SMPTE RECOMMENDED PRACTICE

RP 136-2004
Revision of RP 136-1999

Time and Control Codes for 24, 25 or 30 Frame-Per-Second Motion-Picture Systems

1 Scope

This practice specifies digital code formats and modulation methods for motion-picture film to be used for timing, control, editing, and synchronization purposes. This practice also specifies the relationship of the code to the motion-picture frame. The codes described in this practice are similar to the continuous code described in SMPTE 12M.

There are two types of codes described in this practice. The first type, type C, is a continuous code which is very similar to the continuous code specified in SMPTE 12M. This type of code can be used in situations where the film is moving continuously at the time of both recording and reproduction.

The second type of code, type B, is a noncontinuous, block-type code, composed of blocks of data, each complete in itself, with gaps between the blocks. It is designed so that the code may be recorded and played back on equipment with intermittent film motion but still be decoded with the same type of electronic equipment used to read the type C or continuous time code.

The codes described in this practice can be used at various frame rates, the ones currently of interest being 24, 25, and 30 frames per second.

2 Normative references

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

ISO/IEC 2022:1994, Information Technology — Character Code Structure and Extension Techniques

SMPTE RP 114-1994 (R1999), Dimensions of Photographic Control and Data Record on 16-mm Motion-Picture Film

SMPTE RP 115-1997, Dimensions of Photographic Control and Data Record on 35-mm Motion-Picture Release Prints

SMPTE RP 116-2000, Dimensions of Photographic Control and Data Record on 35-mm Motion-Picture Camera Negatives

SMPTE RP 135-1999, Use of Binary User Groups in Motion-Picture Time and Control Codes

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3 Modulation method

The modulation method shall be such that a transition occurs at the beginning of every bit period. One is represented by a second transition one half a bit period from the start of the bit. Zero is represented when there is no transition within the bit period.

4 Code formats

Two code formats are described: type C and type B. Clauses 4.1 and 4.2 describe the unique characteristics of the two code types. The other clauses, 4.3 and 4.4, apply to both code types.

4.1 Type C code format

4.1.1 Each motion-picture frame shall be defined by a unique and complete address.

4.1.2 The frames shall be numbered successively 0 through 23, 24, or 29, corresponding to the frame rate being used.

4.1.3 Each address shall consist of 80 bits numbered 0 through 79.

4.1.4 The bits shall be assigned as shown in the appropriate columns of figure 1 and table 1.

4.1.5 Timing of the address

The address shall start at the clock edge before the first address bit (bit zero). The bits shall be evenly spaced throughout the address period, and they shall fully occupy the address period, which is one frame. Consequently, the bit rate shall be 80 times the frame rate in frames per second.

4.1.6 The start of the address, i.e., the clock edge before the first bit, shall coincide with the frameline at the beginning of the image to which the address refers. The tolerance of this location is +0% (in direction of film travel) and -50% of a frame length (in the other direction). (Thus, the start of the address may lie anywhere in the top half of the frame with the preferred position at the frameline.) (See figure 2.)

4.2 Type B code format

4.2.1 Each motion-picture frame shall be identified by a unique and complete address.

4.2.2 The frames shall be numbered successively 0 through 23, 24, or 29, corresponding to the frame rate being used.

4.2.3 Each address shall consist of 112 bits numbered 0 through 111.

4.2.4 The bits shall be assigned as shown in the appropriate columns of figure 1 and in table 1.

4.2.5 Boundaries of the address

The block of data for a single frame may be recorded anywhere within that frame except that no part of the block may occupy the region extending from the frameline to 5% of a frame length on either side of it. This region is thus a gap in the data which has a minimum length of 10% of a frame length (see figure 3).

4.2.6 Bit length

The length of any one bit shall not differ by more than 5% from the length of either adjacent bit. In addition, the length of no bit shall be so short as to make the recording and reproduction of the data, using practical equipment, unreliable; and the length of no series of bits may cause the total length of 112 bits to exceed 90% of frame length.

BIT NO. TYPE C	BIT NO. TYPE B	BIT VALUE	DESCRIPTION	NOTES	
	0	0	TIMING BITS	START FOR TYPE B	
	1	1		IS CLOCK EDGE	
	2	0		BETWEEN BIT 111	
	3	1		AND BIT 0	
	4	0			
	5	1			
	6	0			
	7	1			
	8	0	SYNC WORD		
	9	0			
	10	1			
	11	1			
	12	1			
	13	1			
	14	1			
	15	1			
	16	1			
	17	1			
	18	1			
	19	1			
	20	1		START FOR TYPE C	
	21	1		IS CLOCK EDGE	
	22	0		BETWEEN BIT 79	
	23	1		AND BIT 0	
0	24	1	FRAME UNITS		
1	25	2			
2	26	4			
3	27	8			
4	28		1ST BINARY GROUP		
5	29				
6	30				
7	31				
8	32	10	FRAMES TENS		
9	33	20			
10	34		DROP FRAME FLAG		
11	35		COLOR FRAME FLAG		
12	36		2ND BINARY GROUP		
13	37				
14	38				
15	39				
16	40	1	SECONDS UNIT		TYPE C TIME CODE
17	41	2			80 BITS PER FRAME
18	42	4			
19	43	8			32 USER BINARY
20	44		3RD BINARY GROUP		SPARE BITS
21	45				
22	46				16 SYNC
23	47				
24	48	10	SECONDS TENS		31 ASSIGNED ADDRESS
25	49	20			
26	50	40			1 UNASSIGNED ADDRESS
27	51		BI-PHASE MARK PHASE CORRECTION BIT		
28	52		4TH BINARY GROUP		UNASSIGNED BIT IS ZERO
29	53				
30	54				
31	55				
32	56	1	MINUTES UNITS		
33	57	2			
34	58	4			
35	59	8			
36	60		5TH BINARY GROUP		
37	61				
38	62				
39	63				
40	64	10	MINUTES TENS		
41	65	20			TYPE B TIME CODE
42	66	40			112 BITS PER FRAME
43	67		BINARY GROUP FLAG BIT		
44	68		6TH BINARY GROUP		32 USER BINARY
45	69				SPARE BITS
46	70				
47	71				48 SYNC
48	72	1	HOURS UNITS		31 ASSIGNED ADDRESS
49	73	2			
50	74	4			1 UNASSIGNED ADDRESS
51	75	8			
52	76		7THBINARY GROUP		UNASSIGNED BIT IS ZERO
53	77				
54	78				
55	79				
56	80	10	HOURS TENS		
57	81	20			
58	82		UNASSIGNED ADDRESS BIT		
59	83		BINARY GROUP FLAG BIT		
60	84		8TH BINARY GROUP		
61	85				
62	86				
63	87				

BIT NO. TYPE C	BIT NO. TYPE B	BIT VALUE	DESCRIPTION	NOTES
64	88	0	SYNC WORD	
65	89	0		
66	90	1		
67	91	1		
68	92	1		
69	93	1		
70	94	1		
71	95	1		
72	96	1		
73	97	1		
74	98	1		
75	99	1		
76	100	1		
77	101	1		
78	102	0		
79	103	1		
	104	1	TIMING BITS	
	105	0		
	106	1		
	107	0		
	108	1		
	109	0		
	110	1		

Figure 1 – Bit assignment

Table 1 – Assignment of bits

Bits type C code	Bits type B code	
[1]	0-7	Alternating zero, one pattern
[1]	8-23	Synchronizing word
[1]	8-9	Fixed zero
[1]	10-21	Fixed one
[1]	22	Fixed zero
[1]	23	Fixed one
0-3	24-27	Units of frame
4-7	28-31	First binary group
8-9	32-33	Tens of frames
10	34	Drop frame flag (see 4.4)
11	35	Color frame flag (see 4.4)
12-15	36-39	Second binary group
16-19	40-43	Units of seconds
20-23	44-47	Third binary group
24-26	48-50	Tens of seconds
27	51	Bi-phase mark phase correction bit (see 4.4)
28-31	52-55	Fourth binary group
32-35	56-59	Units of minutes
36-39	60-63	Fifth binary group
40-42	64-66	Tens of minutes
43	67	Binary group flag bit (see 4.4)
44-47	68-71	Sixth binary group
48-51	72-75	Units of hours
52-55	76-79	Seventh binary group
56-57	80-81	Tens of hours
58	82	Unassigned address bit (0 until assigned by the SMPTE)
59	83	Binary group flag bit (see 4.4)
60-63	84-87	Eighth binary group
64-79	88-103	Synchronizing word
64-65	88-89	Fixed zero
66-77	90-101	Fixed one
78	102	Fixed zero
79	103	Fixed one
[1]	104-111	Alternating one, zero pattern

[1] These bits do not exist in the type C code.

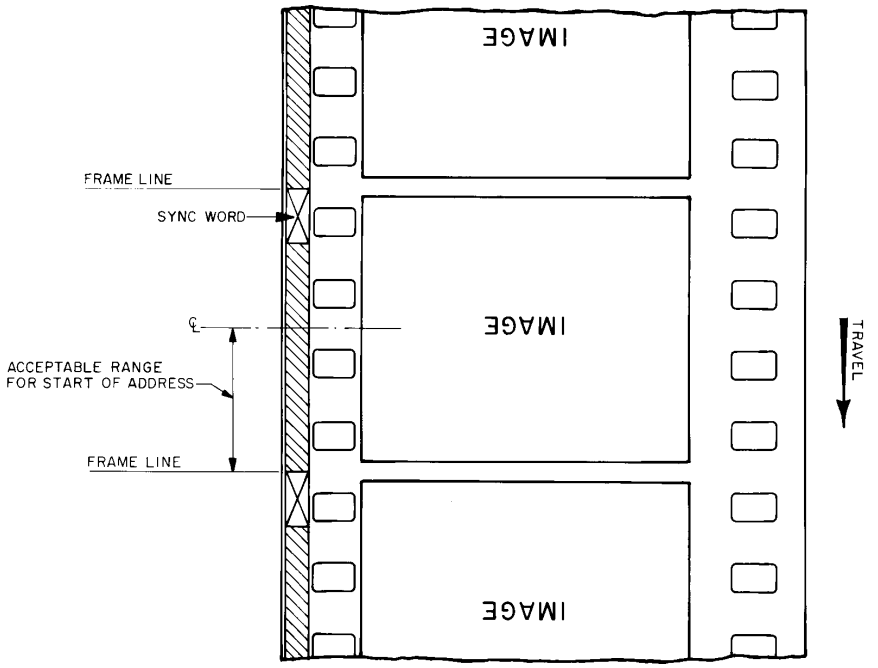

Figure 2 – Type C code

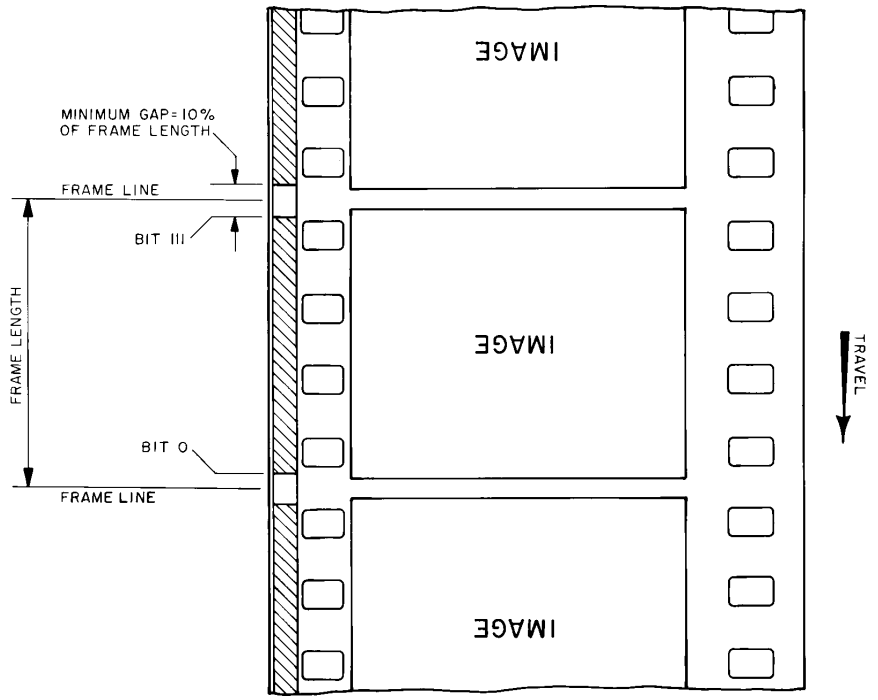

Figure 3 – Type B code

NOTE – Figures 2 and 3 illustrate the preferred longitudinal placement of a frame of time code relative to the picture frame. Thy are not intended to identify the track position on the film. The figures apply to all film formats, even though 35-mm is shown.

4.2.7 Data in the gap

In order to reduce the dc content of the signal, a repetitive pattern of zeros and ones shall be recorded in as much of the gap area (the frameline region defined in 4.2.5) as is practical. In no case may this region contain a sync word nor may these bits, together with the second sync word of the previous frame and the first sync word of the following frame, be decodable as a valid time code word. The bit length tolerance in 4.2.6 does not apply to data in the gap.

4.3 Use of binary groups

The binary groups are intended for storage of data by the users, and the 32 bits within the 8 groups may be assigned in any fashion without restrictions if the character set used for the data insertion is not specified and the binary group flag bits, Nos. 43 and 59, both are zero.

The binary group flag bits 43 and 59 (67 and 83 for type B code) shall be set according to the following truth table:

	Bit 43 (67)	Bit 59 (83)
Character set not specified	0	0
Character set as defined in ISO/IEC 2022	1	0
Data and checksum as defined in SMPTE RP 135	0	1
Unassigned	1	1

The unassigned state of the truth table cannot be used and its assignment is reserved to the SMPTE.

4.4 Assigned and unassigned address bits

Six bits are reserved within the address groups, 4 for identifying operational modes when this type of code is used for television systems (see SMPTE 12M), 1 for bi-phase correction, and 1 unassigned but reserved for future assignment and defined as zero until further specified by the SMPTE.

Bit 10, type C code; bit 34, type B code —

Drop frame flag. If certain numbers are being dropped to resolve the difference between real time and color time, as defined in 5.2.2, a 1 shall be recorded.

Bit 11, type C code; bit 35, type B code —

Color frame flag. If color frame identification has been intentionally applied, a 1 shall be recorded.

Bit 27, type C code; bit 51, type B code —

Bi-phase mark phase correction. Shall be put in a state so that every 80- or 112-bit word will contain an even number of logic zeros. This requirement results in the following truth table for bit 27 (51):

Number of logic zeros in bits 0 to 26 (24 to 50), and bits 28 to 63 (52 to 87)	Type C bit 27	Type B bit 51
Odd	1	0
Even	0	1

Bits 43, 59, type C code; bits 67, 83 type B code —

Binary group flag bits. These two bits shall be set in accordance with the truth table specified in 4.3.

Bit 58, type C code; bit 82, type B code —

Unassigned address. 0 until assigned by SMPTE.

5 Time discrepancies

5.1 When the film on which the time code is recorded is transferred from or will be transferred to television, or is otherwise used in conjunction with a 525-line/60-field television system, there may be a need to use the drop frame counting mode. This clause presents pertinent definitions.

5.1.1 Real time is defined as the time elapsed during the scanning of 60 fields (or any multiple thereof) in an ideal television system at a vertical field rate of exactly 60 fields per second.

5.1.2 Color time is defined as the time elapsed during the scanning of 60 fields (or any multiple thereof) in a color television system at a vertical field rate of approximately 59.94 fields per second.

5.2 Because the vertical field rate of a color signal is approximately 59.94 fields per second, straightforward counting at 30 frames per second (60 fields per second) will yield an error of +108 frames (+216 fields), equivalent to +3.6 seconds timing error, in one hour of running time. For correction of this time discrepancy, two methods of operation are allowed:

5.2.1 Nondrop frame — uncompensated mode (30-frame code only). During a continuous recording, no numbers shall be omitted from the chain of addresses. Each address shall be increased by 1 frame over the frame number immediately preceding it. When this mode is used, bit No. 10 (34) of each address shall be a 0 as specified in 4.4.

5.2.2 Drop frame — compensated mode (30-frame code only). To resolve the color time error, the first two frame numbers (0, 1) at the start of each minute, except minutes 0, 10, 20, 30, 40, and 50, shall be omitted from the count. When this mode is used, bit No. 10 (34) of each address shall be a 1 as specified in 4.4.

6 Structure of the address bits

The basic structure of the address is based on the Binary Coded Decimal (BCD) system. Because the count, in some cases, does not rise to 9, conservation of bits is achieved because 4 bits are not needed as in an ordinary BCD code. (Bits shown in parentheses are for type B code.)

6.1 Units frames. Bits 0-3 (24-27) — 4 bit BCD arranged 1, 2, 4, 8. Count 0-9.

6.2 Tens frames. Bits 8-9 (32-33) — 2 bit BCD arranged 1, 2. Count 0-2.

6.3 Units seconds. Bits 16-19 (40-43) — 4 bit BCD arranged 1, 2, 4, 8. Count 0-9.

6.4 Tens seconds. Bits 24-26 (48-50) — 3 bit BCD arranged 1, 2, 4. Count 0-5.

6.5 Units minutes. Bits 32-35 (56-59) — 4 bit BCD arranged 1, 2, 4, 8. Count 0-9.

6.6 Tens minutes. Bits 40-42 (64-66) — 3 bit BCD arranged 1, 2, 4. Count 0-5.

6.7 Units hours. Bits 48-51 (72-75) — 4 bit BCD arranged 1, 2, 4, 8. Count 0-9.

6.8 Tens hours. Bits 56-57 (80-81) — 2 bit BCD arranged 1, 2. Count 0-2.

NOTE – The 24-hour clock system is used; 2:00 p.m. is 14 hours, 0 minutes.

7 Position of the address on motion-picture film

7.1 Optical tracks

7.1.1 35-mm release print film

The address shall be recorded in the data track whose location is specified in SMPTE RP 115.

7.1.2 35-mm camera film

The address shall be recorded in the data track whose location is specified in SMPTE RP 116.

7.1.3 16-mm film

The address shall be recorded in the data track whose location is specified in SMPTE RP 114.

8 Addresses on motion-picture prints

When the time code is used on final prints, the time code of the picture start frame shall be 01 hours, 00 minutes, 00 seconds, 00 frames. All frames on the reel prior to the picture start frame shall each have the time code 01 hours, 00 minutes, 00 seconds, 00 frames. If the film is longer than one reel, the picture start frame and all preceding frames on the second reel shall be 02 hours, 00 minutes, 00 seconds, 00 frames. Successive reels shall be numbered likewise, with the number of hours increasing sequentially and the minutes, seconds, and frames being zero for the picture start frame.

The picture start frame referred to above precedes the first frame to be projected by exactly eight seconds, as identified in SMPTE 55.

Annex A (informative)
Bibliography

SMPTE 55-2000, Motion-Picture Film — 35- and 16-mm Television Release Prints — Leaders and Cue Marks

SMPTE 12M-1999, Television, Audio and Film — Time and Control Code