SMPTE ST 318:2015
Revision of
SMPTE 318M-1999

SMPTE STANDARD

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

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Approved
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Foreword

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SMPTE Engineering Documents are drafted in accordance with the rules given in its Standards Operations Manual. This SMPTE Engineering Document was prepared by Technology Committee 32NF.

Intellectual Property

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Introduction

This section is entirely informative and does not form an integral part of this Engineering Document.

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.

1 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 60/1.001 (nominal 59.94) 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 60/1.001 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. 24/1.001 (nominal 23.98) Hz or 48 kHz).

Note: SMPTE ST 12-1 Annex B gives guidance on conversion of 24/1.001 (23.98) frames-per-second video to 30/1.001 (29.97) frames-per-second video using the ten-field sequence.

2 Conformance Notation

Normative text is text that describes elements of the design that are indispensable or contains the conformance language keywords: "shall", "should", or "may". Informative text is text that is potentially helpful to the user, but not indispensable, and can be removed, changed, or added editorially without affecting interoperability. Informative text does not contain any conformance keywords.

All text in this document is, by default, normative, except: the Introduction, any section explicitly labeled as "Informative" or individual paragraphs that start with "Note:"

The keywords "shall" and "shall not" indicate requirements strictly to be followed in order to conform to the document and from which no deviation is permitted.

The keywords, "should" and "should not" indicate that, among several possibilities, one is recommended as particularly suitable, without mentioning or excluding others; or that a certain course of action is preferred but not necessarily required; or that (in the negative form) a certain possibility or course of action is deprecated but not prohibited.

The keywords "may" and "need not" indicate courses of action permissible within the limits of the document.

The keyword “reserved” indicates a provision that is not defined at this time, shall not be used, and may be defined in the future. The keyword “forbidden” indicates “reserved” and in addition indicates that the provision will never be defined in the future.

A conformant implementation according to this document is one that includes all mandatory provisions ("shall") and, if implemented, all recommended provisions ("should") as described. A conformant implementation need not implement optional provisions ("may") and need not implement them as described.

Unless otherwise specified, the order of precedence of the types of normative information in this document shall be as follows: Normative prose shall be the authoritative definition; Tables shall be next; then formal languages; then figures; and then any other language forms.

3 Normative References

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

SMPTE ST 12-1:2014, Time and Control Code

SMPTE ST 170:2004 (Stabilized 2010), Television – Composite Analog Video Signal – NTSC for Studio Applications

IEC 61169-8 Ed1.0 (2007-02), Radio-Frequency Connectors — Part 8: Sectional Specification — RF Coaxial Connectors with Inner Diameter of Outer Conductor 6,5 mm (0,256 in) with Bayonet Lock — Characteristic Impedance 50 ohm (Type BNC)

Recommendation ITU-R BT.1700 (2005), Characteristics of Composite Video Signals for Conventional Analogue Television Systems

4 Timing Reference Application

4.1 Output Reference

Where a separate reference is required for the output function, the equipment may 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. Vertical interval switching points for various standard definition and high definition video systems are defined in SMPTE RP 168.

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 SMPTE ST 170 or Recommendation ITU-R BT.1700, as appropriate, except as noted herein. The signal shall include the appropriate color burst.

5.1.1 60/1.001 Hz related

525 line; 2:1 interlace; 30/1.001 frames/s; (60/1.001 fields/s); 3.58 MHz (nominal) subcarrier burst (NTSC).

5.1.2 50 Hz related

625 line; 2:1 interlace; 25 frames/s; (50 fields/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 Section 7, 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 Section 7, 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 color 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

75 ohm BNC connectors shall be in accordance with IEC 61169-8.

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 Section 7, Note 2).

6.1 Vertical Interval Time Code

Vertical Interval Time Code (VITC) 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. If present, the Vertical Interval Time Code shall be in accordance with SMPTE ST 12-1.

6.2 Ten-Field Reference (60/1.001 Hz Related Systems only)

For 60/1.001-Hz related systems (e.g., 525-line NTSC), a 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

If present, the ten-field (five-frame) sequence identification shall be coded over 6 pulse positions as shown in Table 1. The Start pulse (position 1) shall always be present. The Frame Count Pulses (positions 2 through 5) indicate the frame number within the sequence, the number of pulses increasing from zero to four during the sequence. The Field Pulse (position 6) shall indicate odd field (pulse absent) or even field (pulse present).

The pulses shall be present on both line 15 and line 278 with the exception of the even-field identification pulse which is present on line 278 (even field) only. Pulse positions shall be separated by spaces of duration equal to the pulses. The waveform is shown in Table 1.

The start of the ten-field sequence shall be the field with zero frame count pulses and no even-field identification pulse, i.e. pulse logical values 1, 0, 0, 0, 0, 0.

Table 1 – Pulse coding for ten-field sequence

Ten-field Sequence	Five-Frame Sequence	Start Pulse 1	Frame Count Pulses				Field Pulse 6
			Pulse 2	Pulse 3	Pulse 4	Pulse 5	
1	1	1	0	0	0	0	0
2		1	0	0	0	0	1
3	2	1	1	0	0	0	0
4		1	1	0	0	0	1
5	3	1	1	1	0	0	0
6		1	1	1	0	0	1
7	4	1	1	1	1	0	0
8		1	1	1	1	0	1
9	5	1	1	1	1	1	0
10		1	1	1	1	1	1
Note: Implementers should be aware that the 'Frame of Sequence' numbers are one-based; however, the Frame Count Pulse coding is zero-based.							

6.2.2 Pulse waveshape, position and jitter

The pulse edges should be skew-symmetric. Raised cosine shaping is preferred. Other signal parameters shall be as specified in Figure 1 and Table 2.

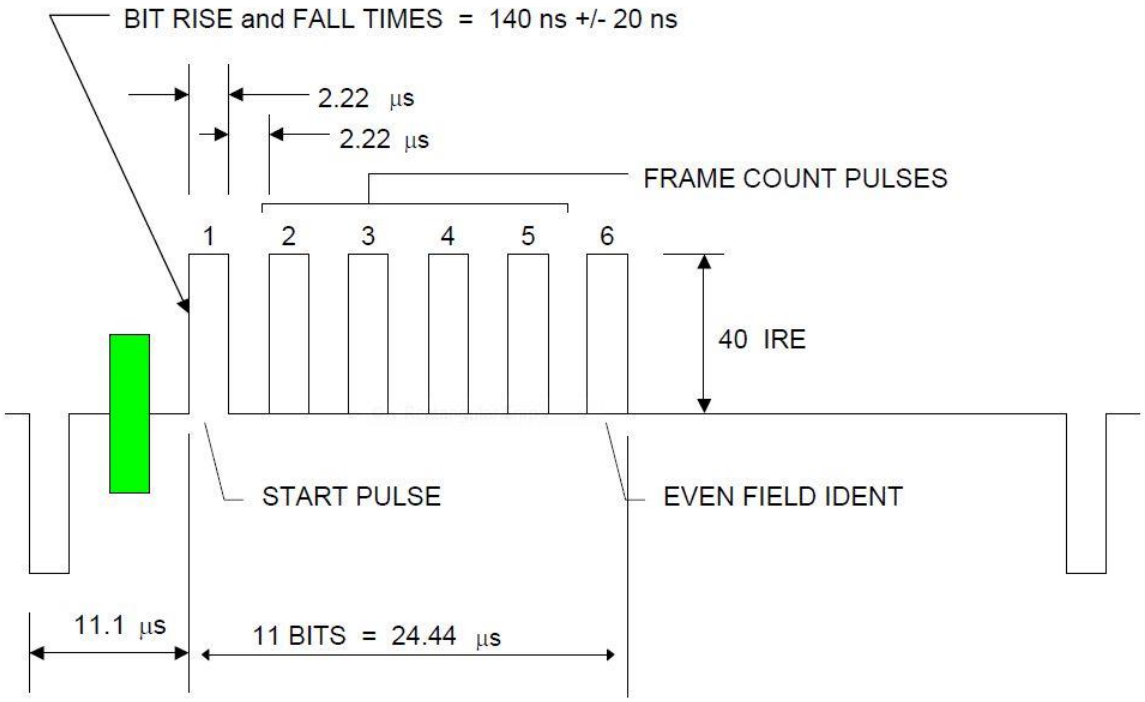

Figure 1 – Ten-field identification signal

Table 2 – Ten-field 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	± 0.10	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 SMPTE ST 170. [2)] A basic clock frequency of 4.5 MHz is assumed; the pulse width is related to the period of that clock.			

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 ST 318-A.

A reference signal including the ten-field sequence identification would be said to conform to SMPTE ST 318-B.

A reference signal including both VITC and the ten-field sequence identification would be said to conform to SMPTE ST 318-AB.

7 **Notes** (Informative)

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

2. Reference signals of higher constant average picture level (APL) are specifically avoided because they can 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 can 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, it is recommended that the effect of permitted ancillary signals be considered.

3. Reference signals with minimal jitter are preferred for many applications. For example, SMPTE ST 259 specifies a worst-case figure for alignment and timing of jitter of 0.2 UI.

Annex A Bibliography (Informative)

AES3-2009, AES Standard for Digital Audio — Digital Input-Output Interfacing — Serial Transmission Format for Two-Channel Linearly-Represented Digital Audio Data

AES11-2009, AES Recommended Practice for Digital Audio Engineering — Synchronization of Digital Audio Equipment in Studio Operations

SMPTE ST 125:2013, SDTV Component Video Signal Coding 4:4:4 and 4:2:2 for 13.5 MHz and 18 MHz Systems

SMPTE ST 244:2003, Television — System M/NTSC Composite Video Signals — Bit-Parallel Digital Interface

SMPTE ST 259:2008, Television — SDTV Digital Signal/Data — Serial Digital Interface

SMPTE ST 274:2008, Television — 1920 × 1080 Image Sample Structure, Digital Representation and Digital Timing Reference Sequences for Multiple Picture Rates

SMPTE ST 293:2003, Television — 720 × 483 Active Line at 59.94-Hz Progressive Scan Production — Digital Representation

SMPTE ST 294:2001, Television — 720 × 483 Active Line at 59.94-Hz Progressive Scan Production — Bit-Serial Interfaces

SMPTE ST 295:1997, Television — 1920 × 1080 50-Hz — Scanning and Interface

SMPTE ST 296:2012, 1280 × 720 Progressive Image 4:2:2 and 4:4:4 Sample Structure — Analog and Digital Representation and Analog Interface

SMPTE ST 2059-1:2015, Generation and Alignment of Interface Signals to the SMPTE Epoch

SMPTE RP 168:2009, Definition of Vertical Interval Switching Point for Synchronous Video Switching