PROPOSED SMPTE STANDARD

SMPTE 12M
Revision of ANSI/SMPTE 12M-1986

for Television, Audio and Film — Time and Control Code

1 Scope

This standard specifies a digital time and control code for use in television, film, and accompanying audio systems operating at 30, 25, and 24 frames per second.

Clauses 4, 5, and 6 specify the manner in which time is represented in frame-based systems. Clause 7 describes the structure of the time address and control bits of the code, and sets guidelines for storage of user data in the code. Clause 8 specifies the modulation method and interface characteristics of a linear time code (LTC) source. Clause 9 specifies the modulation method for inserting the code into the vertical interval of a television signal. Clause 10 summarizes the relationship between the two forms of time and control code.

2 Normative references

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

ANSI/SMPTE 125M-1992, Television — Component Video Signal 4:2:2 — Bit-Parallel Digital Interface

ANSI/SMPTE 170M-1994, Television — Composite Analog Video Signal — NTSC for Studio Applications

ANSI/SMPTE 258M-1993, Transfer of Edit Decision Lists

SMPTE 262M, Television, Audio and Film — Storage and Transmission of Data — Binary Groups of Time and Control Codes

SMPTE 240M-1994, Television — Signal Parameters — 1125-Line High-Definition Production Systems

SMPTE 260M-1992, Television — Digital Representation and Bit-Parallel Interface — 1125/60 High-Definition Production System

SMPTE RP 159-1991, Vertical Interval Time Code and Longitudinal Time Code Relationship

SMPTE RP 164-1992, Location of Vertical Interval Time Code

SMPTE RP 169, Television, Audio and Film Time and Control Code — Auxiliary Time Address Data in Binary Groups — Dialect Specification of Directory Index Locations

ISO/IEC 646:1991, Information Technology — ISO 7-Bit Coded Character Set for Information Interchange

ISO 2022:1986, Information Processing — ISO 7-Bit and 8-Bit Coded Character Sets — Code Extension Techniques

ITU-R 470-3 Annex, Television Systems

3 Definitions

3.1 Linear time code (LTC)

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

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3.2 Vertical interval time code (VITC)

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

3.3 Source

A time and control code source is any device which generates a time and control code signal, or regenerates a time and control code signal from a recorded medium or transmission channel. An original source refers specifically to the device which is generating the time and control code signal.

3.4 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 1×2^0, 1×2^1, 1×2^2, and 1×2^3, while the bit weights for a "tens" digit would be 10×2^0, 10×2^1, 10×2^2, and 10×2^3.

4 Time representation in 30-frame systems

4.1 Definitions of real time and NTSC time

4.1.1 In a system running at a frame rate of 30 frames per second, exactly one second of real time elapses during the scanning of 30 frames. An example of such a system is an 1125/60 high-definition system.

4.1.2 In an NTSC television system running at a vertical field rate of 60/1.001 fields per second (≈ 59.94 Hz), one second of NTSC time elapses during the scanning of 60 television fields or 30 television frames. Because of the difference in vertical scanning rates, the relationship between real time and NTSC time is:

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

4.2 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. Refer to SMPTE 258M for standard formats used to display frame-based time.

The hours, minutes, and seconds follow the ascending progression of a 24-hour clock beginning with 0 hours, 0 minutes, and 0 seconds to 23 hours, 59 minutes, and 59 seconds. The frames shall be numbered successively according to the counting mode (drop frame or nondrop frame) as described below:

4.2.1 Nondrop frame — Uncompensated mode

Frames shall be numbered 0 through 29, successively, with no omissions.

4.2.2 Drop frame — NTSC time compensated mode

Because the vertical field rate of an NTSC television signal is 60/1.001 fields per second (≈ 59.94 Hz), straightforward counting at 30 frames per second will yield an error of approximately +108 frames (+3.6 sec_{REAL}) in one hour of running time.

To minimize the NTSC time error, the first two 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.

When drop-frame compensation is applied to an NTSC television time code, the total error accumulated after one hour is reduced to –3.6 ms. The total error accumulated over a 24-hour period is –86 ms.

4.3 Color frame identification in 525/60 television systems

If color frame identification in the time code is required, the even units of frame numbers shall identify color fields I and II, and the odd units of frame numbers shall identify color fields III and IV.

5 Time representation in 25-frame systems

5.1 Definition of real time

In a system running at a frame rate of 25 frames per second, exactly one second of real time elapses during the scanning of 25 frames. An example of such a system is a 625/50 television system.

5.2 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-hour clock beginning with 0 hours, 0 minutes, and 0 seconds to 23 hours, 59 minutes, and 59 seconds. The frames shall be numbered successively 0 through 24.

5.3 Color frame identification in 625/50 television systems

If identification of the eight-field color sequence in the time code is required, the time address shall bear a predictable relationship with the eight-field color sequence (as specified in ITU-R 470-3). This relationship can be expressed using either logical or arithmetic notations as given in 5.3.1 and 5.3.2, respectively.

5.3.1 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) ^ C ^ D ^ E ^ F shall be:

"1" for fields 1, 2, 3, and 4,
"0" for fields 5, 6, 7, and 8

where:

A equals the value of the 1's bit of the frame number;
B equals the value of the 1's bit of the second number;
C equals the value of the 2's bit of the frame number;
D equals the value of the 10's bit of the frame number;
E equals the value of the 2's bit of the second number;
F equals the value of the 10's bit of the second number;
| represents the logical OR operation,
^ represents the logical EXCLUSIVE OR operation.

5.3.2 Arithmetic relationship

The remainder of the quotient:

$$\frac{(S + P)}{4}$$

shall be:

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 equals the decimal value of the "seconds" digits of the time address, and P equals the decimal value of the frames digits of the time address.

6 Time representation in 24-frame systems

6.1 Definition of real time

In a system running at a frame rate of 24 frames per second, exactly one second of real time elapses during the passing of 24 frames. An example of such a system is a film system.

6.2 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-hour clock beginning with 0 hours, 0 minutes, and 0 seconds to 23 hours, 59 minutes, and 59 seconds. The frames shall be numbered successively 0 through 23.

7 Structure of the time address and control bits

7.1 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.

7.2 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. Thus, the entire time address is coded into 26 bits.

7.3 Flag bits

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

7.3.1 Drop frame flag (525/60 television system only)

This flag shall be set to "one" when drop-frame compensation is being performed as specified in 4.2.2. When the count is not drop-frame compensated, this flag bit shall be set to "zero."

7.3.2 Color frame flag (525/60 and 625/50 television systems only)

If color frame identification has intentionally been applied to the time and control code by the original source, as defined in 4.3 or 5.3, this flag shall be set to "one."

Color frame identification may be forced by an original source of time and control code by halting the time address until the color field to time code relationship is satisfied, after which the time address is incremented normally each frame. As long as neither the time address counting sequence nor the color field sequence is changed, the relationship will remain satisfied.

7.3.3 Binary group flags

Three flags provide eight unique combinations which specify the use of the binary groups (see 7.4).

7.3.4 Modulation method specific flag

The remaining flag bit is reserved for use by each modulation method. This flag is defined in 8.2.5 and 9.2.4.

7.4 Use of the binary groups

The binary groups are intended for storage and transmission of data by the 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 sections define the current assignments of the binary group flag states. Table 1 summarizes the present assigned combinations.

7.4.1 Character set not specified (BGF2=0, BGF1=0, BGF0=0)

This combination of binary group flags 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 in any manner without restriction.

7.4.2 Eight-bit character set (BGF2=0, BGF1=0, BGF0=1)

This combination specifies an eight-bit character set conforming to ISO/IEC 646 or ISO 2022. If the seven-bit ISO codes are being used, then 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.

7.4.3 Page/line multiplex system (BGF2=1, BGF1=0, BGF0=1)

This combination specifies the page/line multiplex system described in SMPTE 262M. This multiplex system defines a hierarchy which can be used to encode large amounts of data in the binary groups through the use of time multiplexing. Applications for this encoding scheme include control codes, text data, and production information.

7.4.4 Unassigned binary group flag states

Unassigned combinations of the binary group flags are reserved and should not be used until assigned by the SMPTE.

Table 1 – Binary group flag assignments

BGF2	BGF1	BGF0	Assignment
0	0	0	Unspecified
0	0	1	8-bit codes
0	1	0	Unassigned
0	1	1	Unassigned
1	0	0	Unassigned
1	0	1	Page/line
1	1	0	Unassigned
1	1	1	Unassigned

8 Linear time code application

8.1 Code word format

Each LTC code word consists of 80 bits numbered 0 through 79. The bits are generated serially beginning with bit 0. Bit 79 of the code word is followed by bit 0 of the next code word. Each code word is associated with one television or film frame.

8.2 Code word data content

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

8.2.1 Time address

The time address bits of the frame as defined in 7.2. The lowest numbered bit of each group corresponds to the least significant bit of each BCD digit. The bit positions are tabulated in table 2.

Table 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

8.2.2 Flag bits

The drop frame, color frame, and binary group flag bits, as defined in 7.3. The bit positions are listed in table 3. Note that not all flag bits are used by all systems, as designated by the symbol "—." Unused flag bits should be set to zero by original sources and ignored by receiving equipment.

Table 3 – LTC flag bit positions

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

8.2.3 Binary groups

Eight 4-bit binary groups as defined in 7.3. 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 4.

Table 4 – 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

8.2.4 Synchronization word

The synchronization word is a static combination of bits which can be used by receiving equipment to accurately identify the bit position of the serial code. 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 center 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.

Table 5 – LTC synchronization word bit positions and values

Bit	Sync word 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

8.2.5 Biphase mark polarity correction

This flag bit is specific to the LTC modulation method described in 8.3. The position of this flag is listed in table 3.

Because of the nature of the modulation method, the polarity of the first clock transition of the first bit of the synchronization word may differ from code word to code word depending on the number of logical zeros in the data.

Applications which switch between two sources of time and control code 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. This requirement is summarized as follows:

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," else the polarity correction bit shall be set to "zero."

8.3 Modulation method

The NRZ unmodulated signal is biphase mark encoded according to the following coding rules (see figure 1):

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

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

3) 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.

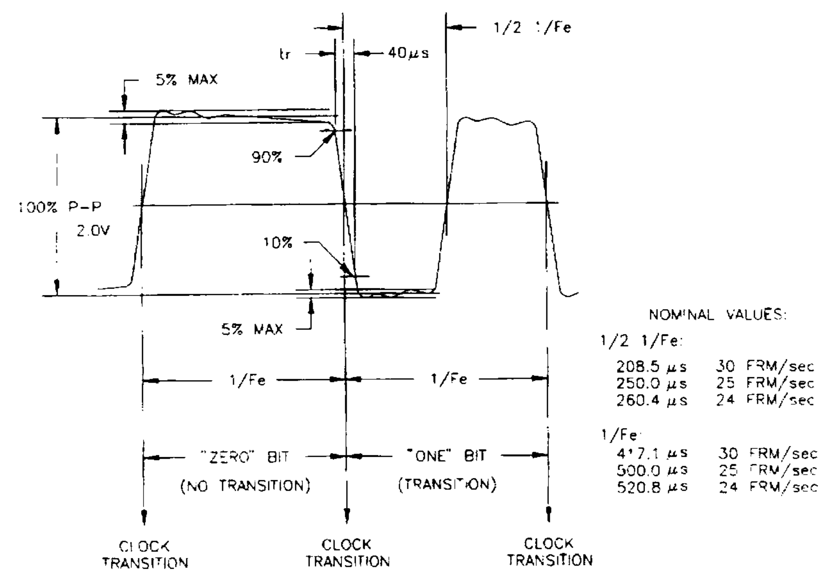


Figure 1 – Linear time code source output waveform

8.4 Bit rate

The bits shall be evenly spaced throughout the address period, and shall occupy fully the address period which is one frame or two television fields. Consequently, the nominal frequency, F_e, at which the bits are generated shall be:

$$F_e = 80 \bullet F_f$$

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

If an original source is generating an LTC signal referenced to a television signal, the bit clock shall be phase locked to the television signal. If an original source is generating an LTC signal without a reference, the frequency tolerance shall be ± 100 ppm.

8.5 Timing of the code word relative to a television signal

8.5.1 525/60 television systems

The first transition of bit 0 of the code word shall occur at the beginning of line 5 of the frame with which it is associated. The tolerance shall be ± 1½ lines (see figure 2a).

8.5.2 1125/60 television systems

The first transition of bit 0 of the code word shall occur at the vertical sync timing reference of the frame with which it is associated. The tolerance shall be ± 1 line (see figure 2b).

8.5.3 625/50 television systems

The first transition of bit 0 of the code word shall occur at the beginning of line 2 of the frame with which it is associated. The tolerance shall be ± 1½ lines (see figure 2c).

8.6 Linear time code interface electrical and mechanical characteristics

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

8.6.1 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.

8.6.2 Amplitude distortion

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

8.6.3 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.

8.6.4 Interface connector

The preferred connector for double-ended or balanced outputs shall be 3-pin XLR (MALE) and inputs shall be 3-pin XLR (FEMALE). 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 shall be BCN (FEMALE).

8.6.5 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.

8.6.6 Output amplitude

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

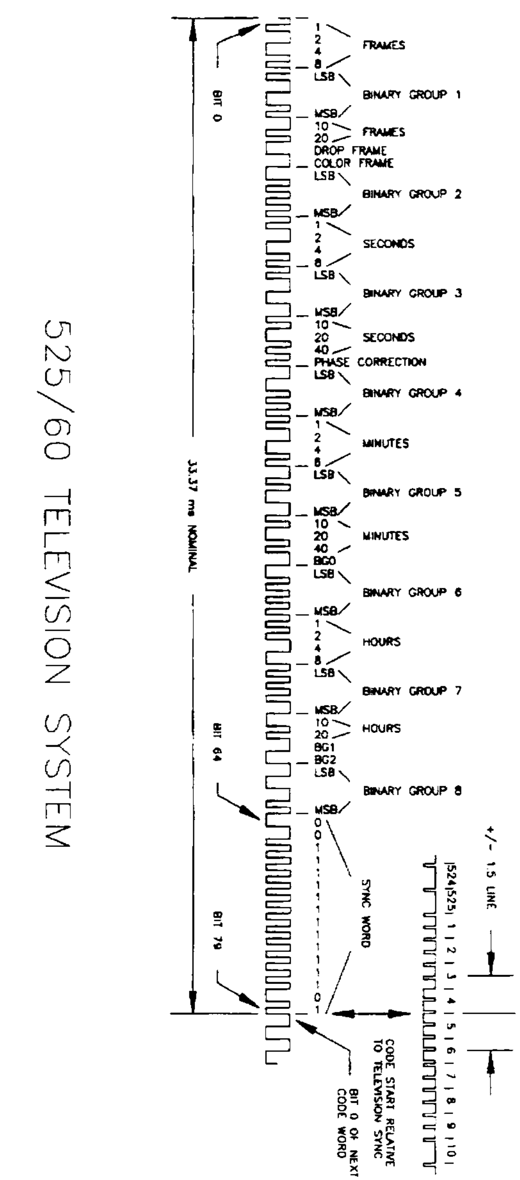


Figure 2a –30-frame linear time code example

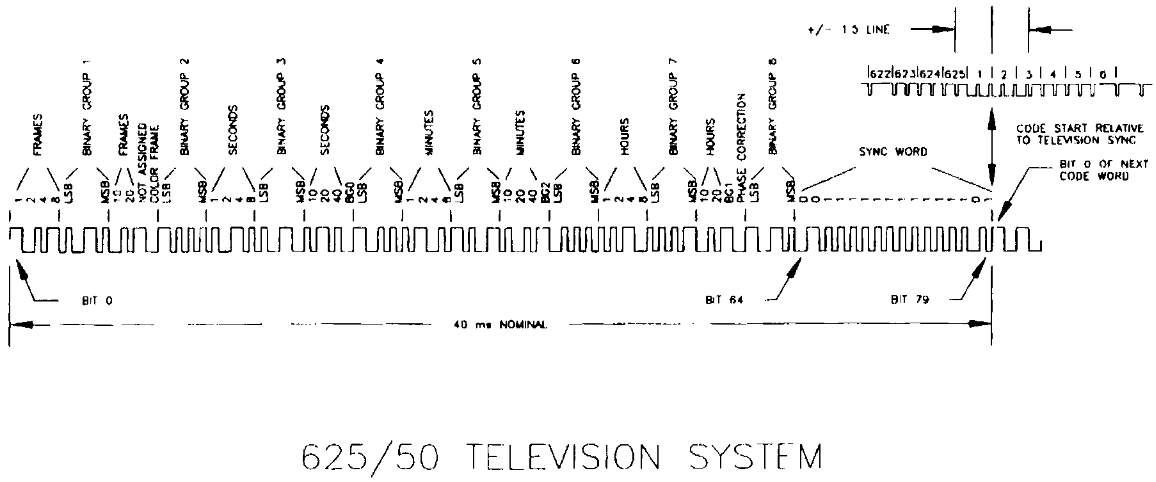


Figure 2c – 25-frame linear time code example

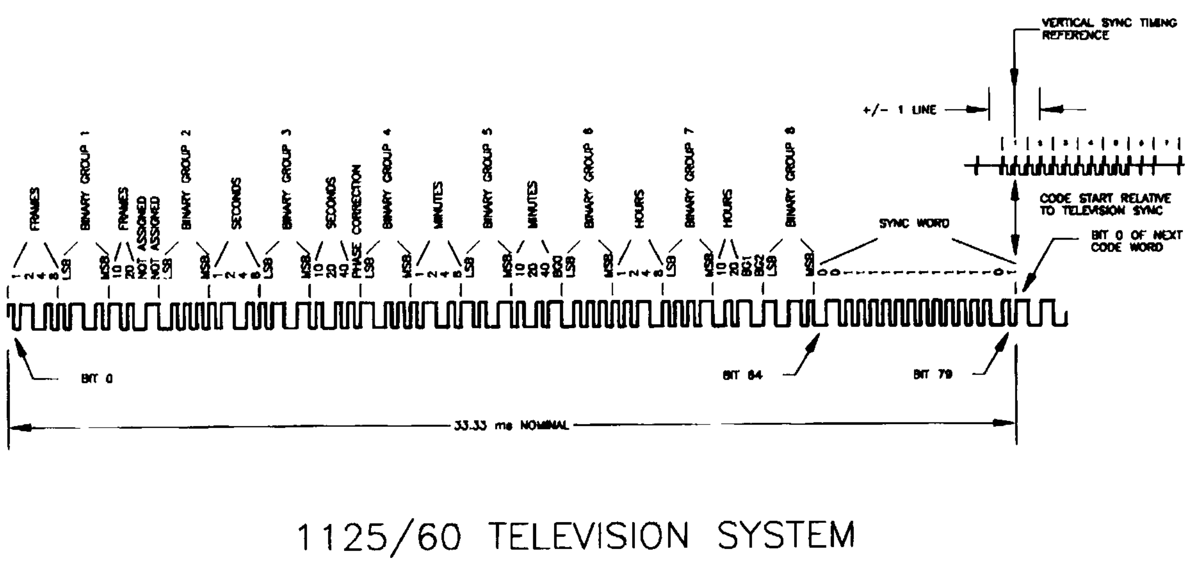


Figure 2b – 30-frame linear time code example

24-FRAME FILM SYSTEM

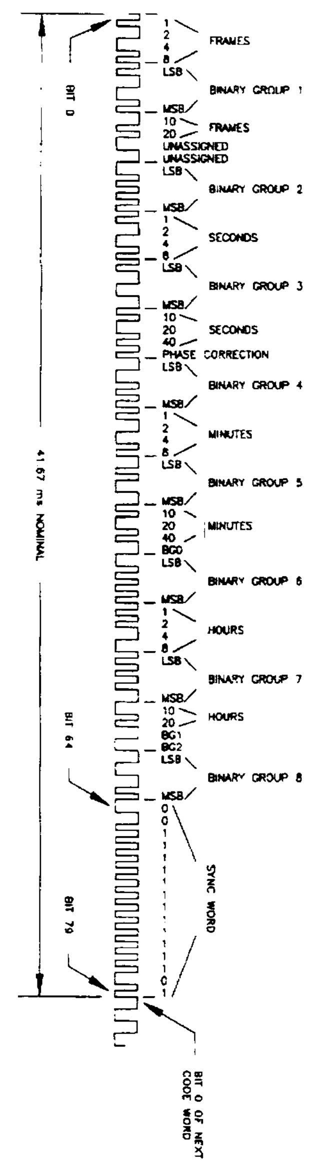


Figure 2d – 24-frame linear time code example

9 Vertical interval application — television systems

9.1 Code word format

Each code word shall consist of 90 bits numbered 0 through 89, organized as nine groups of ten bits. Each ten-bit group starts with a synchronization bit pair, which is a one bit followed by a zero bit. The synchronization bit pair is followed by eight data bits.

The first eight groups contain the sixty-four 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 code word, it shall always have the value of one thus there will always be a rising transition at the leading edge of bit 0 to signal the start of the word.

9.2 Code word data content

Each VITC code word consists of a time address, flag bits, binary groups, field mark flag, CRC code, and synchronization bits. Refer to figures 3a, 3b, and 3c for examples of the VITC signal.

9.2.1 Time address

The time address bits of the frame as defined in 7.2. 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 6.

Table 6 – VITC time address bit positions

Bit	Definition
2–5	Units of frames
12–13	Tens of frames
22–25	Units of seconds
32–34	Tens of seconds
42–45	Units of minutes
52–54	Tens of minutes
62–65	Units of hours
72–73	Tens of hours

9.2.2 Flag bits

The drop frame, color frame, and binary group flag bits as defined in 7.3. The positions of these flags are listed in table 7. Note that not all flag bits are used by all systems, as designated by the symbol "—". Unused flag bits should be set to zero by original sources, and ignored by receiving equipment.

Table 7 – VITC flag bit positions

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

9.2.3 Binary groups

Eight 4-bit binary groups are defined in 7.4. 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 8.

Table 8 – VITC binary group bits

Bit	Definition
6–9	First binary group
16–19	Second binary group
26–29	Third binary group
36–39	Fourth binary group
46–49	Fifth binary group
56–59	Sixth binary group
66–69	Seventh binary group
76–79	Eighth binary group

9.2.4 Field mark flag

The position of this flag is listed in table 7.

9.2.4.1 525/60 television system

Field identification shall be recorded as follows: A "zero" shall represent monochrome field 1 and color field I or III. A "one" shall represent monochrome field 2 or color field II or IV. Color fields I through IV are defined in ANSI/SMPTE 170M.

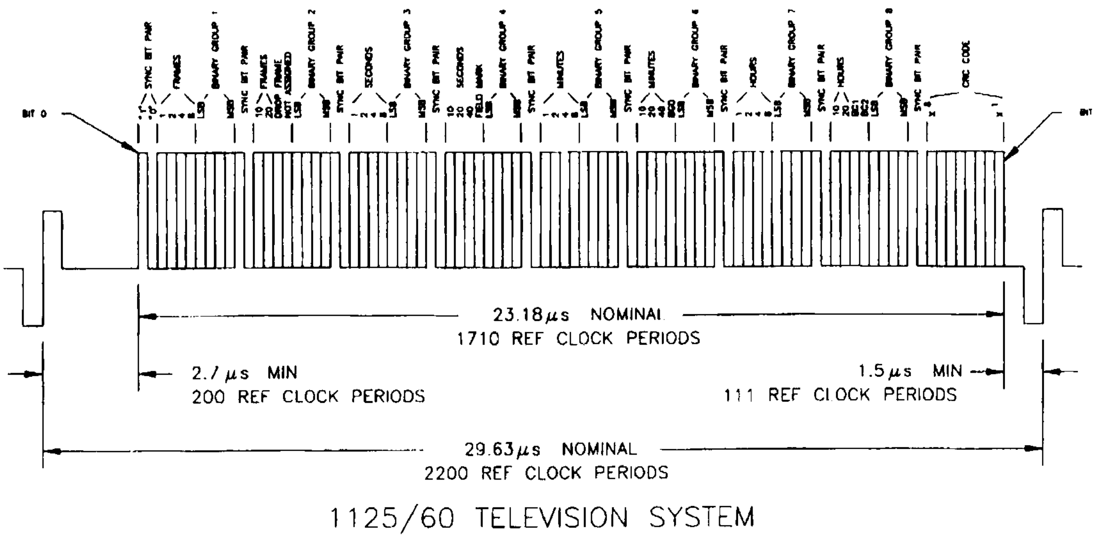


Figure 3b – 1125/60 vertical interval time code address bit assignment and timing

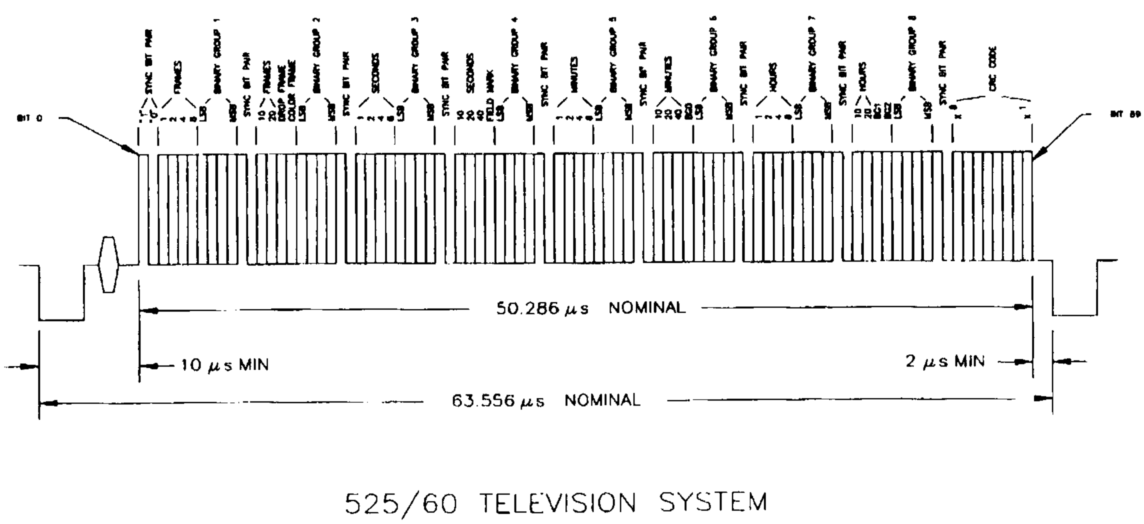
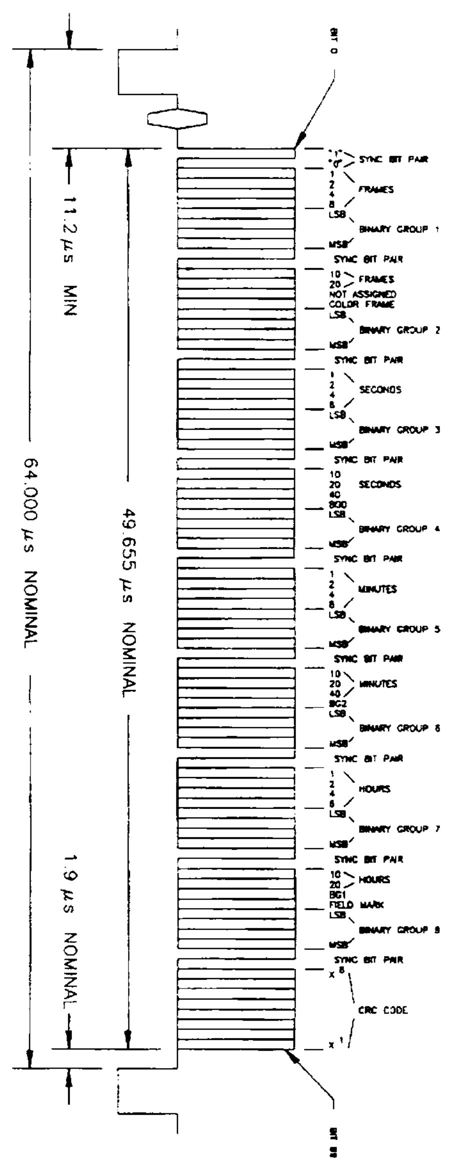


Figure 3a – 525/60 vertical interval time code address bit assignment and timing



625/50 TELEVISION SYSTEM

Figure 3c – 625/50 vertical interval time code address bit assignment and timing

9.2.4.2 1125/60 television system

Field identification shall be recorded 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 SMPTE 240M.

9.2.4.3 625/50 television system

Field identification shall be recorded as follows: A "zero" shall represent color fields 1, 3, 5, and 7. A "one" shall represent color fields 2, 4, 6, and 8. Color fields 1 through 8 are defined in ITU-R 470-3 Annex.

9.2.5 Synchronization bits

A synchronization bit pair consisting of a "one" followed by a "zero" is inserted preceding every eight 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.

9.2.6 Cyclic redundance check code

Eight bits, 82 through 89, are encoded with a CRC code to provide for error detection by cyclic redundance.

The generating polynomial of the cyclic redundance check, 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 9.

Table 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

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.

9.3 Modulation method

The NRZ unmodulated signal is time compressed and inserted as a burst within the nonblanked interval of a selected television line in the vertical interval (see figure 4). Signal level to logic level specifications are listed in 9.8.1.

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. Because of the insertion of fixed-value synchronization bits, a transition is guaranteed to occur at least every ten bits.

9.4 Bit timing

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

$$T_e = \frac{1}{115 \bullet F_h} \pm 2\%$$

NOTE – Previous definitions of the bit timing for 525/60 and 625/50 television systems are different from that given here, but do lie within the tolerance range given.

In 1125/60 television systems, if the reference clock is used to generate the bit timing, then T_e shall be equal to 19 times the reference clock as defined in SMPTE 240M.

9.5 Timing of the code word relative to the television signal

9.5.1 525/60 television system

The half-amplitude point 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.

9.5.2 1125/60 television system

The half-amplitude point 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.

9.5.3 625/50 television system

The half-amplitude point 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.

9.6 Location of the address code signal in the vertical interval

The VITC code word shall be inserted on the same line (or lines) in all fields for a given recording. Line numbers shown in parentheses correspond to the equivalent line in field two.

9.6.1 525/60 television system

Insertion of the address code shall not be earlier than line 10(273) or later than line 20(283). The preferred placement of the VITC code word is outlined in SMPTE RP 164.

9.6.2 1125/60 television system

Insertion of the address code shall not be earlier than line 7(569) or later than line 40(602).

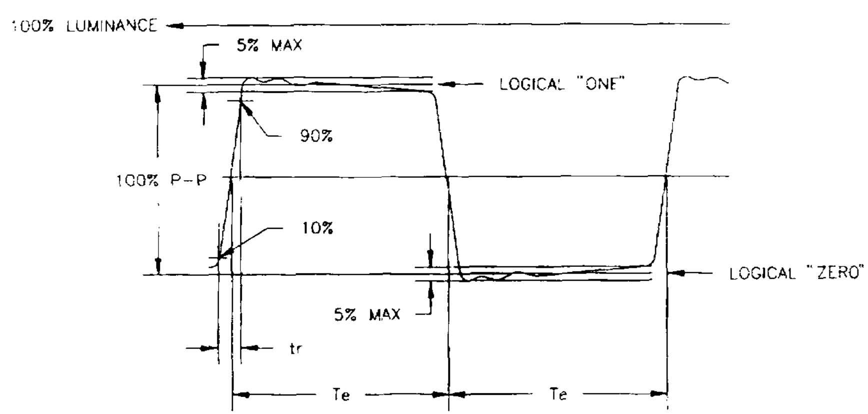
9.6.3 625/50 television system

Insertion of the address code shall not be earlier than line 6(319) or later than line 22(335).

9.7 Redundancy

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

Redundancy of the binary group data is dependent on the binary group flags and the requirements of the encoding system which their values indicate.



NOTE – See 9.8 for values and tolerances of T_e, t_r, logic "one," and logic "zero."

Figure 4 – Vertical interval time code waveform

9.8 Vertical interval time code waveform characteristics

This clause specifies the waveform characteristics of the VITC signal (refer to figure 4).

9.8.1 Logic level

The tolerance ranges specified for logical "one" and logical "zero" states are listed in table 10.

Table 10 – VITC logic level ranges

Television system	Logical "one"	Logical "zero"
525/60	70–90 IRE	0–10 IRE
1125/60	500–600 mV	0–25 mV
625/50	500–600 mV	0–25 mV

9.8.2 Rise/fall time

The rise and fall times of the code shall be 200 ns ± 50 ns for 525/60 and 625/50 television systems, and 100 ns ± 25 ns for 1125/60 television systems. These measurements shall be made between 10% and 90% amplitude points on the waveform.

9.8.3 Amplitude distortion

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

10 Relationship between LTC and VITC

10.1 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 linear time code from a vertical interval time code, or vice versa, the time address of one frame is incremented by one and used as the time address of the next frame. Drop frame and color frame flag bits (if applicable) are maintained.

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

10.2 Binary group data

When transferring binary group data, a one-frame update, 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-frame delay.

The guideline for transferring binary group data between linear and vertical interval time codes shall be as follows:

10.2.1 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 vertical interval time code shall be transferred to the corresponding bits in the linear time code of the next frame.

10.2.2 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 vertical interval time code 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 vertical interval code 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.