SMPTE 318M-1999
Revision of
SMPTE RP 154-1994

SMPTE STANDARD

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.

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

SMPTE 170M-1999, 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.470-6 (6/11/98), Conventional Television Systems

Approved
September 1, 1999

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 SMPTE 170M or ITU-R BT.470-6, 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 $\pm$ 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 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 SMPTE 170M.
2) A basic clock frequency of 4.5 MHz is assumed.

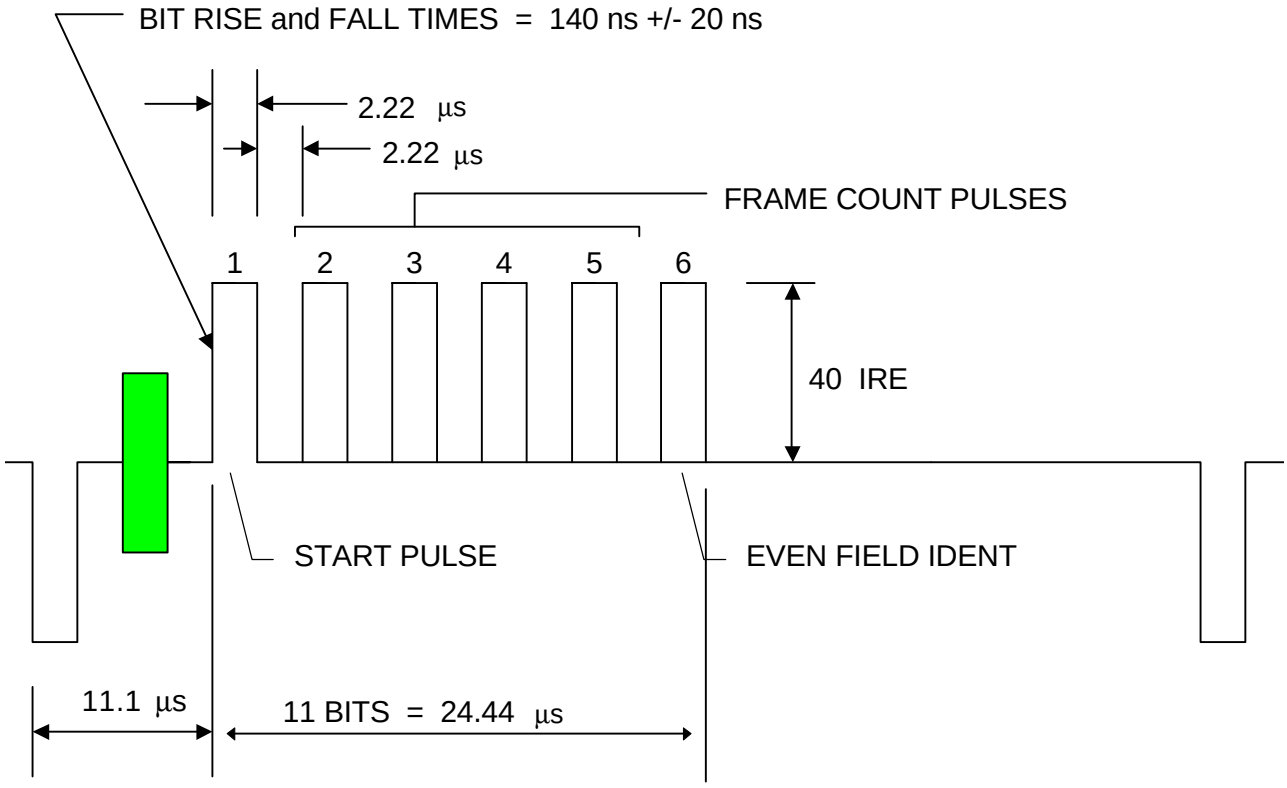

Figure 1 -- Ten-field identification signal

Annex A (informative)
Bibliography

AES3-1992, Digital Audio Engineering — Serial Transmission Format for Two-Channel Linearly Represented Digital Audio Data

AES11-1997, Digital Audio Engineering — Synchronization of Digital Audio Equipment in Studio Operations

ANSI/SMPTE 125M-1995, Television — Component Video Signal 4:2:2 — Bit-Parallel Digital Interface

ANSI/SMPTE 244M-1995, Television — System M/NTSC Composite Video Signals — Bit-Parallel Digital Interface

ANSI/SMPTE 259M-1997, Television — 10-Bit 4:2:2 Component and $4f_{sc}$ Composite Digital Signals — Serial Digital Interface

ANSI/SMPTE 293M-1996, Television — 720 × 483 Active Line at 59.94-Hz Progressive Scan Production — Digital Representation

ANSI/SMPTE 294M-1997, Television — 720 × 483 Active Line at 59.94-Hz Progressive Scan Production — Bit-Serial Interfaces

ANSI/SMPTE 295M-1997, Television — 1920 × 1080 50-Hz — Scanning and Interface

ANSI/SMPTE 296M-1997, Television — 1280 × 720 Scanning, Analog and Digital Representation and Analog Interface

SMPTE 274M-1998, Television — 1920 × 1080 Scanning and Analog and Parallel Digital Interfaces for Multiple Picture Rates