PROPOSED SMPTE STANDARD

SMPTE 12M
Revision of ANSI/SMPTE 12M-1995

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

ANSI/SMPTE 125M-1995, 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 240M-1995, Television — Signal Parameters — 1125-Line High-Definition Production Systems

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

ANSI/SMPTE 262M-1995, Television, Audio and Film — Binary Groups of Time and Control Codes — Storage and Transmission of Data

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

SMPTE 309M, Television — Transmission of Date and Time Zone Information in Binary Groups of Time and Control Code

SMPTE RP 159-1995, Vertical Interval Time Code and Longitudinal Time Code Relationship

SMPTE RP 164-1996, Location of Vertical Interval Time Code

SMPTE RP 169-1995, 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/IEC 2022:1994, Information Technology — Character Code Structure and Extension Techniques

ITU-R BT.470-4 (1994) Annex, Television Systems

THIS PROPOSAL IS PUBLISHED FOR COMMENT ONLY

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).

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 ANSI/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 BT.470). 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 "80s" and "40s" of hours, "80s" of minutes, "80s" of seconds, and the "80s" and "40s" 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). Three combinations of these flags also specify the time address reference as an external precision clock time reference (see 7.5) and these also select subsets of the binary group applications.

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 clauses define the current assignments of the binary group flag states. Table 1 summarizes the present assigned combinations.

7.4.1 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 in any manner without restriction.

7.4.2 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

Table 1 – Binary group flag assignments

BGF2	BGF1	BGF0	Time address	Binary group	Reference
0	0	0	Unspecified	Unspecified	7.4.1
0	0	1	Unspecified	8-bit codes	7.4.2
1	0	0	Unspecified	Date and time zone	7.4.3
1	0	1	Unspecified	Page/line	7.4.4
0	1	0	Clock time	Unspecified	7.4.5, 7.5
0	1	1	Unassigned	Reserved	7.4.6
1	1	0	Clock time	Date and time zone	7.4.7, 7.5
1	1	1	Clock time	Page/line	7.4.8, 7.5

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.

7.4.3 Date/time zone and unspecified clock time (BGF2=1, BGF1=0, BGF0=0)

This combination signifies that the time address is not referenced to an external clock and that the binary groups contain date and time zone encoding as described in SMPTE 309M.

7.4.4 Page/line multiplex system and unspecified clock time (BGF2=1, BGF1=0, BGF0=1)

This combination signifies that the time address is not referenced to an external clock and that the binary groups contain information formatted according to the page/line multiplex system described in ANSI/SMPTE 262M. This multiplex system defines a hierarchy that 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.

7.4.5 Clock time specified and unspecified character set (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 in any manner without restriction (also see 7.5).

7.4.6 Unassigned binary group usage and unassigned clock time (BGF2=0, BGF1=1, BGF0=1)

This combination is unassigned and is reserved for future definition by SMPTE and should not be used.

7.4.7 Date/time zone and clock time (BGF2=1, BGF1=1, BGF0=0)

This combination specifies that the time address is referenced to an external clock and specifies date and time zone encoding as described in SMPTE 309M (also see 7.5).

7.4.8 Specified clock time and page/line multiplex system (BGF2=1, BGF1=1, BGF0=1)

This combination specifies that the time address is referenced to an external clock and specifies the page/line multiplex system described in ANSI/SMPTE 262M. This multiplex system defines a hierarchy that 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 (also see 7.5).

7.5 Clock time reference – Binary group flag combinations

One of three flag combinations shall be set "true" when the time code time address has been referenced to an external precision clock time reference and the time address is maintained within a tolerance of ± 0.5 second. These flag combinations also define subsets of the available binary group applications (see 7.4.5, 7.4.7, and 7.4.8). One of these combinations may also define the encoding of the time zone and the date in the binary groups (see 7.4.7).

NOTE – Additional information relating to time precision is included in annex A.

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
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

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.

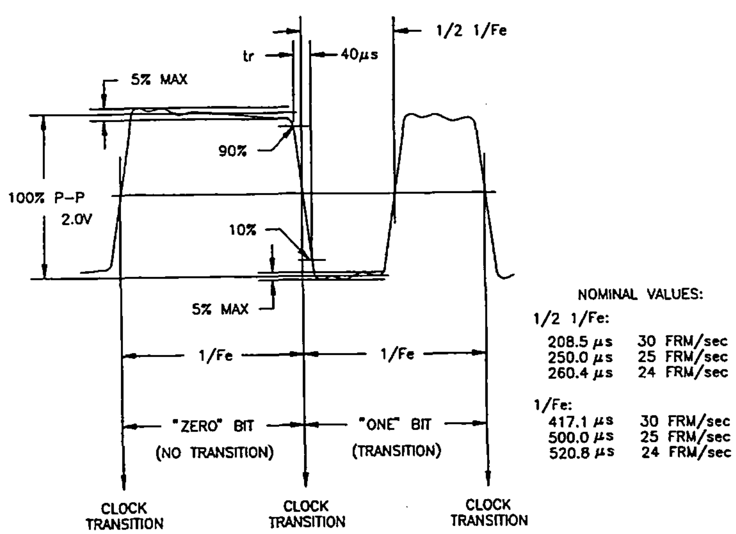


Figure 1 – Linear time code source output waveform

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 kΩ.

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 BNC (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.

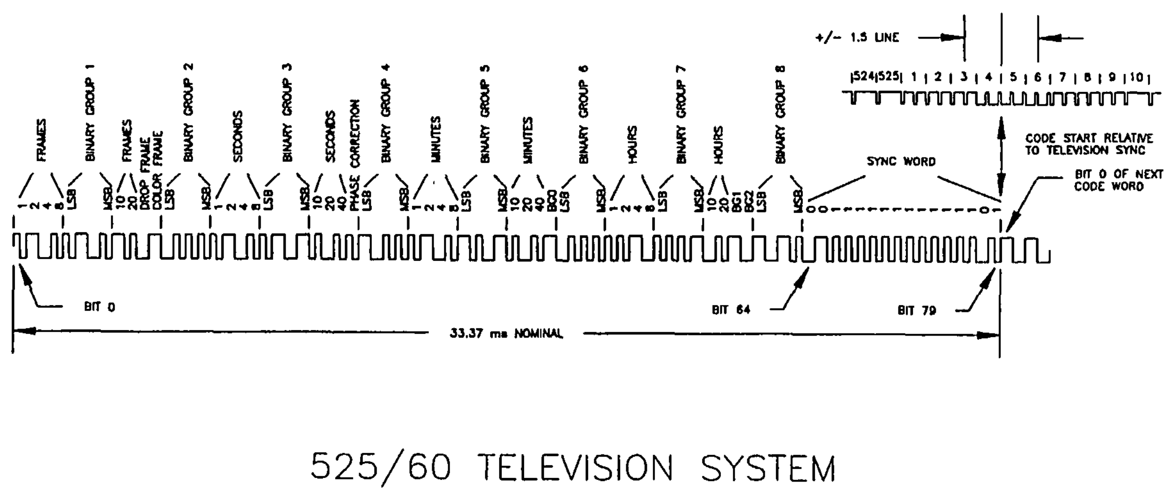


Figure 2a – 30-frame linear time code example

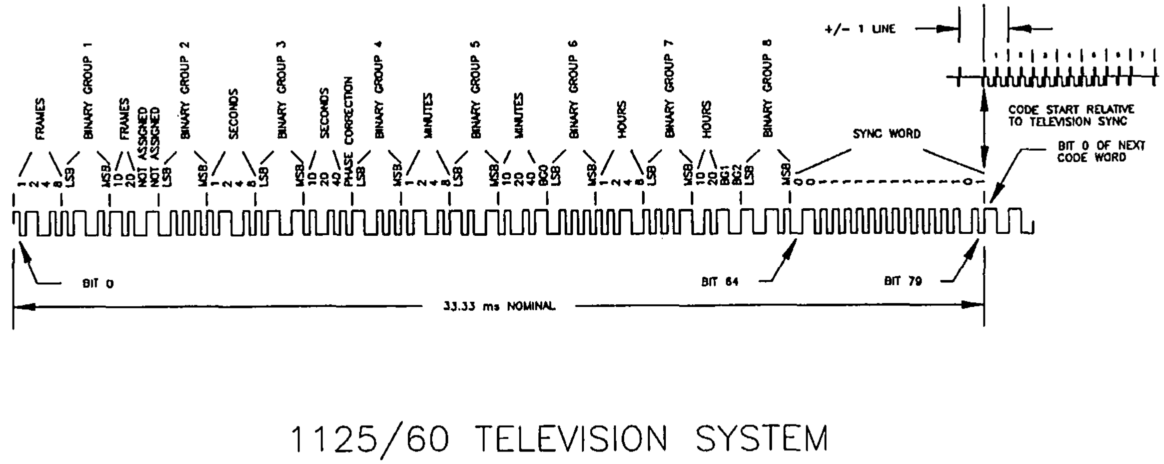


Figure 2b – 30-frame linear time code example

SMPTE 12M

Page 12 of 21 pages

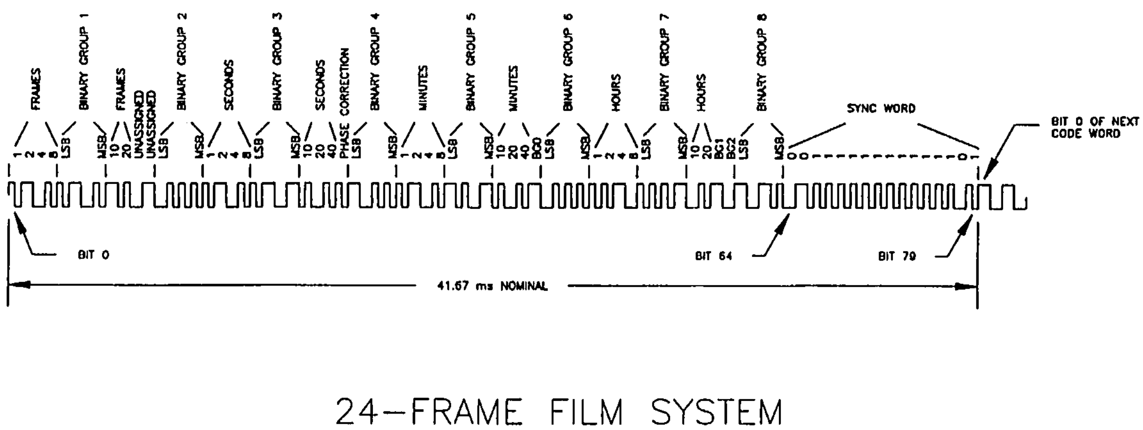


Figure 2d – 24-frame linear time code example

SMPTE 12M

Page 11 of 21 pages

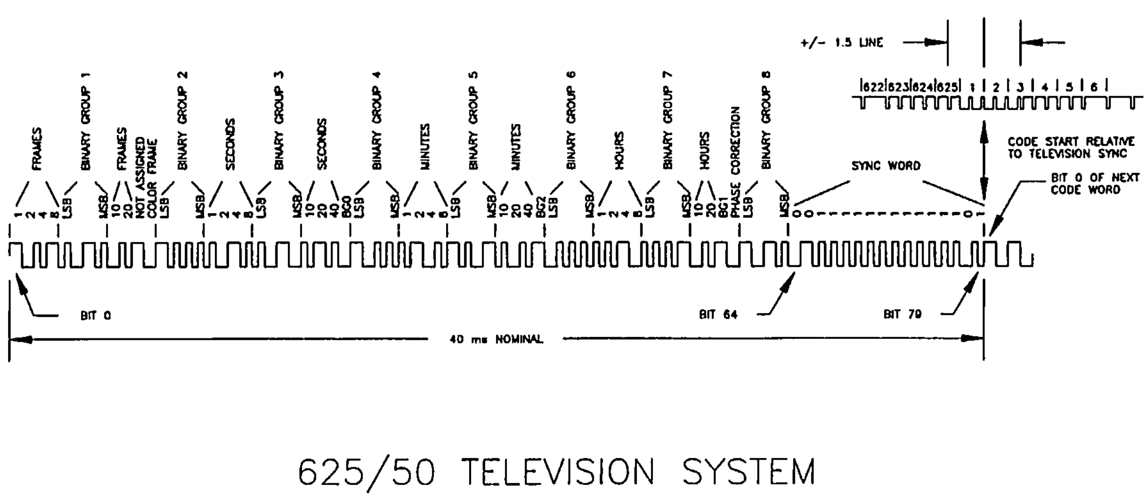


Figure 2c – 25-frame linear time code example

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
35	75	Field flag
55	35	Binary group flag BGF0
74	74	Binary group flag BGF1
75	55	Binary group flag BGF2

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.

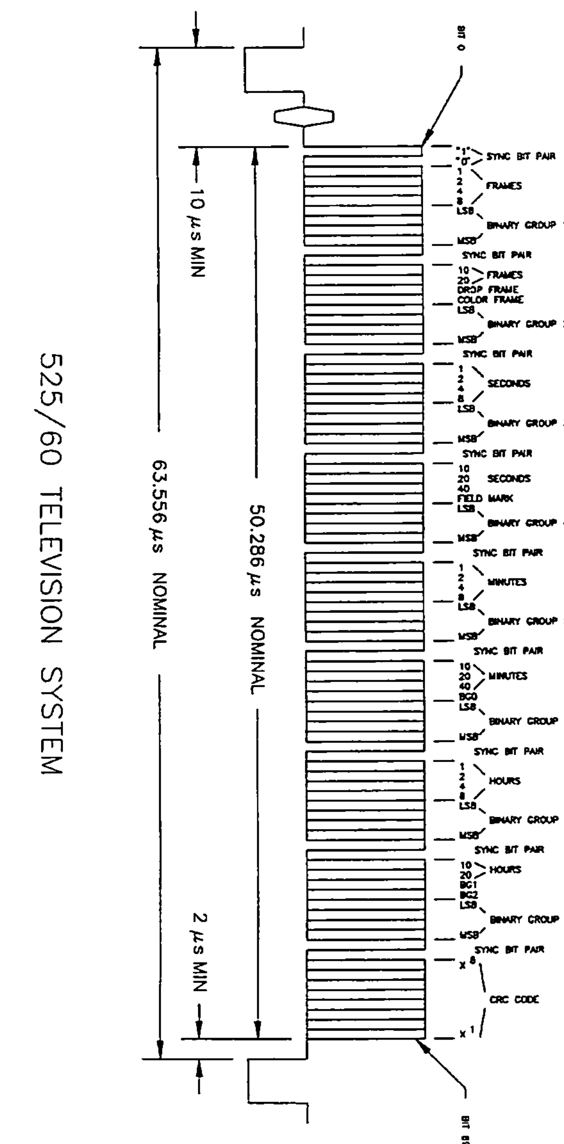


Figure 3a – 525/60 vertical interval time code address bit assignment and timing

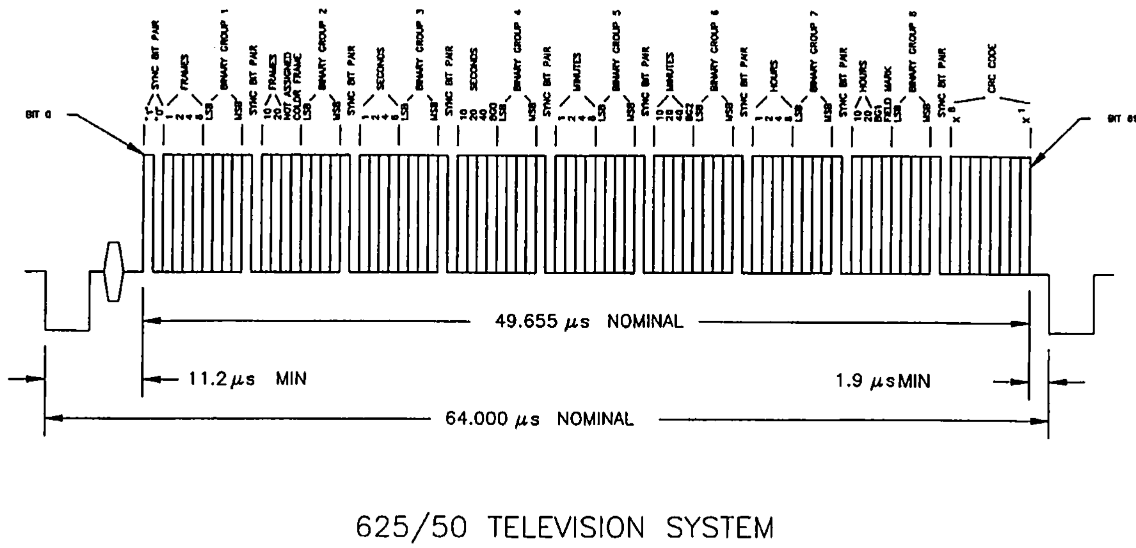


Figure 3c – 625/50 vertical interval time code address bit assignment and timing

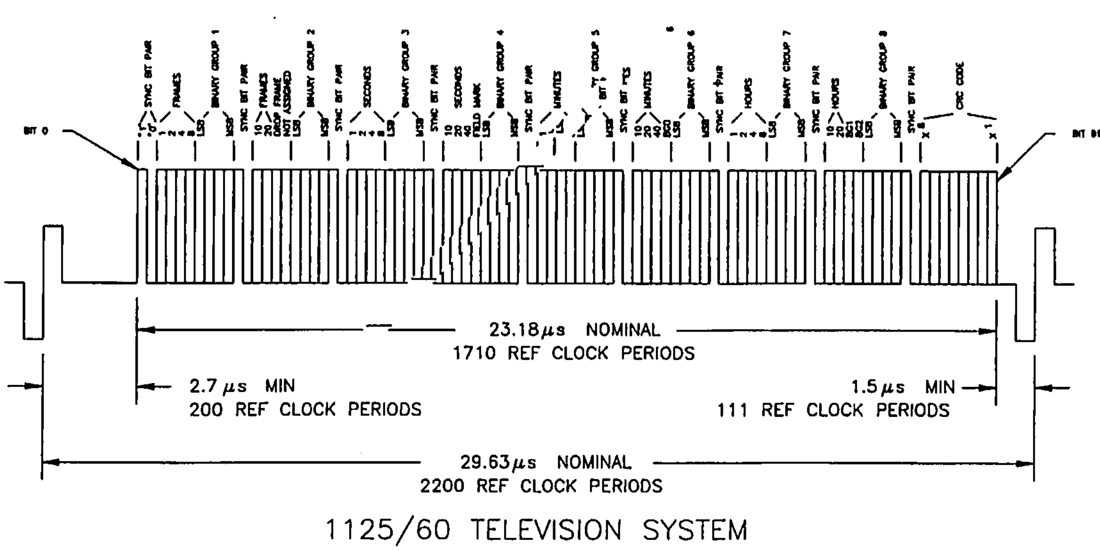


Figure 3b – 1125/60 vertical interval time code address bit assignment and timing

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 ANSI/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 BT.470 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.

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 ANSI/SMPTE 240M.

9.5 Timing of the code word relative to the television signal

9.5.1 525/60 television system

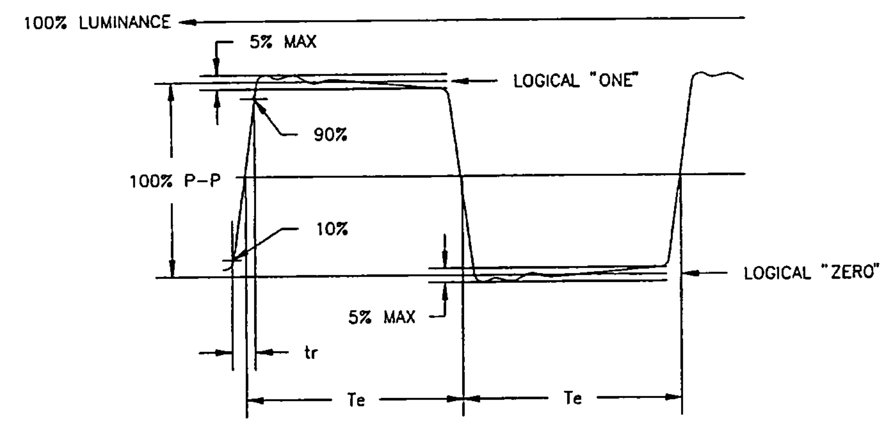
The half-amplitude point of bit 0 shall occur no earlier than 10.0 µs following the half-amplitude point of the leading edge of the line synchronizing pulse. The half-amplitude point of the trailing edge of bit 89 (logical 1) shall occur no later than 2.1 µs before the half-amplitude point of the leading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

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

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



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

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 us (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 us 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.

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 I 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.

10.3 VITC and LTC code word comparison

Table 11 summarizes the correspondence between the VITC and LTC code words for 30-, 25-, and 24-frame systems.

Table 11 – Summation of VITC and LTC code word bit definitions

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

Annex A (informative)
Explanatory notes

A.1 Time precision

The precision of the clock time in the time code may be subject to variances due to the video phase relative to midnight rollover, the use of color field identification, cyclic drift associated with drop frame compensation, systematic drift associated with noninteger frame rates, the reference video frequency accuracy, and the precision of the clock reference. It is the responsibility of the system implementers to take appropriate measures to ensure satisfactory system operation.

SMPTE 309M provides a method of signaling the degree of time precision that is intended. This standard also provides for indicating the date and time zone to which the time applies.

A.2 Leap second corrections

Because of small differences between atomic time (UTC) and time based on the rotational speed of the earth (UTCI), periodic admustments to atomic time are made in increments of one second. These adjustments, when required, are made at the end of June 30, or preferably December 31, universal time so that UTC never deviates by more than 0.9 second. The last minute of the day on which an adjustment is made has 61 or 59 seconds. It could happen that leap seconds would need to be removed (negative leap seconds); however, all leap seconds so far have been positive.

The occurrence of a positive leap second time correction results in a second of time being added. It may not be possible to create or display a second with the value of 60 to identify uniquely this second due to the design of existing SMPTE time code devices. For uniformity in adding a leap second, it is suggested that at the end of the hour, the last second with a value of 59 seconds should be repeated.

For 625/50 systems that are also implementing color field identification, the occurrence of a leap second adjustment *may result in a time shift of one or three frames depending* on the method of adjusting time to identify the color frame sequence. Systems implementers should be aware that this may change the intended time precision of the system.

Annex B (informative)
Bibliography

SMPTE RP 188-1996, Transmission of Time Code and Control Code in the Ancillary Data Space of a Digital Television Data Stream

SMPTE RP 196-1997, Transmission of LTC and VITC Data as HANC Packets in Serial Digital Television Interfaces

PROPOSED SMPTE STANDARD

SMPTE 96M
Revision of
ANSI/SMPTE 96-1992

for Television — 35- and 16-mm Motion-Picture Film — Scanned Image Area

1 Scope

This standard specifies the size and location of that portion of 35- and 16-mm motion-picture film to be captured by a scanning device for 4:3 and 16:9 aspect ratio.

2 Normative references

The following standards contain provisions which, through reference in this standard, 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 7-1994, Motion-Picture Film (16-mm) — Camera Aperture Image and Usage

ANSI/SMPTE 201M-1996, Motion-Picture Film (16-mm) — Type W Camera Aperture Image

SMPTE 59-1998, Motion-Picture Film (35-mm) — Camera Aperture Images and Usage

3 Television reproduction

3.1 Film prepared for television

Film prepared by conventional photographic techniques for television reproduction shall be in accordance with ANSI/SMPTE 7, SMPTE 59, and ANSI/SMPTE 201M, which specify the location and size of the 16- and 35-mm camera exposed images.

3.2 Dimensions for television reproduction

The telecine shall scan the areas given in tables 1 through 4. In the case of television display formats given as letterbox or sidebar, the center of the television scanned area (television production aperture), safe action area, and safe title area shall coincide with the centers given in the appropriate camera aperture documents.

In the case of television display formats given as full screen, the centers of the television scanned, safe action, and safe title areas may be jointly moved (panned) into the cropped area. Such movement shall not cause the scanned area (television production aperture) to move outside the extremes of the corresponding dimension given in the letterbox or sidebar display format for that film format.

THIS PROPOSAL IS PUBLISHED FOR COMMENT ONLY

Table 1 – 35-mm for 4:3 television
(for 4:3 nominal aspect ratio television reproduction of 35-mm motion-picture film)

Type 'A' Apertures (Academy) - Image Center 18.75mm

Composed Aspect Ratio (See Note 5)	TV Display Mode	Intended TV Aspect Ratio	Image as mapped into 4:3	Scanned Area (mm) Width	Scanned Area (mm) Height	Scanned Area (in.) Width	Scanned Area (in.) Height	Notes
1.37	Full Screen	1.33		20.12	15.09	0.792	0.594	3
1.66	Full Screen	1.33		16.83	12.62	0.663	0.497	3
1.66	Letterbox	1.66		20.95	12.62	0.825	0.497	1,2
1.78	Full Screen	1.33		15.71	11.78	0.619	0.464	3
1.78	Letterbox	1.78		20.95	11.78	0.825	0.464	1.2
1.85	Full Screen	1.33		15.09	11.32	0.594	0.446	3
1.85	Letterbox	1.85		20.95	11.32	0.825	0.446	1,2

Cropped Area of the Film Image not displayed — Black area on the television display — Image Area on the Television display

Type 'B' Apertures (Academy) - Image Center 18.75mm

Composed Aspect Ratio (See Note 5)	TV Display Mode	Intended TV Aspect Ratio	Image as mapped into 4:3	Scanned Area (mm) Width	Scanned Area (mm) Height	Scanned Area (in.) Width	Scanned Area (in.) Height	Notes
2.39	Full Screen	1.33		11.69	17.53	0.460	0.690	3,4
2.39	Letterbox	2.39		20.95	17.53	0.825	0.690	1,2,4

Cropped Area of the Film Image not displayed — Black area on the television display — Image Area on the Television display

Table 1 (continued) – 35-mm for 4:3 television
(for 4:3 nominal aspect ratio television reproduction of 35-mm motion-picture film)

Type 'C' Apertures (Full) - Image Center 17.48mm

Composed Aspect Ratio (See Note 5)	TV Display Mode	Intended TV Aspect Ratio	Image as maped into 4:3	Scanned Area (mm) Width	Scanned Area (mm) Height	Scanned Area (in.) Width	Scanned Area (in.) Height	Notes
1.33	Full Screen	1.33		24.00	18.00	0.945	0.709	
1.66	Full Screen	1.33		19.28	14.46	0.759	0.569	3
1.66	Letterbox	1.66		24.00	14.46	0.945	0.569	1,2
1.78	Full Screen	1.33		18.00	13.50	0.709	0.531	3
1.78	Letterbox	1.78		24.00	13.50	0.945	0.531	1,2
1.85	Full Screen	1.33		17.29	12.97	0.680	0.511	3
1.85	Letterbox	1.85		24.00	12.97	0.945	0.511	1,2
2.39	Full Screen	1.33		13.39	10.04	0.527	0.395	3
2.39	Letterbox	2.39		24.00	10.04	0.945	0.395	1,2

Cropped Area of the Film Image not displayed — Black area on the television display — Image Area on the Television display

Type 'D' Apertures (3 Perf.) – Image Center 17.48mm

Composed Aspect Ratio (See Note 5)	TV Display Mode	Intended TV Aspect Ratio	Image as mapped into 4:3	Scanned Area (mm) Width	Scanned Area (mm) Height	Scanned Area (in.) Width	Scanned Area (in.) Height	Notes
1.78	Full Screen	1.33		17.29	12.97	0.680	0.511	3,6
1.78	Letterbox	1.78		23.06	12.97	0.910	0.511	1,2,6

Cropped Area of the Film Image not displayed — Black area on the television display — Image Area on the Television display

Table 2 – 35-mm for 16:9 television
(for 16:9 nominal aspect ratio television reproduction of 35-mm motion-picture film)

Type 'A' Apertures (Academy) - Image Center 18.75mm

Composed Aspect Ratio (See Note 5)	TV Display Mode	Intended TV Aspect Ratio	Image as mapped into 16:9	Scanned Area (mm) Width	Scanned Area (mm) Height	Scanned Area (in.) Width	Scanned Area (in.) Height	Notes
1.37	Sidebar	1.33		20.12	15.09	0.792	0.594	1,3
1.37	Sidebar	1.37		20.95	15.29	0.825	0.602	1,3
1.66	Full Screen	1.78		20.95	11.78	0.825	0.464	2
1.66	Sidebar	1.66		20.95	12.62	0.825	0.497	1,3
1.78	Full Screen	1.78		20.95	11.78	0.825	0.464	
1.85	Full Screen	1.78		20.12	11.32	0.792	0.446	3
1.85	Letterbox	1.85		20.95	11.32	0.825	0.446	1,2

Cropped Area of the Film Image not displayed — Black area on the television display — Image Area on the Television display

Type 'B' Apertures (Academy) - Image Center 18.75mm

Composed Aspect Ratio (See Note 5)	TV Display Mode	Intended TV Aspect Ratio	Image as mapped into 16:9	Scanned Area (mm) Width	Scanned Area (mm) Height	Scanned Area (in.) Width	Scanned Area (in.) Height	Notes
2.39	Full Screen	1.78		15.58	17.53	0.613	0.690	3,4
2.39	Letterbox	2.39		20.95	17.53	0.825	0.690	1,2,4

Cropped Area of the Film Image not displayed — Black area on the television display — Image Area on the Television display

Table 2 (continued) – 35-mm for 16:9 television
(for 16:9 nominal aspect ratio television reproduction of 35-mm motion-picture film)

Type 'C' Apertures (Full) - Image Center 17.48mm

Composed Aspect Ratio (See Note 5)	TV Display Mode	Intended TV Aspect Ratio	Image as mapped into 16:9	Scanned Area (mm) Width	Scanned Area (mm) Height	Scanned Area (in.) Width	Scanned Area (in.) Height	Notes
1.33	Sidebar	1.33		24.00	18.00	0.945	0.709	1,3
1.66	Full Screen	1.78		24.00	13.50	0.945	0.531	2
1.66	Sidebar	1.66		24.00	14.46	0.945	0.569	1,3
1.78	Full Screen	1.78		24.00	13.50	0.945	0.531	
1.85	Full Screen	1.78		23.06	12.97	0.908	0.511	3
1.85	Letterbox	1.85		24.00	12.97	0.945	0.511	1,2
2.39	Full Screen	1.78		17.85	10.04	0.703	0.395	3
2.39	Letterbox	2.39		24.00	10.04	0.945	0.395	1,2

Type 'D' Aperture (3 Perf.) – Image Center 17.48mm

Composed Aspect Ratio (See Note 5)	TV Display Mode	Intended TV Aspect Ratio	Image as mapped into 16:9	Scanned Area (mm) Width	Scanned Area (mm) Height	Scanned Area (in.) Width	Scanned Area (in.) Height	Notes
1.78	Full Screen	1.78		23.06	12.97	0.910	0.511	6

Cropped Area of the Film Image not displayed — Black area on the television display — Image Area on the Television display

Table 3 – 16-mm for 4:3 television
(for 4:3 nominal aspect ratio television reproduction of 16-mm motion-picture film)

Composed Aspect Ratio (See Note 5)	TV Display Mode	Intended TV Aspect Ratio	Image as mapped into 4:3	Scanned Area (mm) Width	Scanned Area (mm) Height	Scanned Area (in.) Width	Scanned Area (in.) Height	Notes
Regular Aperture 16mm - Image Center 7.98mm								
1.33	Full Screen	1.33		9.35	7.01	0.368	0.276	
Super 16 (Type W) - Image Center 9.00mm								
1.66	Full Screen	1.33		9.80	7.35	0.386	0.289	3
1.66	Letterbox	1.66		12.20	7.35	0.480	0.289	1,2
1.78	Full Screen	1.33		9.15	6.86	0.360	0.270	3
1.78	Letterbox	1.78		12.20	6.86	0.480	0.270	1,2

Cropped Area of the Film Image not displayed — Black area on the television display — Image Area on the Television display

Table 4 – 16-mm for 16:9 television
(for 16:9 nominal aspect ratio television reproduction of 16-mm motion-picture film [width, height])

Composed Aspect Ratio (See Note 5)	TV Display Mode	Intended TV Aspect Ratio	Image as mapped into 16:9	Scanned Area (mm) Width	Scanned Area (mm) Height	Scanned Area (in.) Width	Scanned Area (in.) Height	Notes
Regular Aperture 16mm - Image Center 7.98mm								
1.33	Sidebar	1.33		9.35	7.01	0.368	0.276	3
Super 16 (Type W) - Image Center 9.00mm								
1.66	Sidebar	1.66		12.20	7.35	0.480	0.289	3
1.66	Full Screen	1.78		12.20	6.86	0.480	0.270	1,2
1.78	Full Screen	1.78		12.20	6.86	0.480	0.270	

Cropped Area of the Film Image not displayed — Black area on the television display — Image Area on the Television display

Notes to tables 1 through 4

1 Letterbox and sidebar scanned areas will not fill the entire television scanned area (television production aperture); the balance of the television picture outside the scanned area shall be filled with a suitable matting image.

2 Film image shall be adjusted so that the scanned width fills the television image width.

3 Film image shall be adjusted so that the scanned height fills the television image height.

4 Film image is anamorphic. The display image is deanamorphic (unsqueezed).

5 Composed aspect ratio is the aspect ratio for which the image was originally composed and at which it was originally intended to be displayed. All dimension calculations were done to at least four decimal places, but aspect ratios are nominally indicated.

6 Scanned area shown differs from the corresponding area in type C (4 perf) apertures to allow room for mechanical splices in 3-perf film.

4 Definitions

4.1 letterbox: An image mapped into the total display area such that the full width of the display area is utilized, but the height is not (see figure 1).

4.2 sidebar: An image mapped into the total display area such that the full height of the display area is utilized, but the full width is not (see figure 2).

Figure 1 – Letterbox

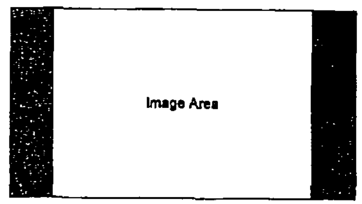


Figure 2 – Sidebar image mapping

Annex A (informative)
Production and clean apertures

A marking on the reticle of the film camera viewfinder may be used to indicate the production aperture (scanned image area).

Since the great majority of television receivers display less than the clean aperture, it may be desirable to indicate smaller areas in the film camera viewfinder within which essential information should be photographed (refer to SMPTE RP 187 for a description of production and clean apertures).

Annex B (informative)
Bibliography

ANSI/SMPTE 195-1993, Motion-Picture Film (35-mm) — Motion-Picture Prints — Projectable Image Area

ANSI/SMPTE 233-1998, Motion-Picture Film (16-mm) — Projectable Image Area and Projector Usage

SMPTE RP 187-1995, Center, Aspect Ratio and Blanking of Video Images

SMPTE EG 25-1996, Telecine Scanning for Film Transfer to Television

ISO 1223:1993, Cinematography — Picture Areas for Motion-Picture Films and Slides for Television — Position and Dimensions

ISO 2906:1984, Cinematography — Image Area Produced by Camera Aperture on 35 mm Motion-Picture Film — Position and Dimensions

ISO 2907:1984, Cinematography — Maximum Projectable Image Area on 35 mm Motion-Picture Film — Position and Dimensions

ISO 5768:1996, Cinematography — Image Produced by Camera Aperture Type W on 16-mm Motion-Picture Film — Position and Dimensions

PROPOSED SMPTE STANDARD

for Transmission of Date and Time Zone Information in Binary Groups of Time and Control Code

1 Scope

This standard specifies a coding technique for the transmission of date and time zone information in the user groups of a time and control code signal. A two-digit hexadecimal code in a pair of binary groups specifies the time zone and the format for the date encoding in the remaining six binary groups. Date information is encoded either as six decimal digits to display the date in the YYMMDD format or as six decimal digits in the modified Julian date (MJD) format.

2 Normative references

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

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

ANSI/SMPTE 262M-1995, Television, Audio and Film – Binary Groups of Time and Control Codes — Storage and Transmission of Data

ISO 8601:1988, Data Elements and Interchange Formats — Information Interchange — Representation of Dates and Times

ITU-R TF.457-1, Use of the Modified Julian Date by the Standard Frequency and Time-Signal Services

3 Glossary

3.1 coordinated universal time or universal time, coordinated (UTC): UTC is an international atomic time standard and is the basis for civil time. It is the current term for what was commonly refererred to as Greenwich meridian time (GMT). Zero (0) hours UTC is midnight in Greenwich, England, which lies on the zero longitudinal meridian.

3.2 daylight saving time: The civil time observed when daylight saving is adopted in a country or region.

3.3 Julian date (JD): The Julian day number is a count of days that have elapsed since Greenwich mean noon on 1 January 4713 B.C., Julian proleptic calendar.

3.4 modified Julian date (MJD): The MJD is an abbreviated version of the Julian date (JD) dating method. It is defined as MJD = JD-2400000.5. An MJD day thus begins at midnight, civil date.

3.5 standard time: The civil time adopted for a country or region.

4 Date and time zone in binary groups

Two binary groups (BG7 and BG8) encode the time zone and define the format for the encoding of the date in the remaining six binary groups. The date, as specified by a date format flag bit in binary group 8, may be either six decimal digits in YYMMDD format or a six-decimal digit modified Julian date (MJD).

4.1 Time zone, date format, and time precision in binary groups 7 and 8

Binary groups 7 and 8 as detailed in table 1 define the format of the date encoded in binary groups 1 through 6, the time zone and time precision (refer to table 2).

4.1.1 MJD format flag bit

If this bit is logical zero, then the date is specified as six decimal digits in the format YYMMDD (see 4.2). The time address represents the local clock time that has been offset from coordinated universal time (UTC) as specified by the time zone offset. If this bit is logical one, then the date is specified as MJD encoded as six BCD digits (see 4.3). The time address portion of time code represents UTC without any offset. The time zone offset and daylight saving time flag are provided for information only. They may be used to calculate and display time in the local time.

4.1.2 Unassigned bit

One bit in binary group 8 is unassigned and reserved for future definition. This bit should be set to zero until it is defined.

4.1.3 Time zone coding and time precision coding

Six bits in binary groups 7 and 8 code the local time zone or time precision as defined in table 2. This table also includes entries to specify time precision as defined in 4.1.4.

4.1.4 Time precision

Table 2 includes four entries for time precision. When one of these codes is selected, UTC time is implied. Table 3 shows these time precision classes.

For classes 1, 2 and 3, the video frequencies and frame rate are adjusted to fit an integral number of video frames in a 24-hour period.

For classes 1 and 2 with video with a nominal frame rate of 29.97 Hz, there will be a drift of two frames between the clock time and the time address. For class 2, this is compensated by a leap drop frame counting mode in which the normally dropped frame counts 23:59:00:00 and 23:59:00:01 are not dropped. For class 1, this is corrected by a time jam sync at a user selected time.

For class 3, the number of time code counts matches the number of video frames in a 24-hour period.

For time code referenced to video with a frame rate of 29.97 Hz, the drop frame counting mode shall be used.

4.1.5 Binary group flags

Binary group flag assignments conforming to the values shown in table 4 shall signal that the date and time zone are encoded using the methods described in this standard. These assignments may also signal that the time address is referenced to a precision clock time reference as described in ANSI/SMPTE 12M.

Table 1 – Date format and time zone offset coding in binary groups

Binary group	Assignation	Description	
7.0	TZ-0	1's bit	Time zone code 0-63 (00-3F$_{HEX}$) see table 2
7.1	TZ-1	2's bit	
7.2	TZ-2	4's bit	
7.3	TZ-3	8's bit	
8.0	TZ-4	16's bit	
8.1	TZ-5	32's bit	
8.2	Unassigned	Reserved for cuture use; set to zero until assigned.	
8.3	MJD flag	0 = YYMMDD format 1 = MJD (6-digit) format	

Table 2 – Time zone offset and time precision coding

Code	Offset Hours	Standard time (see note 2)	Daylight saving	Code	Offset Hours	Standard time (see note 2)	Daylight saving
00	UTC	Greenwich		0A	UTC-00:30		
01	UTC-01:00	Azores		0B	UTC-01:30		
02	UTC-02:00	Mid-Atlantic		0C	UTC-02:30		Newfoundland
03	UTC-03:00	Buenos Aires	Halifax	0D	UTC-03:30	Newfoundland	
04	UTC-04:00	Halifax	New York	0E	UTC-04:30		
05	UTC-05:00	New York	Chicago	0F	UTC-05:30		
06	UTC-06:00	Chicago	Denver	1A	UTC-06:30		
07	UTC-07:00	Denver	Los Angeles	1B	UTC-07:30		
08	UTC-08:00	Los Angeles		1C	UTC-08:30		
09	UTC-09:00	Alaska		1D	UTC-09:30	Marquesa Islands	
10	UTC-10:00	Hawaii		1E	UTC-10:30		
11	UTC-11:00	Midway Island		1F	UTC-11:30		
12	UTC-12:00	Kwaialein		2A	UTC+11:30	Norfolk Island	
13	UTC+13:00		New Zealand	2B	UTC+10:30	Lord Howe Is.	
14	UTC+12:00	New Zealand		2C	UTC+09:30	Darwin	
15	UTC+11:00	Solomon Islands		2D	UTC+08:30		
16	UTC+10:00	Guam		2E	UTC+07:30		
17	UTC+09:00	Tokyo		2F	UTC+06:30	Rangoon	
18	UTC+08:00	Beijing		3A	UTC+05:30	Bombay	
19	UTC+07:00	Bangkok		3B	UTC+04:30	Kabul	
20	UTC+06:00	Dhaka		3C	UTC+03:30	Tehran	
21	UTC+05:00	Islamabad		3D	UTC+02:30		
22	UTC+04:00	Abu Dhabi		3E	UTC+01:30		
23	UTC+03:00	Moscow		3F	UTC+00:30		
24	UTC+02:00	Eastern Europe		32	UTC+12:45	Chatham Island	
25	UTC+01:00	Central Europe		33	Undefined	Reserved; do not use	
26	Undefined	Reserved; do not use		34	Undefined	Reserved; do not use	
27	Undefined	Reserved; do not use		35	Undefined	Reserved; do not use	
28	TP-3	Time precision class 3		36	Undefined	Reserved; do not use	
29	TP-2	Time precision class 2		37	Undefined	Reserved; do not use	
30	TP-1	Time precision class 1		38	User defined time offset		
31	TP-0	Time precision class 0		39	Undefined	Unknown	Unknown

NOTES

1 The frames that are not dropped in precision class 2 are the last two frames in a 24-hour day that are dropped in normal drop frame. These values are subject to revision in the course of future development.

2 The locations shown are informative to aid the reader.

4.2 Date as binary coded decimal digits

When the date in the YYMMDD format is used, the date information shall be encoded as six BCD digits in binary groups 1 to 6 as specified in table 5.

NOTE – If definition of the century is important, then the date should be encoded as a modified Julian date as described in 4.3.

4.3 Modified Julian date

When the date in the modified Julian date format is used, the date information shall be encoded as six BCD digits in ascending order of magnitude in binary groups 1 to 6 as specified in table 6.

4.4 Time and date coordination

The date shall increment at the time address midnight rollover from 23:59:59:2x to 00:00:00:00. This implies that the date and time address are coordinated and are applicable to the local time zone or UTC, as specified by the MJD format flag and time zone offset code (see 4.1).

Table 3 – Time precision classes

Precision class	Maximum deviation from UTC	Remarks
0	± 3 frames	Minimum of 1 jam sync to UTC per day.
1	± 2 frames	For NTSC video, the subcarrier is adjusted by –0.82 Hz. Minimum of 1 jam sync to UTC per day at user defined time.
2	± 2 frames	For NTSC video, the subcarrier is adjusted by –0.82 Hz. Leap drop frame counting mode (frames [23:59:00:00] and [23:59:00:01] are not dropped. Note 1. Minimum of 1 jam sync to UTC per day.
3	± 1 frame	For NTSC video, the subcarrier is adjusted by –3.58 Hz. Minimum of 1 jam sync to UTC per day.

Table 4 – Binary group flag assignments for date and time zone encoded in binary groups

BGF2	BGF1	BGF0	Time address reference
1	0	0	Unspecified
1	1	0	Precision clock
NOTE – Refer to ANSI/SMPTE 12M for LTC and VITC bit numbers for 24, 25, and 30-frame-per-second systems.			

Table 5 – Date data in binary groups

Binary group	Assignation	Value	Description
1	D	0-9	Day units
2	D	0-3	Day tens
3	M	0-9	Month units
4	M	0,1	Month tens
5	Y	0-9	Year units
6	Y	0-9	Year tens

Table 6 – Modified Julian date data in binary groups

Binary group	Assignation	Value	Comments
1	MJD units	0-9	
2	MJD tens	0-9	
3	MJD hundreds	0-9	
4	MJD thousands	0-9	
5	MJD ten thousands	0-9	
6	MJD hundred thousands	0-9	Will be zero until the year 2131

Annex A (informative)
Differences between GPS time and UTC time

Users are cautioned to apply any necessary corrections to adjust their chosen clock reference to UTC. GPS satellite time reference signals have a known published offset from UTC and manufacturers of time code systems based on GPS signals must account for the current offset and make provisions for current and future leap second corrections.

Annex B (informative)
Additional data in binary groups

Additional data may be encoded into the binary groups by multiplexing data over several frames. When this is implemented, the binary group flags will be changed to the appropriate flag combination for the binary group encoding in use. ANSI/SMPTE 262M describes a method using a page/line index to identify and multiplex a wide variety of data types into the binary groups.

Annex C (informative)
Modified Julian date (MJD)

The modified Julian date (MJD) is an abbreviated version of the Julian date (JD) dating method which has been in use by astronomers, geophysicists, chronologers, and others who need to have an unambiguous dating system based on continuing day counts.

The MJD is defined as the JD minus 2400000.5. It should be noted that JD increments at noon while MJD increments at midnight. MJD is thus a continuous count of the number of days that have elapsed since 17 November 1858.

MJD is often more useful than conventional calendar dates for record keeping over long periods of time, since the MJDs of two events can easily be subtracted to determine the time difference in days. Since the MJD is a linear counting of days, there is no requirement to differentiate between days, months, and years. As an example, the MJD for 1 January 1995 is 49718.

Usually, the MJD is specified as a decimal number with five significant digits. With five digits, the count is good until the year 2132. Since this standard extends to six digits, this precludes any foreseeable problems with future date rollovers from 99,999 to 00,000.

Annex D (informative)
Bibliography

SMPTE RP 188-1996, Transmission of Time Code and Control Code in the Ancillary Data Space of a Digital Television Data Stream

SMPTE RP 196-1997, Transmission of LTC and VITC Data as HANC Packets in Serial Digital Television Interfaces

PROPOSED SMPTE STANDARD

SMPTE 318M
Revision of RP 154-1994

for Television and Audio— Synchronization of 59.94- or 50-Hz Related Video and Audio Systems in Analog and Digital Areas — Reference Signals

Contents

1 Introduction

Composite and component video equipment frequently requires an external reference signal for synchronization. The use of digital video and audio signals places additional reliance on the reference to avoid buffer management problems, manage jitter, and maintain a defined relationship between video and audio signals.

Color black is the external reference signal used traditionally for analog NTSC and PAL equipment. This standard specifies a compatible extension of the color black signal to extend its application to digital equipment operating at most frequency related standards.

2 Scope

This standard specifies the use of a derivative of a color black signal as a reference for the synchronization of all forms of composite or component, digital or analog equipment using a system standard related to 59.94 Hz (60/1.001) or 50 Hz.

It also provides the option for the reference signal to carry VITC. This will allow the reference to distribute local or UTC time data.

In the case of the reference for 59.94-Hz related signals, the signal may carry optionally a ten-field sequence identification signal. This facilitates interworking with equipment operating at related rates (e.g., 23.97 Hz (24/1.001) or 48 kHz).

3 Normative references

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

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

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

SMPTE RP 164-1996, Location of Vertical Interval Time Code

IEC 60169-8 (1978-01), Radio Frequency Connectors, Part 8: R.F. Coaxial Connectors with Inner Diameter of Outer Conductor 6.5 mm (0.256 in) with Bayonet Lock — Characteristic Impedance 50 Ohms (Type BNC), and IEC 60169-8-am 1 (1996-03), Amendment No. 1, and IEC 60169-8-am 2 (1997-11), Amendment No. 2.

ITU-R BT.470-4 (1994), Television Systems

THIS PROPOSAL IS PUBLISHED FOR COMMENT ONLY

4 Timing reference application

4.1 Output reference

Where a separate reference is required for the output function, the equipment shall derive its timing reference for the output function from a signal as defined in this standard.

4.2 Input reference

For equipment that stores video with variable delay (i.e., video recorders, synchronizers, and time-base correctors) or that monitors video, the equipment may derive its timing reference for the input function from the input video or from a reference signal as defined in this standard.

4.3 Relative timing

Some equipment, e.g., routing switchers, may use the reference signal to derive a trigger for switching. In systems using ATV and other signals, care should be exercised to ensure that these transitions occur in the appropriate period.

5 General characteristics

The reference signal is defined as follows:

5.1 Signal characteristics

The signal waveform shall conform to the system specifications as defined in ANSI/SMPTE 170M or ITU-R BT.470-4, as appropriate, except as noted herein. The signal must include the appropriate color burst.

5.1.1 59.94 Hz related

525 line; 2:1 interlace; 29.97 picture/s; 3.58 MHz (nominal) subcarrier burst (NTSC).

5.1.2 50 Hz related

625 line; 2:1 interlace; 25 picture/s; 4.43 MHz (nominal) subcarrier burst (PAL).

5.2 Active picture signal level

The signal level throughout the active picture period shall correspond to black level (see notes 1 and 2).

5.3 Sync and burst jitter

The timing of individual leading edges of horizontal synchronization pulses at the reference generator output shall be within 2 ns peak to peak, measured over at least one field (see note 3).

The zero-crossing points of color burst subcarrier shall be within 500 ps peak to peak measured over at least one field.

5.4 Master oscillator frequency

The chroma subcarrier frequency should remain within ± 1 Hz of its nominal value. The rate of change should not exceed 0.1 Hz/s.

5.5 Connectors

BNC connectors shall be in accordance with IEC 60169-8.

5.6 Impedance

The reference signal source impedance shall be 75 ohms. Return loss shall be greater than 40 dB from 25 Hz to 10 MHz.

6 Ancillary signals

The reference signal may include signals for the transport of additional information to facilitate timing and synchronization with other systems.

This ancillary information should be coded to avoid excessive disturbance to the average picture level (see note 2).

6.1 Vertical interval time code

Vertical interval time code may be added on lines 14 and 277 only for 525/59.94 (NTSC) systems or lines 19 and 332 only for 625/50 (PAL) systems. This should be in accordance with ANSI/SMPTE 12M and SMPTE RP 164.

6.2 Ten-field reference (59.94-Hz related systems only)

For 59.94-Hz related systems (e.g., 525-line NTSC), a reference signal to establish a unique ten-field sequence may be added using lines 15 and 278. A pulse coded waveform identifies each field over a ten-field (five-frame) sequence.

6.2.1 Ten-field sequence identification

The ten-field (five-frame) sequence identification is coded as follows: The first pulse is always present, and functions as a start pulse. There follows a string of between zero and four frame count pulses that increase by one on line 15 (each odd field). The sixth pulse is present on line 278 (even field) only. Pulses are separated by spaces of duration equal to the pulses.

The start of the ten-field sequence is unspecified and is not aligned with any time or time code value. Some applications or equipment may specify an alignment to enable transient free switching between reference signal sources.

6.2.2 Pulse waveshape, position and jitter

The six-field identification pulse edges should be skew symmetric. Raised cosine shaping is preferred. Other signal parameters are specified in table 1 and figure 1.

6.3 Compliance nomenclature

The default compliance is defined as a signal containing no ancillary information.

A suffix letter or letters should be appended to indicate the addition of ancillary data.

A reference signal including VITC would be said to conform to SMPTE 318M-A.

A reference signal including the five-frame reference would be said to conform to SMPTE 318M-B.

A reference signal including both VITC and the five-frame reference would be said to conform to SMPTE 318M-AB.

Notes

1 In some parts of the world, a nominal value from 0 IRE to 10 IRE may be used for the setup pedestal.

2 Reference signals of higher constant average picture level (APL) are specifically avoided because they may cause performance degradation related to APL variations between the vertical interval and other parts of the signal. Furthermore, reference signals with changing APL, such as moving video or switched test signals, are also specifically excluded because they may cause disturbances to the video signal being processed by the equipment for which they are the reference. Also, it has become a common practice to use the reference signal as a convenient source of a *black* picture. In this case, the effect of permitted ancillary signals should be considered.

3 Reference signals with minimal jitter are preferred for many applications. For example, ANSI/SMPTE 259M specifies a worst-case figure for alignment and timing of jitter of 0.2 UI. Usually, this is accomplished using a burst-referenced genlock since the burst has less jitter than sync and provides more data for the locking oscillator. For PAL systems using burst lock, allowance must be made for the V-axis phase alternation and irregular vertical interval blanking sequence.

Table 1 – Five-frame identification pulse parameters

Parameters	Value	Tolerance	Units
Logic 0 level	0	−0 +5	IRE 1)
Logic 1 level	40	± 5	IRE 1)
Pulse width	2.22	± 0.1	µs 2)
Pulse edge 10%–90%	140	± 20	ns
Pulse edge jitter	<2		ns p-p
H-sync to first pulse	11.11	± 0.2	µs

NOTES
1) IRE units are specified in ANSI/SMPTE 170M.
2) A basic clock frequency of 4.5 MHz is assumed.

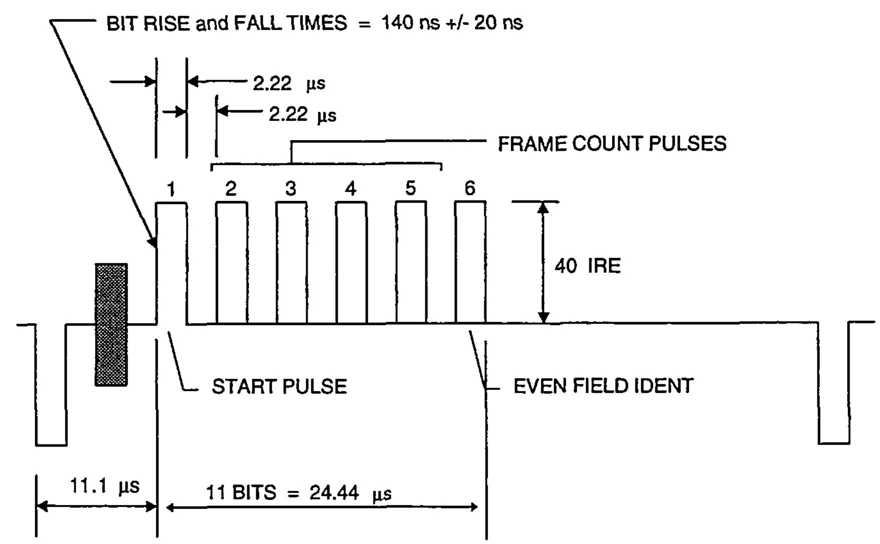


Figure 1 – Ten-field identification signal