frames may be identified by their timing relative to the LTC with the first frame being aligned with LTC bits 0 through 39 and the second frame aligned with LTC bits 40 through 79.

## 5 Structure of the time address and control bits

### 5.1 Digital code

The digital code consists of sixteen 4-bit groups, eight groups containing time address and flag bits, and eight 4-bit binary groups for user-defined data and control codes.

### 5.2 Time address

The basic structure of the time address is based upon the BCD system, using units and tens digit pairs for hours, minutes, seconds and frames. 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 frames. The entire time address is coded into 26 bits.

### 5.3 Flag bits

Six bits are reserved for the storage of flags which define the operational mode of the time and control code. A device that decodes a time and control code may utilize these flags to interpret properly the time address and binary group data.

### 5.3.1 Drop frame flag (29.97 Hz or 59.94 Hz systems only)

This flag shall be set to one when drop frame compensation is being used. When the count is not drop frame compensated, this flag bit shall be set to zero.

### 5.3.2 Colour frame flag (525/59.94 and 625/50 systems only)

If colour frame identification has been applied to the time and control code this flag shall be set to one.

### 5.3.3 Binary group flags

Three flags provide eight unique combinations that specify the use of the binary groups (see § 5.4). Three combinations of these flags also specify the time address reference as being related to clock time and these also select subsets of the binary group applications.

### 5.3.4 Modulation method specific flag

The remaining flag bit is reserved for use by each modulation method. This flag is defined in § 6.7 for LTC and § 6.16.4 for VITC.

### 5.4 Use of the binary groups

The binary groups are intended for storage and transmission of data by users. The format of the data contained in the binary groups is specified by the value of three binary group flag bits BGF2, BGF1 and BGF0. The following clauses define the current assignments of the binary group flag states. Table 1-1 summarizes the present assigned combinations.

TABLE 1-1

**Binary group flag assignments**

| BGF2 | BGF1 | BGF0 | Binary group | Reference Section |
|------|------|------|--------------|-------------------|
| 0 | 0 | 0 | Unspecified | 5.5 |
| 0 | 0 | 1 | 8-bit codes | 5.7 |
| 1 | 0 | 0 | Reserved | |
| 1 | 0 | 1 | Reserved | |
| 0 | 1 | 0 | Unspecified | 5.6 |
| 0 | 1 | 1 | Reserved | 5.8 |
| 1 | 1 | 0 | Reserved | |
| 1 | 1 | 1 | Reserved | |

## 5.5        Character set not specified and unspecified clock time (BGF2=0, BGF1=0, BGF0=0)

This combination of binary group flags signifies that the time address is not referenced to an external clock and that the binary groups contain an unspecified character set. If the character set used for the data insertion is unspecified, the 32 bits within the eight binary groups may be assigned without restriction.

## 5.6        Character set not specified and clock time (BGF2=0, BGF1=1, BGF0=0)

This combination specifies that the time address is referenced to an external clock and signifies an unspecified character set. If the character set used for the data insertion is unspecified, the 32 bits within the eight binary groups may be assigned without restriction.

## 5.7        Eight-bit character set and unspecified clock time (BGF2=0, BGF1=0, BGF0=1)

This combination signifies that the time address is not referenced to an external clock and that the binary groups contain an eight-bit character set conforming to ISO/IEC 646 or ISO/IEC 2022. If the seven-bit ISO codes are being used, they shall be converted to eight-bit codes by setting the eighth bit to zero. Four ISO codes may be encoded in the binary groups, each occupying two binary groups. The first ISO code is contained in binary groups 7 and 8, with the least significant four bits in binary group 7 and the most significant four bits in binary group 8. The three remaining ISO codes are stored in binary groups 5/6, 3/4 and 1/2 accordingly.

## 5.8        Unassigned binary group usage and unspecified clock time (BGF2=0, BGF1=1, BGF0=1)

This combination is reserved.

## 6        Linear time code structure

## 6.1      Codeword format

Each LTC codeword consists of 80 bits numbered 0 through 79. The bits are generated serially beginning with bit 0. Bit 79 of the codeword is followed by bit 0 of the next codeword. Each codeword is associated with a television or film frame. In the case of 50/60 progressive systems the 80-bit code word is associated with 2 frames (see Fig. 1-1).

**6.2      Codeword data content**

Each LTC codeword contains the time address of the frame, flag bits, binary groups, biphase mark polarity correction bit and a synchronization word.

**6.3      Time address**

The time address bits of the frame as defined in § 5.2. The lowest numbered bit of each group corresponds to the least significant bit of each BCD digit. The bit positions are tabulated in Table 1-2.

**6.4      Flag bits**

The drop frame, colour frame, and binary group flag bits, as defined in § 5.3. The bit positions are listed in Table 4. Unused flag bits should be set to zero.

**6.5      Binary groups**

Eight 4-bit binary groups are defined in § 5.4. The lowest numbered bit of each group corresponds to the least significant bit of that group. The positions of the bits are listed in Table 1-3.

**6.6      Synchronization word**

The synchronization word is a static combination of bits, which can be used by receiving equipment to identify accurately the bit position of the serial code relative to the video signal. The LTC synchronization word is unique in that the same combination cannot be generated by any combination of valid data values in the remainder of the code. Bits 65-78 form a unique pattern that is symmetrical about the centre of the synchronization word, allowing detection in either direction. Bits 64 and 79 are complements of each other, allowing a receiver to determine the direction of the code ascending or descending time.

TABLE 1-2

**LTC time address bit positions**

| Bit | Definition |
|-----|------------|
| 0-3 | Units of frames |
| 8-9 | Tens of frames |
| 16-19 | Units of seconds |
| 24-26 | Tens of seconds |
| 32-35 | Units of minutes |
| 40-42 | Tens of minutes |
| 48-51 | Units of hours |
| 56-57 | Tens of hours |

TABLE 1-3

**LTC binary group bit positions**

| Bit | Definition |
|-----|------------|
| 4-7 | First binary group |
| 12-15 | Second binary group |
| 20-23 | Third binary group |
| 28-31 | Fourth binary group |
| 36-39 | Fifth binary group |
| 44-47 | Sixth binary group |
| 52-55 | Seventh binary group |
| 60-63 | Eighth binary group |

TABLE 1-4

**LTC flag bit positions**

| 30-frame bit | 25-frame bit | 24-frame bit | Definition |
|---|---|---|---|
| 10 | – | – | Drop frame flag |
| 11 | 11 | – | Colour frame flag |
| 27 | 59 | 27 | Polarity correction |
| 43 | 27 | 43 | Binary group flag BGF0 |
| 58 | 58 | 58 | Binary group flag BGF1 |
| 59 | 43 | 59 | Binary group flag BGF2 |

TABLE 1-5

**LTC synchronization word bit positions and values**

| Sync word bit | bit value |
|---|---|
| 64 | 0 |
| 65 | 0 |
| 66 | 1 |
| 67 | 1 |
| 68 | 1 |
| 69 | 1 |
| 70 | 1 |
| 71 | 1 |
| 72 | 1 |
| 73 | 1 |
| 74 | 1 |
| 75 | 1 |
| 76 | 1 |
| 77 | 1 |
| 78 | 0 |
| 79 | 1 |

### 6.7 Biphase mark polarity correction

This flag bit is specific to the LTC modulation method described in § 5.3.4. The position of this flag is listed in Table 1-4. The nature of the biphase modulation rules require that the polarity of the first clock transition of the first bit of the synchronization word differ from code word to code word depending on the number of logical zeros in the data.

Applications that switch between two sources of time and control code may require the polarity of the two sources to be stable during the synchronization word. In order to stabilize the polarity of the sync word, the biphase mark polarity correction bit shall be put in a state so that every 80-bit word will contain an even number of logical zeros.

If polarity correction of the code word is desired and the number of logical zeros in bit positions 0 through 63 (exclusive of the polarity correction bit itself) is odd, then the polarity correction bit shall be set to one, otherwise the polarity correction bit shall be set to zero.
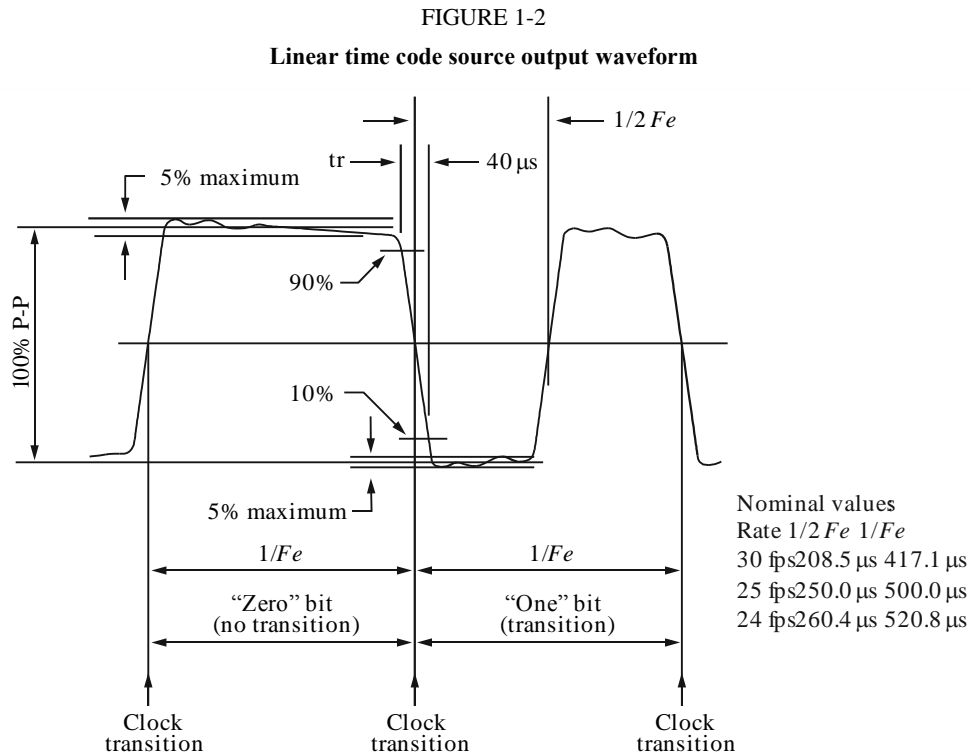
### 6.8 Modulation method

The NRZ unmodulated signal is biphase mark encoded according to the following coding rules (see Fig. 1-2):

−       A transition occurs at each bit cell boundary, regardless of the value of the bit.

– A logic one is represented by an additional transition occurring at the bit cell midpoint.

– A logic zero is represented by having no additional transitions within the bit cell.

The biphase mark encoded signal has no DC component, is amplitude and polarity insensitive and includes transitions at every bit cell boundary from which the clock may be extracted.

FIGURE 1-2

**Linear time code source output waveform**



Nominal values
Rate 1/2 *Fe* 1/*Fe*
30 fps 208.5 µs 417.1 µs
25 fps 250.0 µs 500.0 µs
24 fps 260.4 µs 520.8 µs

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## 6.9 Bit rate

The bits shall be evenly spaced throughout the codeword period and shall fully occupy the codeword period. The nominal frequency, *Fe*, at which the bits are generated shall be:

$$Fe = 80 \times Ff$$

where *Ff* is the frame rate of the television or film system.

NOTE 1 – For frame rates greater than 30 fps $Fe = 80 \times Ff/2$.

## 6.10 Timing of the codeword relative to a television signal

The timing reference datum for LTC is the first transition of bit 0 of the 80-bit LTC codeword.

## 6.11 Television systems reference timing

### 6.11.1 Analogue signal references

The reference datum for 525/59.94 systems is at the beginning of line 4. For 1920 × 1080 formats the reference datum is at the beginning of line 1. The tolerance is +160/−32 µs (see Fig. 1-3a).

The first transition of bit 0 of the codeword shall occur at the reference datum of the frame with which it is associated.

### 6.11.2   Digital signal references

The reference datum for 525/59.94 systems is at:

–       Digital sample 720 of line 4.

The reference datum for 1125/59.94 systems is at:

–       Digital sample 1920 of line 1 (for the progressive format the reference datum occurs every second frame).

The first transition of bit 0 of the codeword shall occur at the reference datum of the frame with which it is associated. With a tolerance of +160/−32 μs (see Fig. 1-3a).

## 6.12     25/50-fps television systems reference timing

### 6.12.1   Analogue signal references

The reference datum for 625/50I 1080/50I and 1080/25/P systems is at the beginning of line 1. The tolerance is −32/+160 μs (see Fig. 1-3b).

### 6.12.2   Digital signal references

The reference datum for 25 Hz/SDTV systems is at:

–       Digital sample 720 of line 1.

        The reference datum for 1125/50/25 systems is at:

–       Digital sample 1920 of line 1 (for the progressive format the reference datum occurs every second frame).

With a tolerance of −32/+160 μs (see Fig. 1-3b).

The first transition of bit 0 of the codeword shall occur at the reference datum of the frame with which it is associated.

## 6.13     23.98/24-fps television system 2 (1920 × 1080)

The digital reference datum for 23.98 Hz and 24 Hz systems, is at sample 1924 of line 1.

With a tolerance of −32/+160 μs (see Fig. 1-3c)

FIGURE 1-3a

**30-frame linear time code example**



BT.1366-0l03a
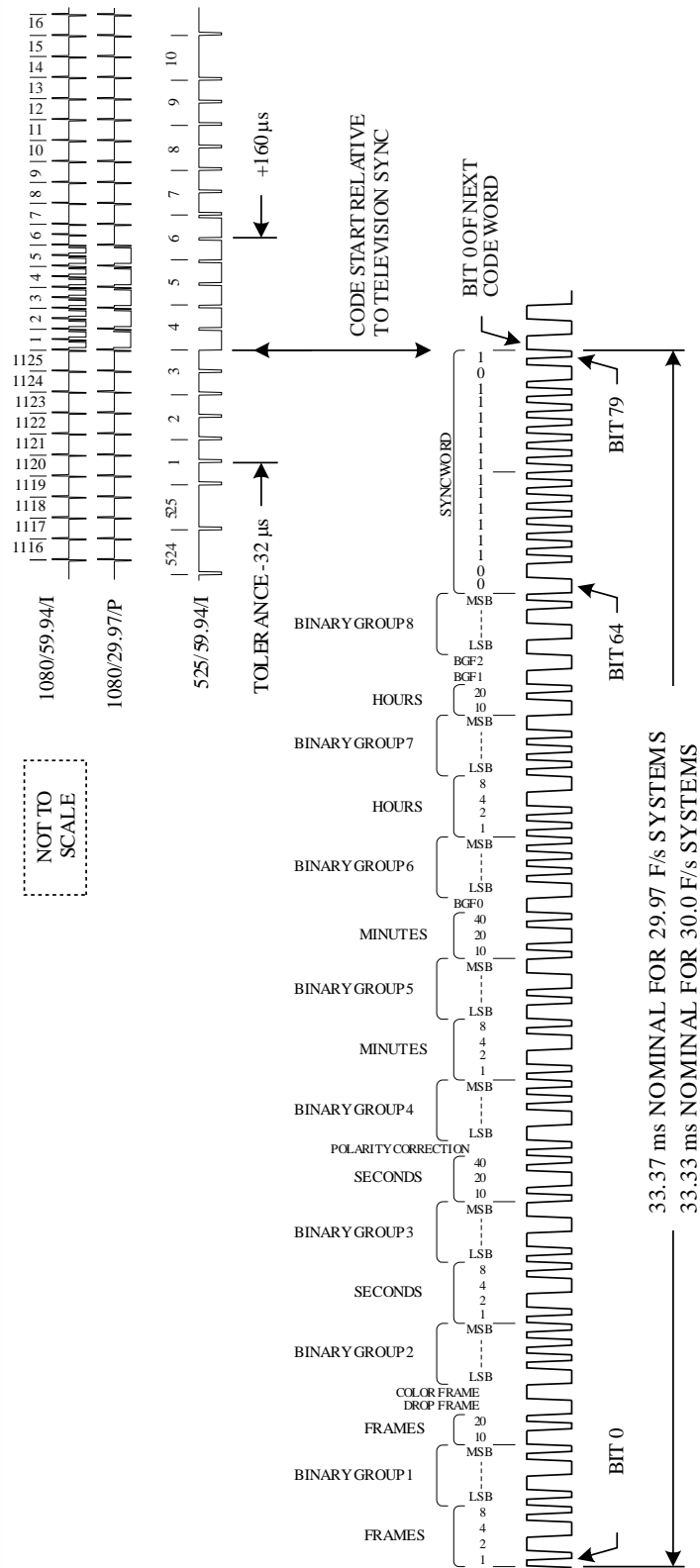
FIGURE 1-3b

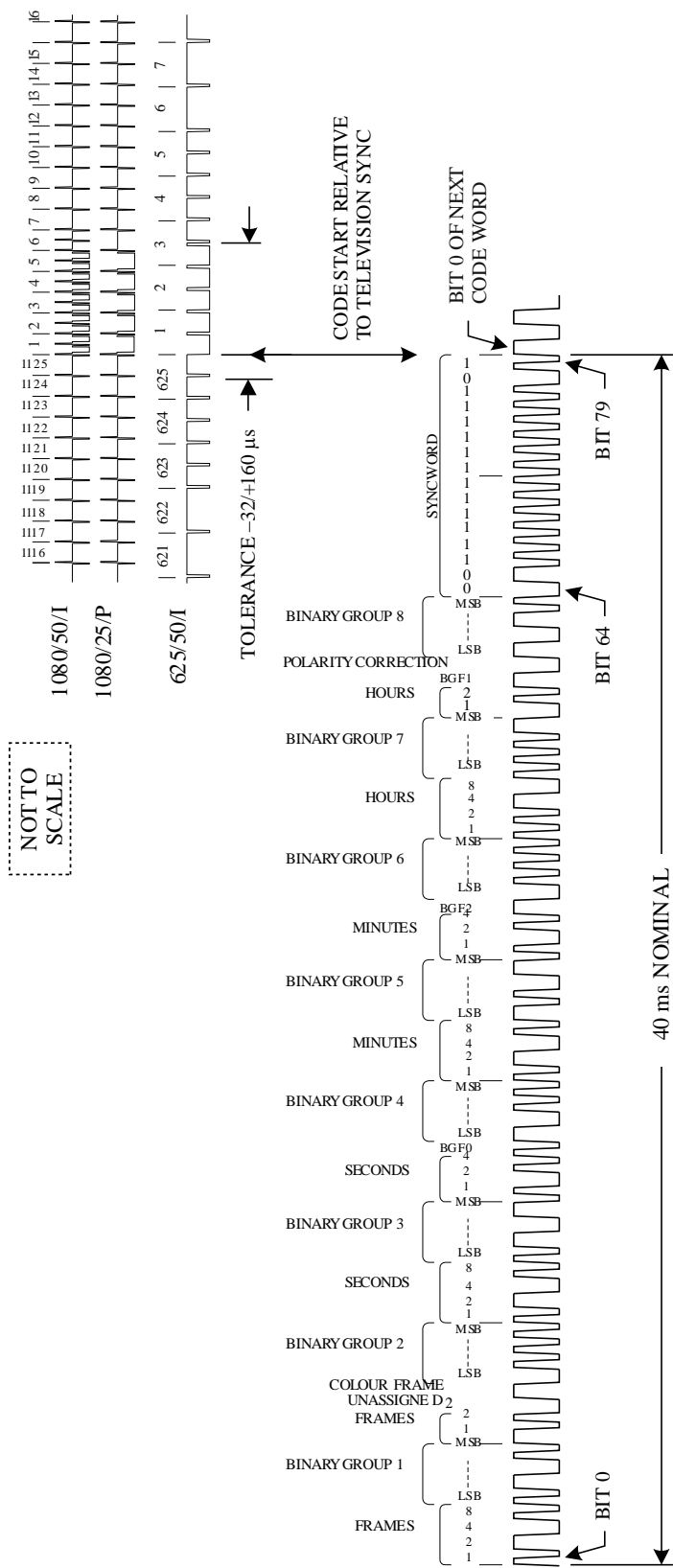**25-frame linear time code example**



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FIGURE 1-3c

**24-frame video linear time code example**
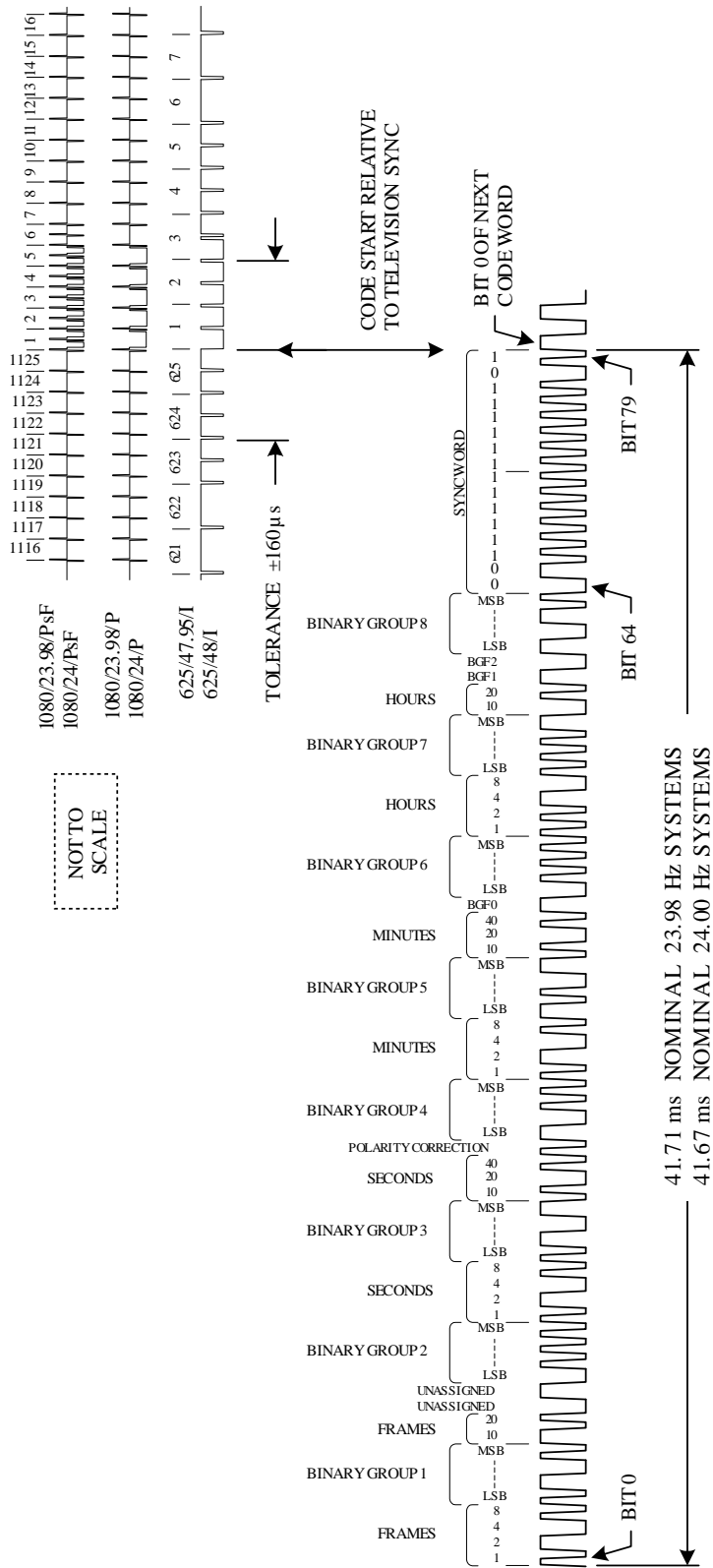


BT.1366-0103c

The first transition of bit 0 of the codeword shall occur at the reference datum of the frame with which it is associated.

FIGURE 1-3d

**24-frame film linear time code example**
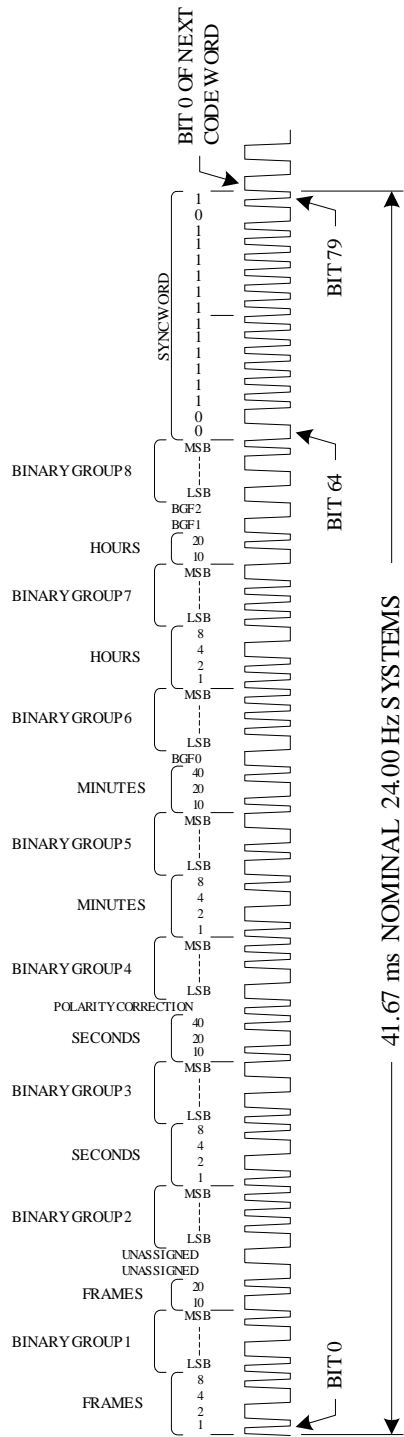


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## 6.14     Linear time code interface electrical and mechanical characteristics

All measurements shall be made at the interface while driving a resistive load of 1 kΩ.

### 6.14.1   Rise/fall time

The rise and fall times of the clock and one transitions of the time code pulse train shall be 40 μs ±10 μs, measured between 10% and 90% amplitude points on the waveform.

### 6.14.2 Amplitude distortion

Any combination of overshoot, undershoot and tilt shall be limited to 5% of the peak-to-peak amplitude of the code waveform.

### 6.14.3 Timing of the transitions

The time between clock transitions shall not vary more than 1.0% of the average clock period measured over at least one frame. The "one" transition shall occur midway between the two clock transitions within 0.5% of one clock period. Measurement of these timings shall be made at half-amplitude points on the waveform.

### 6.14.4 Interface connector

The preferred connector for double-ended or balanced outputs is a 3-pin XLR (male) connector and for inputs is a 3-pin XLR (female) connector. Pin 1 is signal ground, pins 2 and 3 carry the double-ended or balanced signals. The preferred connector for single-ended or unbalanced outputs or inputs is a BNC (female) connector.

### 6.14.5 Output impedance

The output impedance of a single-ended, balanced or unbalanced source shall be no greater than 50 Ω. The output impedance of a double-ended output shall be no greater than 25 Ω for each output side.

### 6.14.6 Output amplitude

A preferred output is between 1 and 2 V peak-to-peak. The allowable range of amplitudes is 0.5 to 4.5 V peak-to-peak.

**Vertical interval application – television systems**

### 6.15 Codeword format

Each codeword shall consist of 90 bits numbered 0 through 89, organized as 9 groups of 10 bits. Each 10-bit group starts with a synchronization bit pair, which is a bit 1 followed by a bit 0. The synchronization bit pair is followed by 8 data bits.

The first eight groups contain the 64 time and control code data bits; the ninth contains a cyclic redundancy check (CRC) code used to detect errors in the data. The boundaries of the word are defined as the leading edge of the first bit (bit 0) and the trailing edge of the last bit (bit 89). Since bit 0 is the first synchronization bit of the codeword, it shall always have the value of one.

NOTE 1 – There shall always be a rising transition at the leading edge of bit 0 to signal the start of the word.

### 6.16 Codeword data content

Each VITC codeword consists of a time address, flag bits, binary groups, field mark flag, CRC code and synchronization bits. Refer to Figs. 4a, 4b, and 4c for examples of the VITC signal.

FIGURE 1-4a

**525/59.94 vertical interval time code address bit assignment and timing**
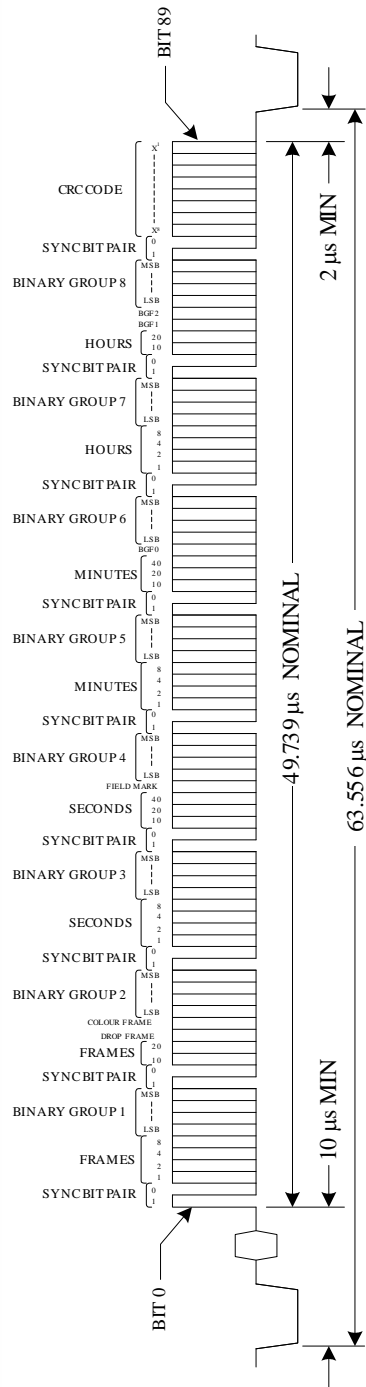


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FIGURE 1-4b

**1 125/60/60/1.001 vertical interval time code address bit assignment and timing**
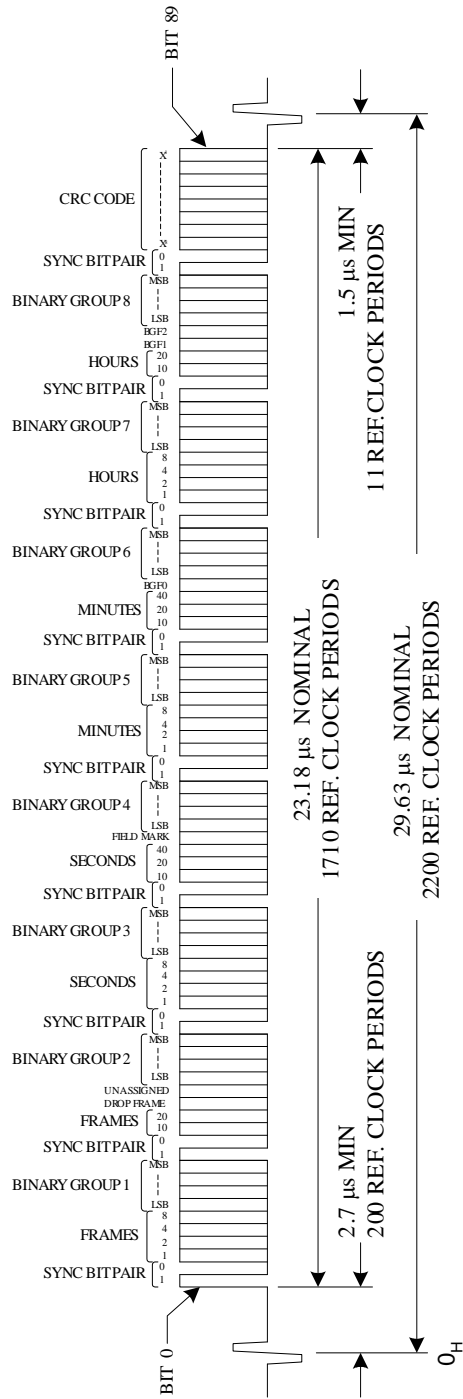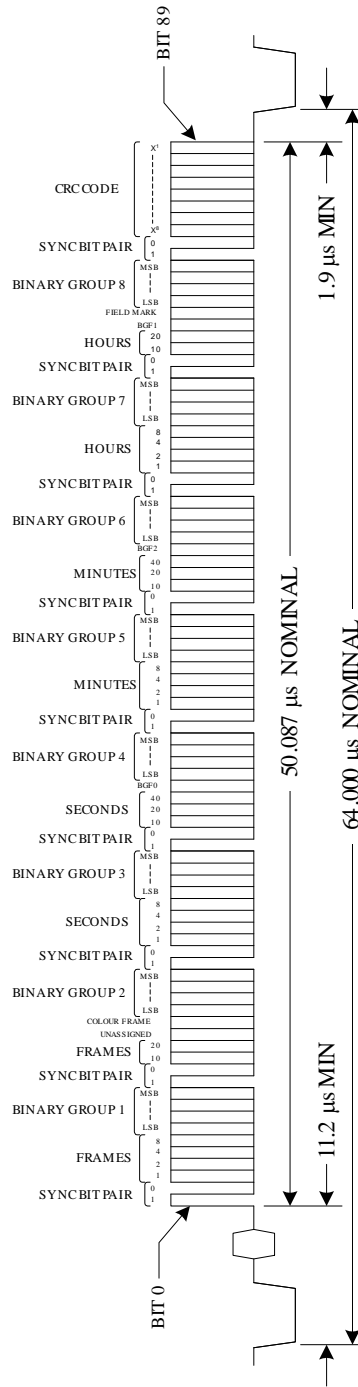


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FIGURE 1-4c

**625/50 vertical interval time code address bit assignment and timing**



BT.1366-0404c

## 6.16.1 Time address

The time address bits of the frame as defined in § 5.2. The lowest numbered bit of each group corresponds to the least significant bit of each BCD digit. The positions of these bits are listed in Table 1-6.

### 6.16.2 Flag bits

The drop frame, colour frame and binary group flag bits as defined in § 5.3. The positions of these flags are listed in Table 1-8. Note that not all flag bits are used by all systems. Unused flag bits should be set to zero by original sources and ignored by receiving equipment.

### 6.16.3 Binary groups

Eight 4-bit binary groups are defined in § 5.4. The lowest numbered bit of each group corresponds to the least significant bit of that group. The positions of these bits are listed in Table 1-7.

### 6.16.4 Field mark flag

The position of this flag is listed in Table 1-8.

#### 6.16.4.1 525/59.94 NTSC system

Field identification shall be indicated as follows: A zero shall represent field 1 and colour field I or III. A one shall represent field 2 or colour field II or IV. Colour fields I through IV are defined in Recommendation ITU-R BT.1700.

<table>
<tr><td colspan="2" align="center">TABLE 1-6</td><td colspan="2" align="center">TABLE 1-7</td></tr>
<tr><td colspan="2" align="center">**VITC time address bit positions**</td><td colspan="2" align="center">**VITC binary group bits**</td></tr>
</table>

| Bit | Definition | Bit | Definition |
|---|---|---|---|
| 2-5 | Units of frames | 6-9 | First binary group |
| 12-13 | Tens of frames | 16-19 | Second binary group |
| 22-25 | Units of seconds | 26-29 | Third binary group |
| 32-34 | Tens of seconds | 36-39 | Fourth binary group |
| 42-45 | Units of minutes | 46-49 | Fifth binary group |
| 52-54 | Tens of minutes | 56-59 | Sixth binary group |
| 62-65 | Units of hours | 66-69 | Seventh binary group |
| 72-73 | Tens of hours | 76-79 | Eighth binary group |

TABLE 1-8

**VITC flag bit positions**

| 30-frame bit | 25-frame bit | Definition |
|---|---|---|
| 14 | – | Drop frame flag |
| 15 | 15 | Colour frame flag |
| 35 | 75 | Field flag |
| 55 | 35 | Binary group flag BGF0 |
| 74 | 74 | Binary group flag BGF1 |
| 75 | 55 | Binary group flag BGF2 |

### 6.16.4.2   1125/60/60/1.001 television system

Field identification shall be indicated as follows: A zero shall represent field 1. A one shall represent field 2. Field 1 contains lines 1 through 563 inclusive; field 2 contains lines 564 through 1125 as defined in Recommendation ITU-R BT.709.

### 6.16.4.3   625/50 PAL television system

Field identification shall be indicated as follows: A zero shall represent colour fields I, III, V and VII. A one shall represent colour fields II, IV, VI, and VIII. Colour fields I through VIII are defined in Recommendation ITU-R BT.1700.

### 6.16.4.4   50- and 60-frame progressive television systems

Frame identification shall be indicated as follows: The field flag is used to identify frame pairs. A zero shall represent the first frame and a one shall represent the second frame of the pair of progressive frames.

### 6.16.4.5   Progressive segmented frame (PsF) interfaces

For interfaces where the signal is mapped as a PsF signal, the VITC signal for a frame shall be identical for the segmented fields.

### 6.16.5   Synchronization bits

A synchronization bit pair consisting of a one followed by a zero is inserted preceding every 8 data bits. Bits 0, 10, 20, 30, 40, 50, 60, 70 and 80 are coded as one; bits 1, 11, 21, 31, 41, 51, 61, 71 and 81 are encoded as zero.

### 6.16.6   CRC code

Eight bits, 82 through 89, are encoded with a CRC code to provide for error detection. The generating polynomial of the CRC, $G(X)$, is defined as $G(X) = X^8 + 1$ with an initial condition of all zeros.

The generating polynomial shall be applied to all bits from 0 to 81 inclusive. The remainder is then encoded in bits 82 through 89 as shown in Table 1-9. Applying the generating polynomial to the received data bits 0 through 89, inclusive, shall result in a remainder of all zeros when no error exists.

TABLE 1-9

**CRC bit positions**

| Bit | CRC code bit |
|-----|--------------|
| 82 | $X_8$ |
| 83 | $X_7$ |
| 84 | $X_6$ |
| 85 | $X_5$ |
| 86 | $X_4$ |
| 87 | $X_3$ |
| 88 | $X_2$ |
| 89 | $X_1$ |

## 6.17 Modulation method

The NRZ unmodulated signal is time compressed and inserted as a burst within the non-blanked interval of a selected television line in the vertical interval (see Fig. 1-5).

FIGURE 1-5

**Vertical interval time code bit waveform**
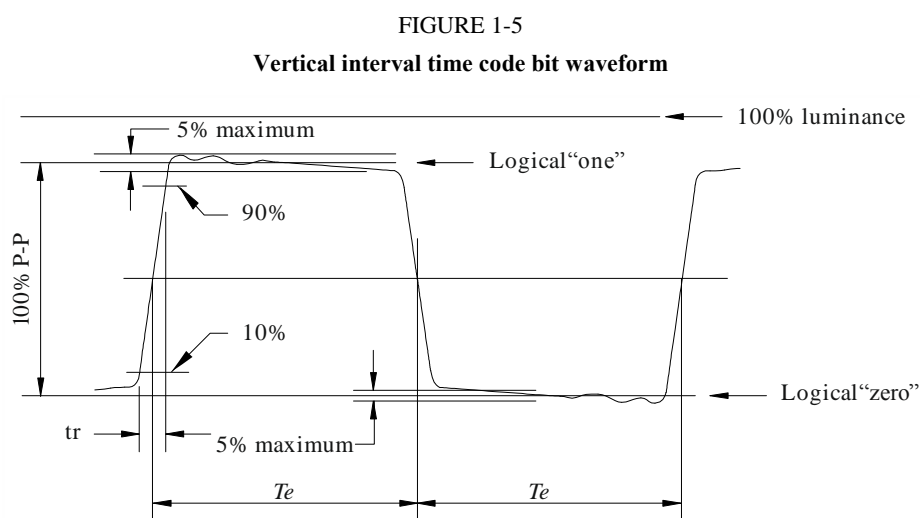


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Since an NRZ code has no self-clocking reference, the signal must be sampled at periodic intervals based on known bit cell timing. The sample period can be adjusted at any available one-zero or zero-one transition.

## 6.18 Bit timing and waveform characteristics

The waveform characteristics of the VITC signal are shown in Fig. 1-5.

Each bit of the code word shall have a uniform period, *Te*, related to the horizontal line frequency, *Fh*, as expressed below:

$$Te = 1/(115 \times Fh) \pm 2\%$$

In 1125/60 television systems, if the reference clock is used to generate the bit timing; *Te* shall be equal to 19 times the reference clock as defined in Recommendation ITU-R BT.709.

### 6.18.1 Logic level

The tolerance ranges specified for logical one and logical zero states are listed in Table 1-10.

TABLE 1-10

**VITC logic level ranges**

| Television system | Logical one | Logical zero |
|---|---|---|
| 525/59.94 | 70--90 IRE | 0--10 IRE |
| 1125 | 500--600 mV | 0--25 mV |
| 625/50 | 500--600 mV | 0--25 mV |

### 6.18.2   Rise/fall time

The rise and fall times, *tr*, of the code shall be 200 ns ±50 ns for 525/59.94 and 625/50 television systems and 100 ns ±25 ns for 1125-line television systems. These measurements are made between 10% and 90% amplitude points on the waveform.

### 6.18.3   Amplitude distortion

Amplitude distortions, such as overshoot, undershoot and tilt, shall be limited to 5% of the peak-to-peak amplitude of the code waveform.

### 6.19      Timing of the codeword relative to the line synchronizing signal

The timing reference datum for VITC is the half-amplitude point of the leading edge of bit 0 of the 90-bit VITC codeword.

### 6.19.1   525/59.94 television system

The half-amplitude point of the leading edge of bit 0 shall occur no earlier than 10.0 µs following the half-amplitude point of the leading edge of the line synchronizing pulse. The half-amplitude point of the trailing edge of bit 89 (logical 1) shall occur no later than 2.1 µs before the half-amplitude point of the leading edge of the following line synchronizing pulse.

### 6.19.2   1125/60 television system

The half-amplitude point of the leading edge of bit 0 shall occur no earlier than 2.7 µs (200 reference clock periods) following the midpoint of the line synchronizing transition. The half-amplitude point of the trailing edge of bit 89 (logical 1) shall occur no later than 1.5 µs (111 reference clock periods) before the midpoint of the following line synchronizing pulse.

### 6.19.3   625/50 television system

The half-amplitude point of the leading edge of bit 0 shall occur no earlier than 11.2 µs following the half-amplitude point of the leading edge of the line synchronizing pulse. The half-amplitude point of the trailing edge of bit 89 (logical 1) shall occur no later than 1.9 µs before the half-amplitude point of the leading edge of the following line synchronizing pulse.

### 6.20      Location of the address code signal in the vertical interval

The VITC codeword shall be inserted on the same line (or lines) in all fields. Line numbers shown in parentheses correspond to the equivalent line in field two.

### 6.20.1   525/59.94 television system

Insertion of the address code shall be on line 14(277) and optionally on line 16(279).

### 6.20.2   1125/60 television system

Insertion of the address code for interlace signals shall not be earlier than line 8(570) or later than line 19(582). For progressive systems the address code shall not be inserted earlier than line 8 or later than line 40.

### 6.20.3   625/50 television system

The preferred placement of the VITC code word is on television lines 19(332) and 21(334). Where line 21 is used to carry captions the VITC should be positioned on lines 18(331) and 20(333) only.

The address code may be inserted on multiple lines of the vertical interval provided all lines contain the same time address, drop frame and colour frame data.

# 7 Relationship between LTC and VITC

## 7.1 Time address data

Because of the relative timing of the two time code modulation methods, direct interchange of time address bits is not possible in real time. In order to generate a LTC from a VITC, or vice versa, the time address of one frame is incremented by one and used as the time address of the next frame.

This method will produce a one-to-one correspondence between the time address and flag bits of the LTC and the VITC as long as the counting sequence is continuous and ascending. Discontinuities will propagate to the second time code after one frame of delay.

## 7.2 Binary group data

When transferring binary group data, look-ahead compensation, similar to that used in time address data transfer, may be applied if the nature of the binary group data format lends itself to being predictable. If this is not the case, then no update shall be applied to the data and the transfer will result in a one- or two-frame latency.

The guideline for transferring binary group data between LTC and VITCs shall be as follows:

### 7.2.1 Transferring vertical interval binary group data to linear binary group data

The binary group data and flag bits from the first line in field 1 of the VITC shall be transferred to the corresponding bits in the linear time code of the next frame.

### 7.2.2 Transferring linear binary group data to vertical interval binary group data

The binary group data and flag bits from the linear time code shall be transferred to the corresponding bits in the VITC of the next frame.

If the binary group data format, as identified by the binary group flag bits, supports line or field independence, then the binary group data and flags of the remaining lines in the VITC for that frame shall be set to zero. If the binary group data format is redundant, then the redundant lines in the frame shall contain identical data.

## 7.3 VITC and LTC code word comparison

Table 1-11 summarizes the correspondence between the bits of the VITC and LTC codewords for 60-, 50-, 30-, 25- and 24-frame systems.

TABLE 1-11

**Summation of VITC and LTC codeword bit definitions**

| VITC BIT NO. | VALUE (WEIGHT) | COMMON ASSIGNMENT | LTC BIT NO. | 30-FRAME/60-FIELD 60-FRAME | 25-FRAME/50-FIELD 50-FRAME | 24-FRAME/48-FIELD |
|---|---|---|---|---|---|---|
| 0 | 1 | VITC SYNC BITS | | | | |
| 1 | 0 | | | | | |
| 2 | (1) | | 0 | | | |
| 3 | (2) | FRAME UNITS | 1 | | | |
| 4 | (4) | | 2 | | | |
| 5 | (8) | | 3 | | | |
| 6 | (LSB) | | 4 | | | |
| 7 | \| | FIRST BINARY GROUP | 5 | | | |
| 8 | \| | | 6 | | | |
| 9 | (MSB) | | 7 | | | |
| 10 | 1 | VITC SYNC BITS | | | | |
| 11 | 0 | | | | | |
| 12 | (10) | FRAME TENS | 8 | | | |
| 13 | (20) | | 9 | | | |
| 14 | FLAG | FLAG | 10 | DROP FRAME FLAG | UNUSED BIT | UNUSED BIT |
| 15 | FLAG | FLAG | 11 | COLOUR FRAME FLAG | COLOUR FRAME FLAG | UNUSED BIT |
| 16 | (LSB) | | 12 | | | |
| 17 | \| | SECOND BINARY GROUP | 13 | | | |
| 18 | \| | | 14 | | | |
| 19 | (MSB) | | 15 | | | |
| 20 | 1 | VITC SYNC BITS | | | | |
| 21 | 0 | | | | | |
| 22 | (1) | | 16 | | | |
| 23 | (2) | SECOND UNITS | 17 | | | |
| 24 | (4) | | 18 | | | |
| 25 | (8) | | 19 | | | |
| 26 | (LSB) | | 20 | | | |
| 27 | \| | THIRD BINARY GROUP | 21 | | | |
| 28 | \| | | 22 | | | |
| 29 | (MSB) | | 23 | | | |
| 30 | 1 | VITC SYNC BITS | | | | |
| 31 | 0 | | | | | |
| 32 | (10) | | 24 | | | |
| 33 | (20) | SECOND TENS | 25 | | | |
| 34 | (40) | | 26 | | | |
| 35 | FLAG | FLAG | 27 | FIELD BIT/LTC POLARITY | BINARY GROUP FLAG 0 | FIELD BIT/LTC POLARITY |
| 36 | (LSB) | | 28 | | | |
| 37 | \| | FOURTH BINARY GROUP | 29 | | | |
| 38 | \| | | 30 | | | |
| 39 | (MSB) | | 31 | | | |
| 40 | 1 | VITC SYNC BITS | | | | |
| 41 | 0 | | | | | |
| 42 | (1) | | 32 | | | |
| 43 | (2) | MINUTE UNITS | 33 | | | |
| 44 | (4) | | 34 | | | |
| 45 | (8) | | 35 | | | |
| 46 | (LSB) | | 36 | | | |
| 47 | \| | FIFTH BINARY GROUP | 37 | | | |
| 48 | \| | | 38 | | | |
| 49 | (MSB) | | 39 | | | |
| 50 | 1 | VITC SYNC BITS | | | | |
| 51 | 0 | | | | | |
| 52 | (10) | | 40 | | | |
| 53 | (20) | MINUTE TENS | 41 | | | |
| 54 | (40) | | 42 | | | |
| 55 | FLAG | FLAG | 43 | BINARY GROUP FLAG 0 | BINARY GROUP FLAG 2 | BINARY GROUP FLAG 0 |
| 56 | (LSB) | | 44 | | | |
| 57 | \| | SIXTH BINARY GROUP | 45 | | | |
| 58 | \| | | 46 | | | |
| 59 | (MSB) | | 47 | | | |
| 60 | 1 | VITC SYNC BITS | | | | |
| 61 | 0 | | | | | |
| 62 | (1) | | 48 | | | |
| 63 | (2) | HOUR UNITS | 49 | | | |
| 64 | (4) | | 50 | | | |
| 65 | (8) | | 51 | | | |
| 66 | (LSB) | | 52 | | | |
| 67 | \| | SEVENTH BINARY GROUP | 53 | | | |
| 68 | \| | | 54 | | | |
| 69 | (MSB) | | 55 | | | |
| 70 | 1 | VITC SYNC BITS | | | | |
| 71 | 0 | | | | | |
| 72 | (10) | HOUR TENS | 56 | | | |
| 73 | (20) | | 57 | | | |
| 74 | FLAG | FLAG | 58 | BINARY GROUP FLAG 1 | BINARY GROUP FLAG 1 | BINARY GROUP FLAG 1 |
| 75 | FLAG | FLAG | 59 | BINARY GROUP FLAG 2 | FIELD BIT/LTC POLARITY | BINARY GROUP FLAG 2 |
| 76 | (LSB) | | 60 | | | |
| 77 | \| | EIGHTH BINARY GROUP | 61 | | | |
| 78 | \| | | 62 | | | |
| 79 | (MSB) | | 63 | | | |
| 80 | 1 | VITC SYNC BITS | | | | |
| 81 | 0 | | | | | |
| 82-89 | | VITC CRC CODE | | | | |
| | | LTC SYNC WORD | 64-79 | | | |

# Annex 1 to
# Part 1
# (Informative)

# Bibliography

ISO/IEC [1991] Standard ISO/IEC 646, Information Technology – ISO 7-Bit Coded Character Set for Information Interchange.

ISO/IEC [1994] Standard ISO/IEC 2022, Corr.1 [1999], Information Technology – Character Code Structure and Extension Techniques.

# Annex 2 to
# Part 1
# (Informative)

# Converting time codes when converting video from 24 fps television systems

When rate converting 24 fps video to 25 or 30 fps video by periodically replicating video fields/frames, the conversion hardware inserts extra fields/frames of some of the images. In addition the incoming time code must be converted from a nominal 24 fps to 25 fps or 30 fps rate. In other cases the original signal is reproduced at a faster rate than acquisition.

## 1 Conversion of 23.98 fps video to 59.94 fps video

In order to deterministically move between the 24 and 30 fps formats it is recommended that the video frames of the high-definition material with the time code frame number zero be converted to an A frame as shown in Fig. 1-6. These frames are called A frame candidate frames. A frames are aligned with the field identified by the field 1 pulse of the 10 field sequence as shown in Fig. 1-6. It follows then that subsequent high definition frame numbers that are evenly divisible by 4 will also become A frames. As specified in § 6 of this Recommendation, the 30 non-drop frame count mode should be used for the time code of the converted material. It is recommended that the A frame candidate zero frame should be numbered as the zero frame on the converted video, resulting in subsequent A frames of the converted video having time code frame numbers that are evenly divisible by 5.

FIGURE 1-6

**Conversion of 23.98 fps video to 525/59.94/I**
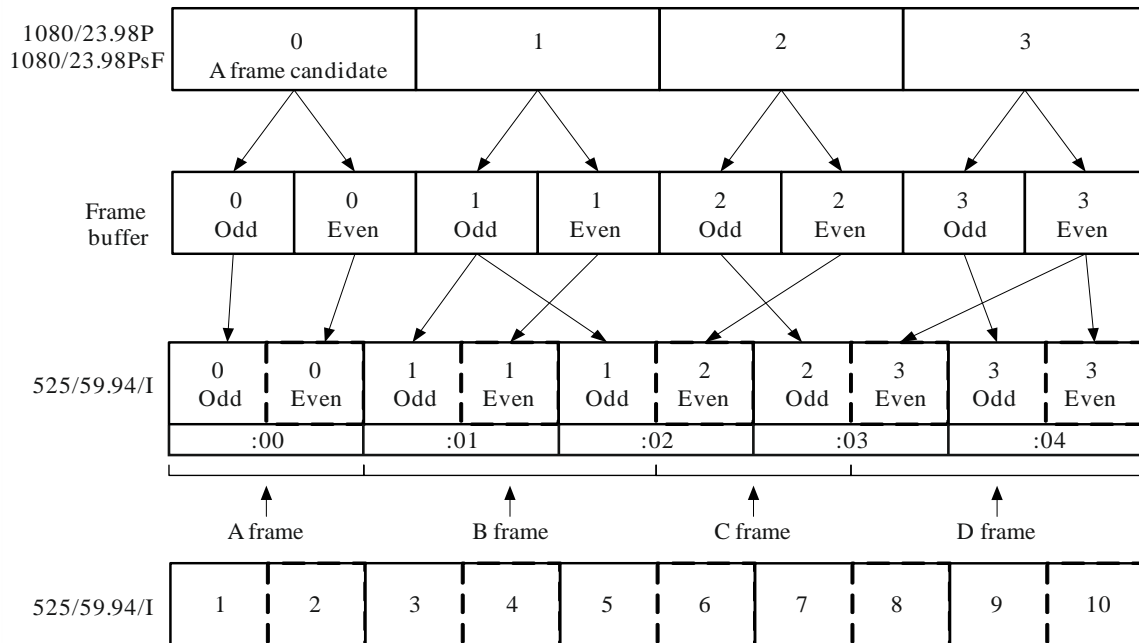


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As there are delays through the conversion hardware it may not be possible to align the vertical sync at the start of an A frame with the vertical sync at the start of an A frame candidate frame, but the vertical sync at the beginning of the A frame (line 4 for 525-line systems) should be aligned with the vertical sync at the beginning of one of the input frames (line 1).

## 2        Conversion of 24 fps video to 25 fps video

For specific editorial applications it may be necessary to perform an 11(2):3 pull-down conversion between systems operating at 24 fps and 25 fps.

NOTE – Due to the visibility of temporal artefacts of the image this process is not recommended for release material.

In order to deterministically move between the 24 fps and 25 fps formats it is recommended that the video frames of the high definition 24 fps material with the time code frame number zero be converted to the first A frame or the 24:25 frame pull-down sequence as shown in Fig. 1-7. These frames are called the A1 frame candidate frames. It follows then that each subsequent high definition 24 fps frame number zero will also become an A frame at the start of the 24:25 pull-down cycle. The converted A1 frame should also be numbered as the zero frame of the time code second.

FIGURE 1-7

**Example of conversion from of 24 fps high-definition video to 625/50/I**



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As there are delays through the conversion hardware it may not be possible to align the vertical sync at the start of an A1 frame with the vertical sync at the start of an A1 candidate frame, but the vertical sync at the beginning of the A1 frame (line 1 for 625-line systems) should be aligned with the vertical sync at the beginning of one of the input frames (line 1).
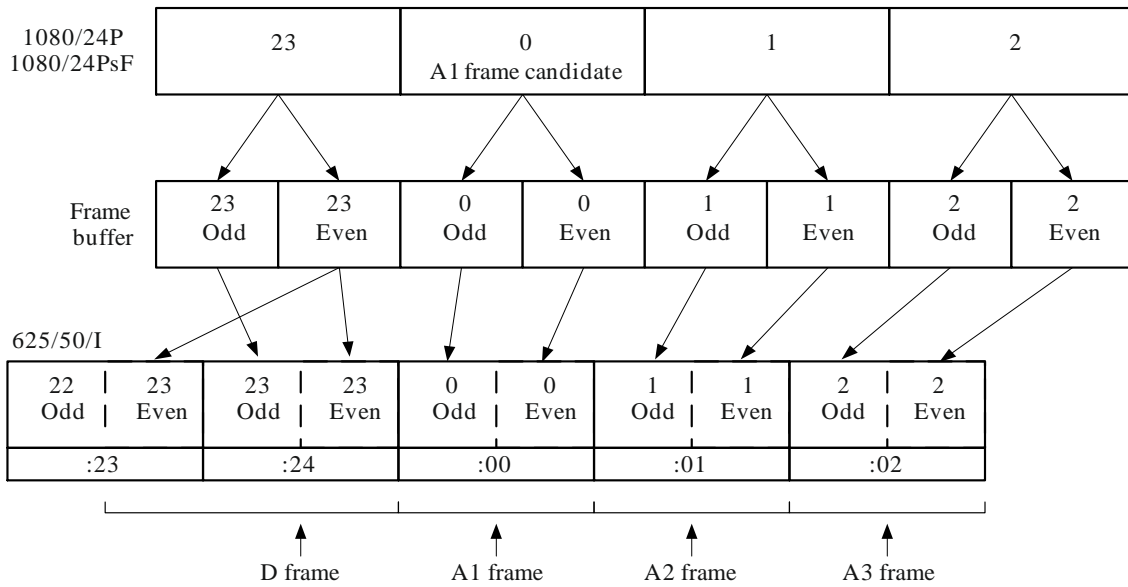
# PART 2

## Time code ancillary data signal format (up to 60 Hz)

## 1      Introduction

This Part defines a transmission format for conveyance of linear (LTC) or vertical interval (VITC) time code data defined in Part 1 in 8- or 10-bit digital television data interfaces according to Recommendations ITU-R BT.656, ITU-R BT.799, ITU-R BT.1120 and ITU-R BT.2077.

Time code information is transmitted in the ancillary data space as defined in Recommendation ITU-R BT.1364. Multiple codes can be transmitted within a serial digital interface data stream. Other time information, such as real-time clock, and other user-defined information, may also be carried in the ancillary time code packet. The actual information transmitted through the interface is identified by the coding of a distributed binary bit.

## 2      Ancillary time code format (ATC)[1]

**2.1**      One ancillary data packet of constant length excluding ancillary data flag shall fully represent an ancillary time code (ATC) word.

---

[1]   ATC is used to convey time code data formatted as LTC, VITC, or both.

**2.2**    The ancillary time code packet shall be type 2, having a data identification (DID) and a secondary data identification (SDID). The DID and SDID shall be set to:

$$DID = 60h$$

$$SDID = 60h$$

**2.3**    The data count (DC) value for ancillary time code shall be set to:

$$DC = 10h$$

## 3        Format of user data words in ancillary time code packet

**3.1**    All user data words in the ancillary time code packets are formatted as shown in Table 2-1.

NOTE 1 – References to user data word (UDW) bits in this Recommendation are for a 10-bit UDW word. Correspondence between an 8-bit word and a 10-bit word is shown in Table 2-1.

TABLE 2-1

**User data words format**

| $UDW_{10}$ bit (10-bit words) | $UDW_8$ bit (8-bit words) | Assignment |
|---|---|---|
| b0 (LSB) | N/A | Set to "0" in 10-bit words. N/A in 8-bit words |
| b1 | N/A | Set to "0" in 10-bit words. N/A in 8-bit words |
| b2 | b0 | Set to "0" in 10-bit and 8-bit words |
| b3 | b1 | Distributed binary bit (DBB) |
| b4 | b2 | ANC binary group LSB |
| b5 | b3 | ANC binary group |
| b6 | b4 | ANC binary group |
| b7 | b5 | ANC binary group MSB |
| b8 | b6 | 10 bit systems: Even parity for data contained in UDW bit 7 through bit 0<br>8 bit systems: Even parity for data contained in UDW bit 5 through bit 0 |
| b9 (MSB) | b7 | 10 bit: Not bit 8, 8 bit: Not bit 6 |

**3.1.1**    Bit b7 through bit b4 of the $UDW_{10}$-1 through $UDW_{10}$-16 shall contain the time code information and additional information as defined in Part 1

**3.2**    Bit b3 of the $UDW_{10}$-1 through $UDW_{10}$-16 form two groups of distributed binary bits DBB 1 and DBB 2 (see Table 2-3).

**3.2.1**    The first group of distributed binary bits (DBB 1) is formed by bit 3 of $UDW_{10}$-1 through $UDW_{10}$-8, where $UDW_{10}$-1 (b3) represents the LSB and $UDW_{10}$-8 (b3) represents the MSB.

**3.2.2**    The second group of distributed binary bits (DBB 2) is formed by bit 3 of $UDW_{10}$-9 through $UDW_{10}$-16, where $UDW_{10}$-9 (b3) represents the LSB and $UDW_{10}$-16 (b3) represents the MSB.

**3.3**    Bits b7 through b4 form an ancillary binary group into which the time code is mapped. Bits b4 of the $UDW_{10}$ represents the LSB of this group.

**3.4**    Information coded in the distributed binary bit group is defined in Table 2-3.

**3.4.1**    Bits b4 through b0 of the distributed binary bit group DBB 2 convey VITC line number location indicating the position of VITC data on the output digital video signal interface within the vertical blanking interval. The line select number depends on the television system and shall be constrained to a range as shown in Table 2-2.

TABLE 2-2

**Line select number**

| DBB 2 bits b4 through b0 | | | | | VITC line select | | | |
|---|---|---|---|---|---|---|---|---|
| | | | | | 525/60I | | 625/50I | |
| | | | | | bit b5 = x | bit b5 = 1 | bit b5 = x | bit b5 = 1 |
| | | | | | VITC on line N | Repeated VITC on line (N+2) | VITC on line N | Repeated VITC on line (N+2) |
| **B4** | **b3** | **b2** | **b1** | **b0** | field 1 (odd) field 2 (even) | field 1 (odd) field 2 (even) | field 1 (odd) field 2 (even) | field 1 (odd) field 2 (even) |
| 0 | 0 | 1 | 1 | 0 | – | – | 6/319 | 8/321 |
| 0 | 0 | 1 | 1 | 1 | – | – | 7/320 | 9/322 |
| 0 | 1 | 0 | 0 | 0 | – | – | 8/321 | 10/323 |
| 0 | 1 | 0 | 0 | 1 | – | – | 9/322 | 11/324 |
| 0 | 1 | 0 | 1 | 0 | 10/273 | 12/275 | 10/323 | 12/325 |
| 0 | 1 | 0 | 1 | 1 | 11/274 | 13/276 | 11/324 | 13/326 |
| 0 | 1 | 1 | 0 | 0 | 12/275 | 14/277 | 12/325 | 14/327 |
| 0 | 1 | 1 | 0 | 1 | 13/276 | 15/278 | 13/326 | 15/328 |
| 0 | 1 | 1 | 1 | 0 | 14/277 | 16/279 | 14/327 | 16/329 |
| 0 | 1 | 1 | 1 | 1 | 15/278 | 17/280 | 15/328 | 17/330 |
| 1 | 0 | 0 | 0 | 0 | 16/279 | 18/281 | 16/329 | 18/331 |
| 1 | 0 | 0 | 0 | 1 | 17/280 | 19/282 | 17/330 | 19/332 |
| 1 | 0 | 0 | 1 | 0 | 18/281 | 20/283 | 18/331 | 20/333 |
| 1 | 0 | 0 | 1 | 1 | 19/282 | – | 19/332 | 21/334 |
| 1 | 0 | 1 | 0 | 0 | 20/283 | – | 20/333 | 22/335 |
| 1 | 0 | 1 | 0 | 1 | – | – | 21/334 | – |
| 1 | 0 | 1 | 1 | 0 | – | – | 22/335 | – |

NOTE – x = irrelevant.

**3.4.2**     Bit b5 of DBB 2 when set to "1" shall signify that the VITC word carried in the ancillary time code word, when converted to an analogue video output signal, shall be inserted on the selected line number and shall be repeated again on the selected line number +2 (see Table 2-2, bit b5 = 1).

**3.4.3**     Bits b7 and b6 of the DBB 2 word represent different time code condition bits (see Table 2-3). Data errors indicated by the error detection system of the received time code signal at the input receiving interface to the ancillary time code formatter and the type of processing of receiving user bits shall be signalled by these bits in the transmitted ATC word. The coding of these two bits is shown in Table 2-4.

TABLE 2-3

**Distributed binary bit group coding**

| DBB group | Bit 3 of UDW | Distributed binary bit (DBB) MSB          LSB | Definition |
|---|---|---|---|
| DBB 1 | UDW$_{10}$-1 through UDW$_{10}$-8 | 0 0 0 0 0 0 0 0 | Longitudinal time code |
| | | 0 0 0 0 0 0 0 1 | Vertical interval time code No. 1 |
| | | 0 0 0 0 0 0 1 0 | Vertical interval time code No. 2 |
| | | 0 0 0 0 0 0 1 1 through 0 0 0 0 0 1 1 1 | User defined |
| | | 0 0 0 0 1 0 0 0 through 0 1 1 1 1 1 1 1 | Locally generated time address and user data (user defined) |
| | | 1 0 0 0 0 0 0 0 through 1 1 1 1 1 1 1 1 | Reserved |
| DBB 2 | UDW$_{10}$-9 | b0 | VITC line select (LSB) (Note) |
| | UDW$_{10}$-10 | b1 | VITC line select (Note) |
| | UDW$_{10}$-11 | b2 | VITC line select (Note) |
| | UDW$_{10}$-12 | b3 | VITC line select (Note) |
| | UDW$_{10}$-13 | b4 | VITC line select (MSB) (Note) |
| | UDW$_{10}$-14 | b5 | VITC line duplication (Note) |
| | UDW$_{10}$-15 | b6 | Time code validity |
| | UDW$_{10}$-16 | b7 | (User bits) process bit |

NOTE 1 – These bits are not used in interfaces which are in accordance with Recommendations ITU-R BT.1120 and ITU-R 2077, and shall be set to logical zero.

**3.5**     Mapping of the time code data into the UDW 1 thorough UDW 16 of the ancillary time-code data packet is shown in Table 2-5.

TABLE 2-4

**Coding of validity and process bits**

| VITC validity bit (b6) and process bit (b7) | Definition |
|---|---|
| b6 = 0 | No time code error received or locally generated time code address |
| b6 = 1 | Transmitted time code interpolated from previous time code (received a time code error) |
| b7 = 0 | Binary group of user bits in time code data stream are processed to compensate for latency |
| b7 = 1 | Binary groups of user bits in time code data stream are only retransmitted (no delay compensation) |

TABLE 2-5

**Mapping of time code data into UDW**

| UDW | | Time code bit | Time code definitions (as per Part 1) |
|---|---|---|---|
| 1 | b4 | 0 | Units of frames 1 |
| | b5 | 1 | Units of frames 2 |
| | b6 | 2 | Units of frames 4 |
| | b7 | 3 | Units of frames 8 |
| 2 | b4 | 4 | LSB binary group 1 |
| | b5 | 5 | xxx binary group 1 |
| | b6 | 6 | xxx binary group 1 |
| | b7 | 7 | MSB binary group 1 |
| 3 | b4 | 8 | Tens of frames 10 |
| | b5 | 9 | Tens of frames 20 |
| | b6 | 10 | Flag |
| | b7 | 11 | Flag |
| 4 | b4 | 12 | LSB binary group 2 |
| | b5 | 13 | xxx binary group 2 |
| | b6 | 14 | xxx binary group 2 |
| | b7 | 15 | MSB binary group 2 |
| 5 | b4 | 16 | Units of seconds 1 |
| | b5 | 17 | Units of seconds 2 |
| | b6 | 18 | Units of seconds 4 |
| | b7 | 19 | Units of seconds 8 |
| 6 | b4 | 20 | LSB binary group 3 |
| | b5 | 21 | xxx binary group 3 |
| | b6 | 22 | xxx binary group 3 |
| | b7 | 23 | MSB binary group 3 |
| 7 | b4 | 24 | Tens of seconds 10 |
| | b5 | 25 | Tens of seconds 20 |
| | b6 | 26 | Tens of seconds 40 |
| | b7 | 27 | Flag |
| 8 | b4 | 28 | LSB binary group 4 |
| | b5 | 29 | xxx binary group 4 |
| | b6 | 30 | xxx binary group 4 |
| | b7 | 31 | MSB binary group 4 |
| 9 | b4 | 32 | Units of minutes 1 |
| | b5 | 33 | Units of minutes 2 |
| | b6 | 34 | Units of minutes 4 |
| | b7 | 35 | Units of minutes 8 |
| 10 | b4 | 36 | LSB binary group 5 |
| | b5 | 37 | xxx binary group 5 |
| | b6 | 38 | xxx binary group 5 |
| | b7 | 39 | MSB binary group 5 |
| 11 | b4 | 40 | Tens of minutes 10 |
| | b5 | 41 | Tens of minutes 20 |
| | b6 | 42 | Tens of minutes 40 |
| | b7 | 43 | Flag |
| 12 | b4 | 44 | LSB binary group 6 |
| | b5 | 45 | xxx binary group 6 |
| | b6 | 46 | xxx binary group 6 |
| | b7 | 47 | MSB binary group 6 |

TABLE 2-5 (*end*)

| UDW | | Time code bit | Time code definitions (as per Part 1) |
|---|---|---|---|
| 13 | b4 | 48 | Units of hours 1 |
| | b5 | 49 | Units of hours 2 |
| | b6 | 50 | Units of hours 4 |
| | b7 | 51 | Units of hours 8 |
| 14 | b4 | 52 | LSB binary group 7 |
| | b5 | 53 | xxx binary group 7 |
| | b6 | 54 | xxx binary group 7 |
| | b7 | 55 | MSB binary group 7 |
| 15 | b4 | 56 | Tens of hours 10 |
| | b5 | 57 | Tens of hours 20 |
| | b6 | 58 | Flag |
| | b7 | 59 | Flag |
| 16 | b4 | 60 | LSB binary group 8 |
| | b5 | 61 | xxx binary group 8 |
| | b6 | 62 | xxx binary group 8 |
| | b7 | 63 | MSB binary group 8 |

NOTE 1 – Appropriate flag information for each television system as per Part 1 is inserted into the corresponding positions of Table 5 marked as "flag."

# 4       Transmission of ancillary time code packets

**4.1**      Multiple transmissions of ancillary time code packets per video frame code information are permissible under the provisions of this Recommendation.

NOTE 1 – This Recommendation permits transmission of different ATC packets within a single video frame; as for example an ATC packet containing LTC information and a second ATC packet containing VITC information. The time code information in these two ATC packets shall correspond to the relevant video frame.

**4.2**      Transmission of ancillary time code packets should be at least once per frame for LTC data word and once per field for VITC data word.

**4.2.1**      Only the 64 information bits of time code are transferred to the ATC. The LTC sync word (bits 64-79) and the VITC ("1"/"0") sync bit pairs and CRC word are omitted from the ancillary time code packets.

# 5       Ancillary time code packets location

**5.1**      Insertion of ancillary time-code (ATC) packets into any available location in the digital data stream is permitted under the provisions of this Recommendation, but it is recommended that packet insertion occurs within the vertical blanking interval after switching point of the interface. ATC information should correspond directly to the video after the switching point.

**5.1.1**      For systems implementing ITU-R BT.1120, the following ATC insertion points should be considered as the preferred location shown in Table 2-6. ATC packets shall be inserted into the Y channel of the interface.

TABLE 2-6

**Preferred locations for Insertion in HDTV signals**

| Type of time code | Location for multiplexing in 1125-line interlace and PsF systems | Location for multiplexing in 1125-line progressive systems |
|---|---|---|
| Packet for LTC | Horizontal ancillary data space of line 10 | |
| Packet for VITC #1 | Horizontal ancillary data space of line 9 | |
| Packet for VITC #2 | Horizontal ancillary data space of line 571 | --- |
| Packet for others | Available any horizontal ancillary data space except lines 9, 10 and 571 | Any lines except lines 9 and 10 |

**5.1.2** When dual link ITU-R BT.1120 interfaces are used for an 1125 line progressive system, the locations of embedded time code packets in each link are the same as for 1125-line interlaced formats.

**5.1.3** When ITU-R BT.656 or ITU-R BT.799 interfaces are used for SDTV signals the preferred location for insertion of ATC packets is in horizontal ancillary data space, following the second line after the line specified for switching.

**5.1.4** When multi-link ITU-R BT.2077 interfaces are used, the locations of embedded time code packets in each link are the same as for 1125-line progressive system.

**5.2** Frame or field address information (LTC or VITC) contained in an ATC packet shall correspond to the respective video frame or field in which the ATC packet resides. Look-ahead compensation shall be applied to the time code (LTC or VITC) frame count when converting between ATC and either LTC or VITC.

**5.3** Transmission of the VITC word for field 1 or field 2 in the ancillary time code word is signalled by a corresponding field flag defined in Part 1 located in the ancillary binary group of the ATC word (see Table 2-5). This same flag shall be used to identify a two-frame sequence when the frame rate is greater than 30 Hz.

# PART 3

# Time code and its ancillary data signal format (greater than 60 Hz)

## 1 Introduction

This Part defines time code formats with frame counts of 72, 96, 100 and 120 and the frame count 120 with drop-frame compensation. This Part also defines the formatting of the ancillary data packet for the High Frame Rate (HFR) time code of Serial Digital interfaces. Reserved bits are assigned for possible future extended frame counts, i.e. counts greater than 120 frames up to 960 frames.

Figure 3-1 illustrates the time code as defined in Part 1 and the time code defined in this Part.

FIGURE 3-1

**Relationship between the Time Code defined in Part 1 and in Part 3**
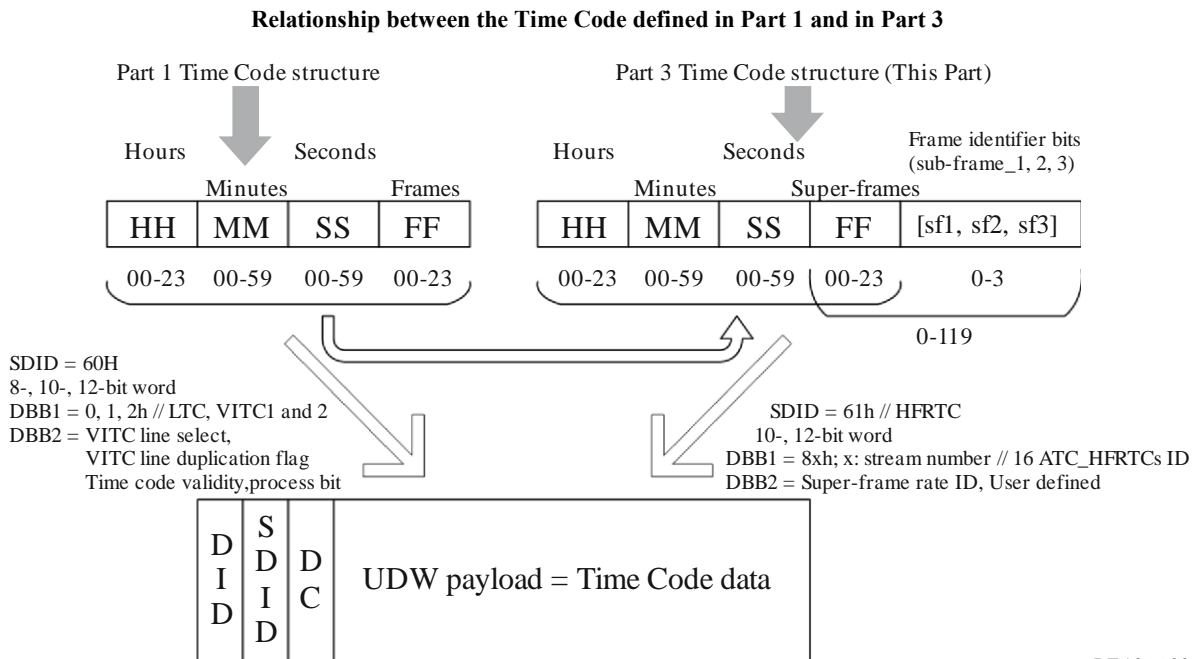


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Overview – e.g. 120 (24x5) frames The time code defined in this Part inherits the time address structure from Part 1 and defines the frame identifier bits (sub-frame_1, sub-frame_2, sub-frame_3, sub-frame_4 and sub-frame_5, (see § 2.2) to extend the frame counts. Use is made of a 'super-frame' (defined § 2.1) 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 this Part 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 Part 1, the use of binary group flags in this Part is deprecated.

This Part defines three differences so as to be able to embed the HFR time code into the ATC defined in Part 1.

1/ SDID code is defined as 61h to indicate a HFR ancillary time code packet.

2/ DBB1 is defined as 8xh where 'x' identifies a HFR time code from up to 16 ATCs.

3/ 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. See § 5.2.2.

## 2      Representation of Time Address in Time Code

### 2.1      Super-frame

A super-frame shall be a group of N frames such that the super-frame count is compatible with Part 1 time code as shown in Table 3-1.

TABLE 3-1

**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 (see § 5.2.2). DBB2 defines the representation of N in DBB2.

## 2.2 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 3-2. The frame identifier bits comprise the frame identifier number which identifies a count for a frame within a super-frame.

Table 3-2 shows the positions of the frame identifier bits within the codeword.

TABLE 3-2

**Frame identifier bit positions**

| 120, 120DF frames (30, 30DF x 4) | 100 frames | 120 frames (24x5) | 96, 72 frames | Part 1 TC. (informative) |
|---|---|---|---|---|
| 11: Sub-frame_2 | 11: Sub-frame_2 | 11: Sub-frame_2 | 11: Sub-frame_2 | Colour 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 § 3.3).

NOTE 1 – *Sub-frame_3 (except 24x5), Sub-frame_4 or sub-frame_5 are not used in this version of this Recommendation, they 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 Part 1 time code. 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. 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.

## 2.3      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

frame number = {10 x (Tens of super-frames) + (Units of super-frames)} x N + (sub-frame_1 bit
            x $1/2^1$ + sub-frame_2 bit x $1/2^2$) x $2^2$

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

frame number = {10 x (Tens of super-frames) + (Units of super-frames)} x N + (sub-frame_1 bit
            x $1/2^1$ + sub-frame_2 bit x $1/2^2$ + sub-frame_3 bit x $1/2^3$) x $2^3$

For 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 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].

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

### 2.4.1   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 § 2.3.

### 2.4.2 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 s in one hour of elapsed time.

### 2.4.3 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).

### 2.5 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 § 2.3

### 2.6 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 § 2.3.

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.

## 3 Structure of the Time Code

## 3.1 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.

## 3.2 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 § 2.3.

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. The decimal digits of each time address are coded into 26 bits.

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

TABLE 3-3

**Time address and a flag bit positions**

| Bit | Definition | | | |
|---|---|---|---|---|
| | **120, 120DF frames (30, 30DF x 4),** | **100 frames** | **120 frames (24x5)** | **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 Recommendation, they are intended to enable future extension to higher frame counting beyond 120 frames and are zero.

### 3.3    Drop frame flag

This flag shall be set to logical one when drop-frame compensation is being performed as defined in § 2.4.3. 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.

## 3.4 Use of the Binary Group

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

## 3.5 Codeword Format

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

## 3.6 Codeword Data Content

Each codeword shall consist of the time address, the flag bit and the binary group as listed in Table 3-4.

TABLE 3-4

**Codeword bit positions**

| Bit | Definition | | |
|---|---|---|---|
| | **120, 120DF frames (30, 30DF x 4)** | **100 frames** | **120 (24x5), 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 Recommendation, they are intended to enable future extension to higher frame counting beyond 120 frames and are zero.

**4        Format of Ancillary Time Code Packets**

The format of Ancillary Time Code Packet shall be as defined in Part 1, for HFR time code the DID and SDID shall be set to:

    DID    60h

    SDID   61h

**5        Format of User Data Words in Ancillary Time Code Packets**

**5.1      General**

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

For digital HDTV interfaces conforming to Recommendation ITU-R BT.1120 and ITU-R BT.2077 only 10-bit operation is suggested for ancillary data signals. See Recommendation ITU-R BT.2077 Part 2 for ANC data packet mapping for 12 bit mapping details.

**5.2      Distributed Binary Bits (DBB)**

DBB1 and DBB2 shall be as defined in Part 1. Information coded in the DBB1 and DBB2 distributed binary bit groups are defined in Table 3-5 and Table 3-7.

**5.2.1    DBB1 – Payload Type**

ATC_HFR_TC shall have the distributed binary bit group 1 (DBB1) value of 8xh as defined in Table 3-5. The bitstream number is given by the notation 'x' and is used to identify different ATC_HFR_TC. 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 3-5

**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_HFR_TC) |
| | 1 0 0 1 0 0 0 0 through 1 1 1 1 1 1 1 1 | Reserved |

**5.2.2    DDB2**

The assignments of DBB2 are defined in Table 3-7. Bit b7 is reserved and shall be set to zero.

Bits b5 and b6 shall be used to identify the frame count of the super-frame defined in § 3.1 and shall be set as follows:

TABLE 3-6

**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'.

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

Where *[b4, b3, b2, b1, b0]* $\neq$ *[0, 0, 0, 0, 0]*

*N = 32*

Where *[b4, b3, b2, b1, b0] = [0, 0, 0, 0, 0]*

TABLE 3-7

**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 3-6 |
| UDW-14 | | |
| UDW-13 | b4 through b0 | *N* as per equations above |
| UDW-12 | | |
| UDW-11 | | |
| UDW-10 | | |
| UDW-9 | | |

## 5.3    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 3-8.

TABLE 3-8

**Mapping of Time Code Data into UDW**

| ATC | | | Time Code Data | | |
|---|---|---|---|---|---|
| | | | Time code bit definitions | | |
| UDW | Bit | Codeword bit | 120-frames (30 x 4) | 100-frames | 120 (24x5), 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 | | |

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

# 6 Transmission of Ancillary Time Code Packets

## 6.1 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 Part. The bit stream number (see § 5.2.1) is used to identify different ATC_HFRTC.

## 6.2 ATC Packet Transmission Rate

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

# 7 Ancillary Time Code Packet Location

## 7.1 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 Recommendation, but it is recommended that packet insertion occurs after the vertical interval switch point of the interface. ATC data shall be inserted into the Y Channel of the interface.

## 7.2 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 Recommendation for the format. ATC may be inserted within the available ancillary data space located within vertical blanking interval after the switching point and before the beginning of active video.

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