



**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**

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| <b>SF</b>  | Frequency sharing and coordination between fixed-satellite and fixed service systems |
| <b>SM</b>  | Spectrum management                                                                  |
| <b>SNG</b> | Satellite news gathering                                                             |
| <b>TF</b>  | Time signals and frequency standards emissions                                       |
| <b>V</b>   | Vocabulary and related subjects                                                      |

**Note:** This ITU-R Recommendation was approved in English under the procedure detailed in Resolution ITU-R 1.

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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)

**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 Time 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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- 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 UHD TV 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:

$$1 \text{ sec}_{DFT} = 1.001 \text{ sec}_{REAL}$$

*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.

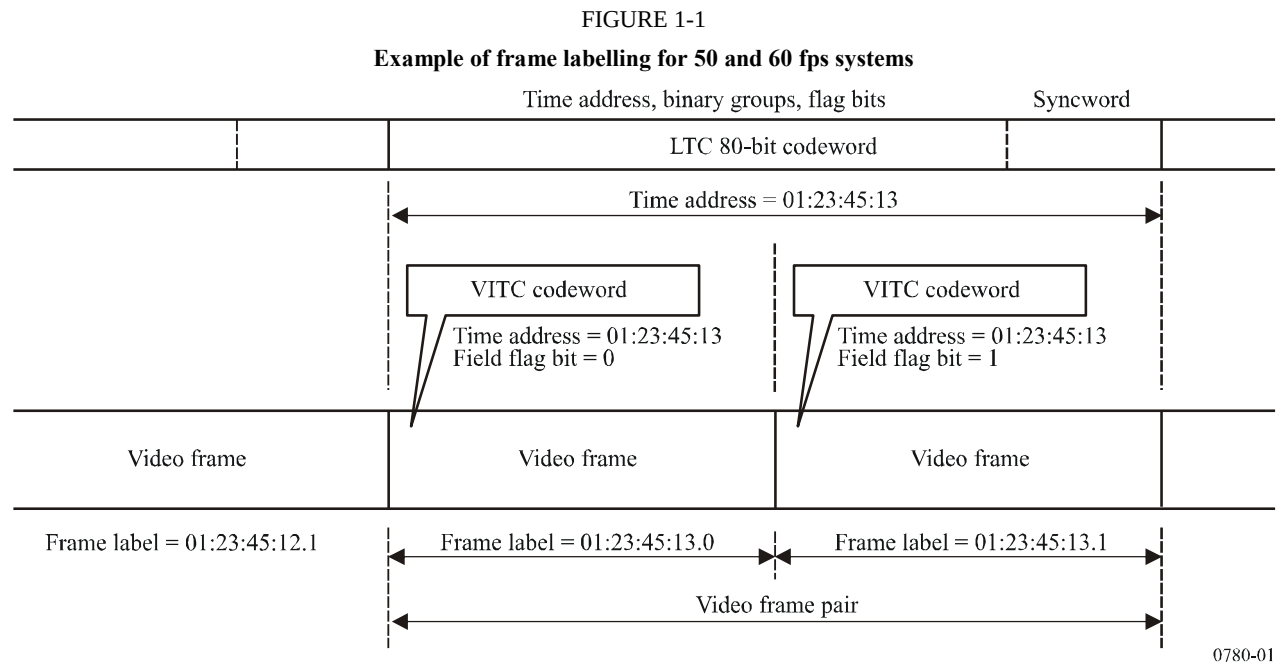
Where it is desired to maintain a correspondence with 25 frame systems the techniques described in Annex 2 to Part 1, § 2 mode should be used.

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.



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.

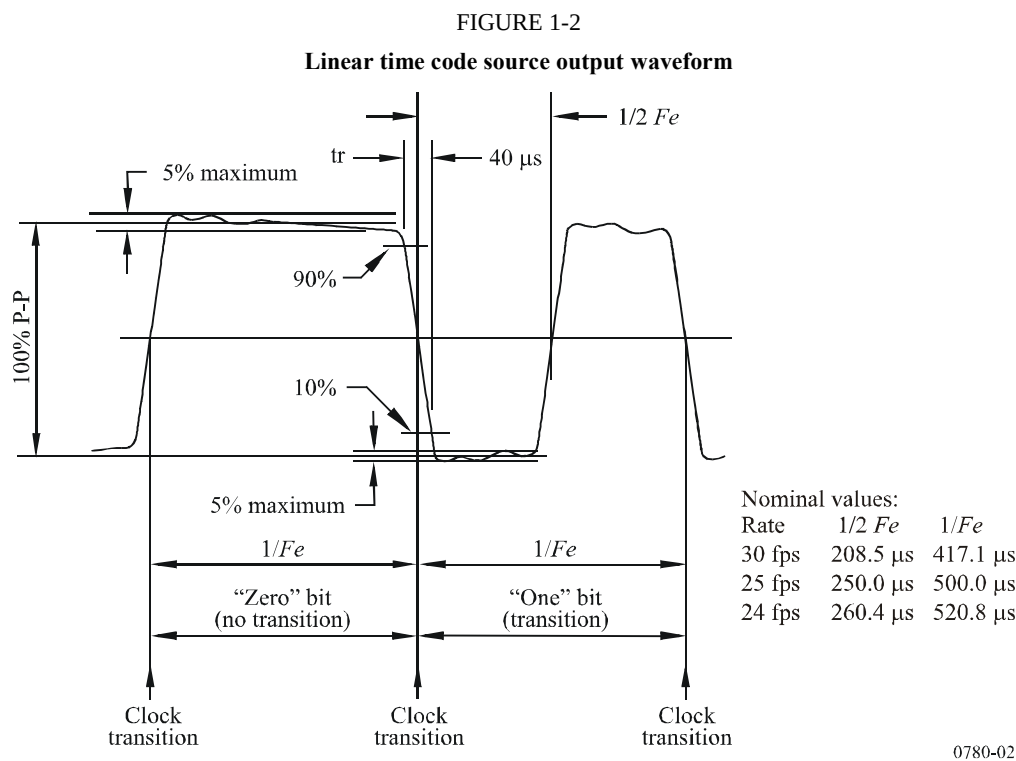
## 6.8 Modulation method

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.



## 6.9 Bit rate

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

$$F_e = 80 \times F_f$$

where  $F_f$  is the frame rate of the television or film system.

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

## 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  $\times$  1080 formats the reference datum is at the beginning of line 1. The tolerance is +160/–32  $\mu$ s (see Fig. 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  $+160/-32 \mu\text{s}$  (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  $-32/+160 \mu\text{s}$  (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  $-32/+160 \mu\text{s}$  (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  $-32/+160 \mu\text{s}$  (see Fig. 1-3c)

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FIGURE 1-3a

**30-frame linear time code example**

