EBU Technical Standard N12-1999
Time-and-control codes for television recording

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Time-and-control codes provide an aid to complex television operations and are widely used by EBU Member organizations.

Two types of time-and-control code exist:

- longitudinal time code (LTC), recorded on a dedicated longitudinal track on modern television recorders or on a longitudinal audio track of earlier television recorders;
- vertical-interval time code (VITC), recorded as a signal inserted in the field-blanking period of the video signal.

The specifications for both these codes are given in IEC Publication 461 [1], which is now the official standard used by the EBU for the specification of time code for 625-line television systems. This standard should be applied whenever television programme recordings, which contain either or both types of time code, are exchanged between EBU Members. Detailed specifications of the time-codes are therefore no longer published by the EBU, although the bit-allocations of the two forms of the code are given in *Appendix 1* for reference.

The EBU has supplemented the specification contained in IEC 461 by a number of operational practices on the use of time-code in 625-line television systems, which are given in the *Appendix 2* to the present Standard. These practices should also be applied, as appropriate, when television recordings are exchanged between EBU Members.

Appendix 1 Bit allocations in time code

Table 1 - Longitudinal time-and-control code (LTC)

Bit	State	Weight	Information
0		1	Units of frames BCD 0-9
1		2	
2		4	
3		8	
4			Binary group 2
5			
6			
7			
8		1	Tens of frames BCD 0-2
9		2	
10	0		Unassigned
11			Colour-lock flag = 1 if code is locked to PAL 8-field sequence of video
12			Binary group 2
13			
14			
15			
16		1	Units of seconds BCD 0-9
17		2	
18		4	
19		8	
20			Binary group 3
21			
22			
23			
24		1	Tens of seconds BCD 0-5
25		2	
26		4	
27			Binary group flag; with bit 43, signals the use of 8-bit character code in binary groups
28			Binary group 4
29			
30			
31			
32		1	Units of minutes BCD 0-9
33		2	
34		4	
35		8	
36			Binary group 5
37			
38			
39			
40		1	Tens of minutes BCD 0-5
41		2	
42		4	
43			Binary group flag; with bit 27, signals the use of 8-bit character code in binary groups
44			Binary group 6
45			
46			
47			
48		1	Units of hours BCD 0-9
49		2	
50		4	
51		8	
52			Binary group 7
53			
54			
55			
56		1	Tens of hours BCD 0-2
57		2	
58	0		Unassigned
59			Bi-phase mark correction; makes an even number of logic "0" in bits 0 to 79
60			Binary group 8
61			
62			
63			
64	0		Synchronizing word
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		

Table 2 – Vertical-interval time-and-control code (VITC)

Bit	State	Weight	Information
0	1		Synchronization bit
1	0		Synchronization bit
2		1	Units of frames BCD 0-9
3		2	
4		4	
5		8	
6			Binary group 1
7			
8			
9			
10	1		Synchronization bit
11	0		Synchronization bit
12		1	Tens of frames BCD 0-2
13		2	
14	0		Unassigned
15			Colour-lock flag _ 1 if code is locked to PAL 8-field sequence of video
16			Binary group 2
17			
18			
19			
20	1		Synchronization bit
21	0		Synchronization bit
22		1	Units of seconds BCD 0-9
23		2	
24		4	
25		8	
26			Binary group 3
27			
28			
29			
30	1		Synchronization bit
31	0		Synchronization bit
32		1	Tens of seconds BCD 0-5
33		2	
34		4	
35			Binary group flag; with bit 55, signals the use of 8-bit character code in binary groups
36			Binary group 4
37			
38			
39			
40	1		Synchronization bit
41	0		Synchronization bit
42		1	Units of minutes BCD 0-9
43		2	
44		4	
45		8	
46			Binary group 5
47			
48			
49			
50	1		Synchronization bit
51	0		Synchronization bit
52		1	Tens of minutes BCD 0-5
53		2	
54		4	
55			Binary group flag; with bit 35 signals the use of 8-bit character code in binary groups
56			Binary group 6
57			
58			
59			
60	1		Synchronization bit
61	0		Synchronization bit
62		1	Units of hours BCD 0-9
63		2	
64		4	
65		8	
66			Binary group 7
67			
68			
69			
70	1		Synchronization bit
71	0		Synchronization bit
72		1	Tens of hours BCD 0-2
73		2	
74	0		Unassigned
75			Field mark bit, set to logic "0" during odd-numbered fields, set to logic "1" during even fields
76			Binary group 8
77			
78			
79			
80	1		Synchronization bit
81	0		Synchronization bit
82			Cyclic redundancy check code (CRC)
83			
84			
85			
86			
87			
88			
89			

Appendix 2

Use of the IEC time-and-control code for television recordings (625-line television systems)

1. Introduction

Time-and-control code was designed to enable complex video tape operations to be carried out, replacing earlier mechanical and physical methods used for editing control and tape-length indication.

The 625-line version of the code, for use on the longitudinal tracks of television tape-recorders, was developed by the EBU. It was later extended to include specifications of the sub-carrier to line-sync relationship (EBU Statement D23 [2]) and the PAL 8-field sequence (EBU Standard N18 [3]) which were necessary for accurate editing in the PAL system.

Later, a version of the code was developed for insertion in the field-blanking interval of the television signal. This is referred to as the vertical-interval time-code (VITC) and the original code is now referred to as the longitudinal time-code (LTC). The specifications of both forms of time-code are now given in IEC Publication 461 and the EBU accepts this as the international standard for time-code.

Over the years, the EBU has found that a number of additional aspects of the operational use of the time-and-control codes need to be defined for the benefit of its Members. These are given in the present *Appendix*.

2. Operational practices

2.1. LTC recording

Table 1 is derived from the various IEC Publications containing the specifications of the television tape-recording formats in common use by the EBU Members. It summarises the specifications regarding the choice of track to carry the LTC, the recording method and the record flux level.

All the IEC Publications refer to IEC Publication 461 for the specification of the time-and-control code.

The AC bias (anhysterisis) method is used for the recording of LTC in all the formats.

In some early broadcast television recording formats (transverse-track, format B, format C) the time-code is recorded on a track which may also be used for audio recordings at other times. The time-code signal is read and used from this track at different speeds which, ideally, may range from almost stationary up to spooling speed. If this is not taken into account in the design of these audio tracks and their associated electronic circuits and transducers, considerable distortion may be produced on the waveform of the time-code signal.

Audio companding systems should not be used when an audio track is used to record time-code.

Table 1 – IEC specifications for the recording of time-and-control code in television recording formats used by broadcasters

Format	IEC Publication and Section		Time-code track	Recording level*	Note
Transverse-track	347 [4]	Section 4.5	Cue track	600 – 800 nWb/m p-p	1
Format B	602 [5], Amt 1	Section 7.4.3.	Audio track 3	720 ± 70 nWb/m p-p	2
Format C	558 [6], Amt 1	Section 8.5.3.	Audio track 3	=> 186 nWb/m p-p	
Betacam SP	961 [7]	Section 13	Dedicated time-code track	500 nWb/m rms	3
MII	1118 [8]	Section 5.4	Dedicated time-code track	250 ± 50 nWb/m p-p	
D1	1016 [9]	Section 35	Dedicated time-code track	185 ± 20 nWb/m p-p	
D2	1709 [10]	Section 9.5	Dedicated time-code track	500 ± 20 nWb/m p-p	
D3	61327[11]	Section 39	Dedicated time-code track	250 ± 20 nWb/m p-p	
Analogue multi-track audio	94-6 [12]		Audio track having the highest number	Not standardized	4

Notes:

* Recording levels are expressed as the rms or peak-to-peak magnetic short-circuit flux level, per metre of record track width.

1. The transverse-track format is obsolete and is no longer recommended for programme exchanges.
2. A recording level of 720 nWb/m p-p corresponds to 254 nWb/m rms, for a sinusoidal signal.
3. The recording level shall be sufficient to ensure full saturation of the magnetic domains.
4. The audio track adjacent to the track carrying the time-code should preferably remain un-recorded. The recording level is chosen to give reliable time-code reading at speeds which are not close to zero, but should be low enough to avoid crosstalk into the audio tracks.

2.2. VITC recording

The EBU considers that the VITC should be used as a supplementary facility alongside the LTC in tape recording formats. It is used on formats with slow and stop-motion replay when it would be difficult or impossible to read the LTC.

The EBU recommends that if VITC is used on analogue television tape recordings in the 625 line standards, intended for programme exchange, the following conditions should be respected:

- The VITC shall be recorded on television lines 19 and 21 (332 and 334) only.
- The time element of the VITC, after decoding as described in *Section 3.2*. below, shall agree with the time element, of the LTC, after decoding as described in *Section 3.1*. below.
- There need be no correspondence between the user data in the VITC and LTC.

3. Decoding delay of time-code signals

3.1. LTC

Time-and-control code information is recorded on tapes at the same time as the video information to which it applies. On replay, the information is available only during the same period as the video. Therefore, it cannot be decoded until after a picture has started or, in the case of LTC, until all the information is available: this will not be until after the picture has been replayed. The decoder can therefore only produce an output code after each television picture has passed. Decoders therefore have to add one frame count to the decoded output, in order to compensate for the delay in reading and decoding. The addition of one frame is illustrated in *Fig. 1*.

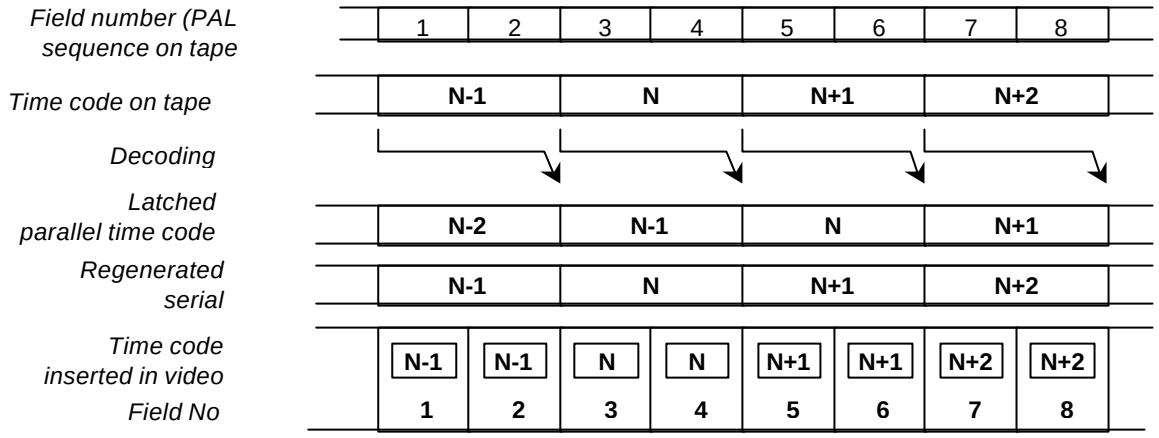


Fig. 1 - Addition of one frame to compensate for the decoding delay

3.2. VITC

A VITC decoder must maintain the correct relationship between the associated video signal and the information it delivers via its serial or parallel output. A recommended method of ensuring this relationship is illustrated in *Fig. 2*.

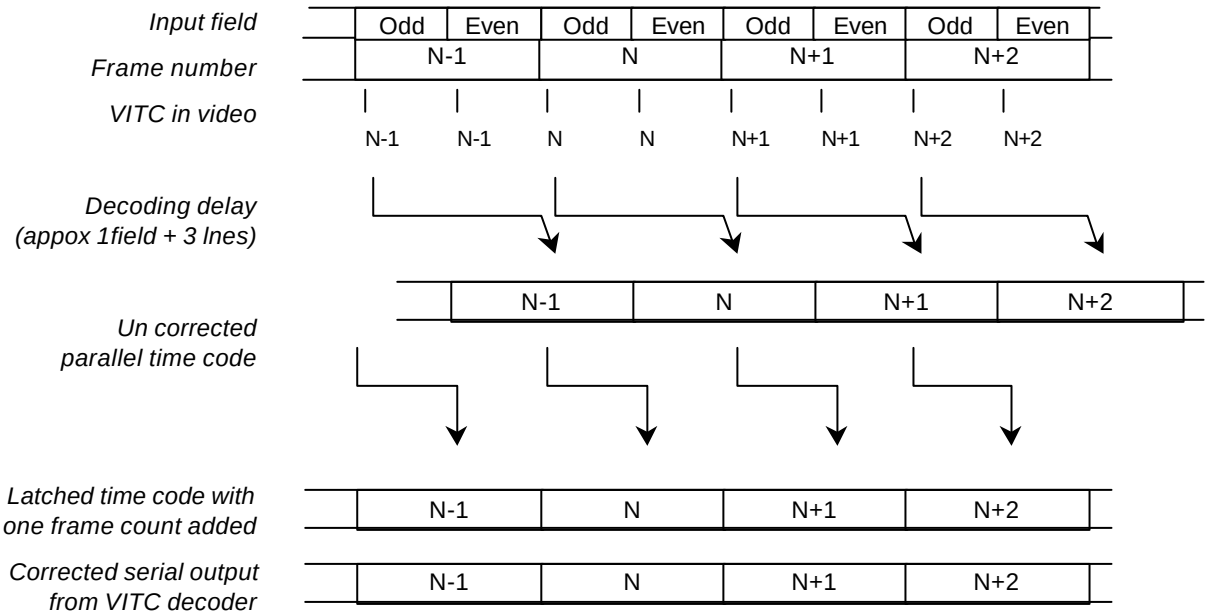


Fig. 2 - Correlation between VITC information and the associated video signal

3.3. Decoding delay compensation when the same field is repeated

The method described in *Section 3.2*. for the compensation of decoding delay by the "add-one-frame" technique is a predictive process which assumes that there is an uninterrupted increase in the time numbers fed to the decoder. This assumption will not be valid if a single recorded field is repeated several times at the VTR output, as happens in slow-motion or stop-frame modes. These modes are achieved either by repeating the scan of a recorded track or by repeatedly reading information from a field store. In this situation, the compensation of the decoding delay outlined above will fail unless counter-measures are taken. This is true in respect of both the LTC and VITC.

In the case of a repeated scan of a recorded track, the only effective counter-measure is to switch off the "add-one-frame" circuit at the right moment. To do this, it is necessary for an external decoder to receive an indication of whether or not the read-out came from a procedure of this sort.

In the case of repeated read-out from a field store, it is necessary that the LTC or VITC information is memorised at the same time as the video information. The solution is the same as for the case described above.

4. Preferred level and impedance for the output of time-code generators

Time-code generators that are not built into television recorders or systems should provide outputs that are compatible with the ordinary practice of audio installations. This generally provides for a load impedance which is greater than 10 kΩ.

The output should have the following characteristics:

- output level: internally adjustable between 0.5 and 4.5 V_{p-p};
- output impedance: less than 30 Ω.

5. Connectors for use with LTC signals

5.1. Video tape recorders and equipment for studio use

The connector for LTC signals should be a 3-pin type XLR connector in accordance with IEC Publication 268-1 [13].

It should be used as shown in *Fig 3*.

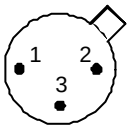
Pin number	Attribution	Front view of pins
1	Screen	
2	Signal (+)	
3	Signal (-)	

Fig. 3 - Contact numbers as seen on the mating face of the pin (male) connector

A fixed connector with pins (male) should be used as an output from equipment.

A fixed connector with sockets (female) should be used as an input to equipment.

5.2. Video tape recorders for portable use

If there are severe space restrictions on portable equipment, a BNC type connectors [14] can be used (the signal will be unbalanced with respect to earth).

A connector with sockets (female) should be used on equipment for both signal input and output.

Bibliography

[1] IEC Publication 461: **Time and control code for video tape recorders**

[2] EBU Statement D23-1999: **Timing relationship between the subcarrier reference and the line sychronizing pulses for 625-line PAL television signals**

[3] EBU Standard N18-1990: **Relationship between the time addresses in the EBU time-and-control code and the eight-field sequence of the 625-line/50-fields PAL television signal with which the code is associated**

[4] IEC Publication 347: **Transverse track video recorders**

[5] IEC Publication 602 plus Amendment No. 1: **Type B helical video recorders**

[6] IEC Publication 558 plus Amendment No. 1: **Type C helical video recorders**

[7] IEC Publication 961 plus Amendment No. 1**: Helical-scan video tape cassette system using 12.65 mm (0.5 in) magnetic tape on type L**

[8] IEC Publication 1118: **Helical-scan video tape cassette systems using 12.65 mm (0.5 in) magnetic tape type MII cassettes**

[9] IEC Publication 1016: **Helical-scan digital component video cassette recording system using 19-mm magnetic tape (format D-1)**

[10] IEC Publication 1709: **Helical-scan digital composite video cassette recording system using 19-mm magnetic tape, format D-2 (NTSC, PAL, PAL-M)**

[11] IEC Publication IEC 61327 - **Helical-scan digital composite video cassette recording system using 12,65 mm (0,5 in) magnetic tape - Format D-3**

[12] IEC Publication 94: **Magnetic tape sound recording and reproducing systems – Part 8: Reel-to-reel systems**

[13] IEC Publication 268: **Sound systems equipment – Part 12: Applications of connectors for broadcast and similar use**

[14] IEC Publication 169: **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)**

Note on IEC Publication numbers:

Recently, the IEC has added 6000 to the numbers of all its former publications to avoid confusion with ISO Standards. Thus Publication 461 now becomes Publication 60461. However, the printed versions will only be renumbered during reprinting. Most of the references above are to the original numbers.