

RECOMMENDATION ITU-R BT.1700

Characteristics of composite video signals for conventional analogue television systems

(2005)

The ITU Radiocommunication Assembly,

considering

- a) that many countries have established analogue colour television broadcasting services based on the NTSC, PAL or SECAM systems;
- b) that it would add further complications to the interchange of programmes to have a greater multiplicity of systems;
- c) that Recommendation ITU-R BT.1701 – Characteristics of radiated signals of conventional analogue television systems, defines the radio-frequency specifications;
- d) that Report ITU-R BT.2043 – Analogue television systems currently in use throughout the world, gives information on different television systems used by different countries,

recommends

- 1** that administrations wishing to implement an analogue composite colour television system should choose the production video signal characteristics of one of the television systems defined in Parts A, B and C.

...

PART A

NTSC signal format and specification

For format specifications and signal waveforms, see SMPTE 170M-1999 Television – Composite Analogue Video Signal – NTSC for Studio Applications.

NOTE 1 – In Japan, the following parameters have been implemented and deviate from those defined in SMPTE 170M-1999.

	Parameter	SMPTE 170M-1999	Value used in Japan
1	Black (set-up) level	Table 1	0
2	Vertical blanking	Table 3	0.07 v-0.082 v, where v is the field period
3	Reference white	Section 4.2	The adjustment of the chromaticity of studio monitor to a D-white at 9 300 K is also used

NTSC analogue video signal specifications

For applications in professional television production and post-production NTSC, video signals should be defined by the detailed parameters given in SMPTE Standard 170M-1999.

This Standard describes the composite analogue colour video signal for studio applications: NTSC, 525 lines, 59.94 Hz field rates, 2:1 interlace with an aspect ratio of 4:3. This Standard specifies the interface for analogue interconnection and serves as the basis for the digital coding necessary for digital interconnection of NTSC equipment.

The composite colour video signal contains an electrical representation of the brightness and colour of a scene being analysed (the active picture area) along defined paths (scan lines). The signal includes synchronizing and colour reference signals that allow the geometric and colorimetric aspects of the original scene to be correctly reconstituted at the display. The synchronizing and colour reference signals are placed in parts of the composite colour video signal that are not visible on a correctly adjusted display. Certain portions of the composite colour video signal that do not contain active picture information are blanked (forced below black level) in order to allow retrace of scanning beams in some types of cameras and display devices.

The video signal representing the active picture area consists of:

- a wideband luminance (brightness) component with set-up and no upper bandwidth limitation for studio applications;
- a pair of simultaneous chrominance (colouring) components, amplitude modulated on a pair of suppressed sub-carriers of identical frequency ($f_{sc} = 3.579545... \text{ MHz}$) in quadrature (i.e. with a 90° difference in phase).

The video signal representing the active picture area corresponds to the scanning of the image at uniform velocities from left to right and from top to bottom. The velocities are such that the picture is repetitively scanned on 525 nominally horizontal lines, with alternate lines scanned on each vertical pass. This process is described as 2:1 interlace.

The aspect ratio of the active picture area is four units horizontally to three units vertically.

The composite colour video signal is produced by an NTSC encoder that functions as follows:

- The input signals to an NTSC encoder are time-coincident green, blue, and red video signals ($G B R$), with no set-up and of equal amplitude when conveying picture information with no colour content. Horizontal and vertical synchronizing signals and reference sub-carrier are also required.
- After low-pass filtering, the colour-difference signals ($B-Y$ and $R-Y$ or I and Q) are fed to balanced, quadrature-phase, sub-carrier amplitude modulators.
- The modulated sub-carrier signals are added to the luminance signal, along with set-up, blanking, sync, and burst (a colour synchronizing signal) to form the composite output video signal.
- There is a fixed frequency and phase relationship between the sub-carrier in the burst signal, the sub-carriers conveying the colour-difference signals, and the horizontal and vertical synchronizing signals.
- The luminance and colour-difference components of the composite colour video signal at the encoder output are time-coincident.

NOTE 1 – SMPTE Standard 170M-1999 is available in electronic form at the ITU website: <http://www.itu.int/ITU-R/study-groups/sg/sg6/SMPTE/> as well as in Annex 1 of this Recommendation. SMPTE Standard 170M-1999 refers to version 1999 only, which is the version approved, by administrations of Member States of the ITU and Radiocommunication Sector Members participating in the work of Radiocommunication Study Group 6 in application of Resolution ITU-R 1-3. By agreement between ITU and SMPTE, this version was provided and authorized for use by SMPTE and accepted by ITU-R for inclusion in this Recommendation. Any subsequent version of SMPTE Standard 170M, which has not been accepted and approved by Radiocommunication Study Group 6 is not part of this Recommendation. For subsequent versions of SMPTE documents, the reader should access the SMPTE website: <http://www.smpte.org>.

PART B

PAL signal format and specification

This Part provides information concerning signal level, timing, chrominance modulation characteristics, and baseband bandwidth characteristics of 525-line and 625-line PAL implementations.

TABLE 1

Basic characteristics of video and synchronizing signals*

Item	Characteristic	525 PAL NOTE – Future use of 525 PAL as a production standard is not recommended	625 PAL {Argentina 625 PAL – Future use of this standard as a production standard is not recommended. Values in brackets { }}
1	Total number of lines per picture (frame)	525	625
1a	Number of active lines	483	576
2	Line frequency f_H (colour)	15 734.26 Hz $\pm$ 0.0003%	15 625 Hz $\pm$ 0.00002%
3	Field frequency (field/s)	$2f_H/525$ (60/1.001)	$2f_H/625$
4	Nominal video bandwidth	There is no constraint in studio/production applications	
5	Chrominance sub-carrier frequency f_{sc}	3 575 611.49 $\pm$ 5 Hz	4 433 618.75 $\pm$ 1 Hz {3 582 056.25 $\pm$ 5 Hz}
6	Relationship between chrominance sub-carrier frequency f_{sc} and line frequency f_H	$f_{sc} = \frac{909}{4} f_H$	$f_{sc} = \left(\frac{1135}{4} + \frac{1}{625} \right) f_H$ $\{f_{sc} = \left(\frac{917}{4} + \frac{1}{625} \right) f_H\}$
7	Type of chrominance sub-carrier modulation	Suppressed-carrier amplitude-modulation of two sub-carriers in quadrature	
8	Luminance signal	$E'_Y = 0.299 E'_R + 0.587 E'_G + 0.114 E'_B$ E'_R, E'_G and E'_B are gamma-pre-corrected primary signals	
8a	Assumed gamma of display device	2.8	
9	Chrominance signals (colour difference) matrix equations	$E'_U = 0.493 (E'_B - E'_Y)$ $E'_V = 0.877 (E'_R - E'_Y)$	

Document generated by IHS Markit

TABLE 1

Basic characteristics of video and synchronizing signals*

Item	Characteristic		525 PAL			625 PAL					
			NOTE – Future use of 525 PAL as a production standard is not recommended			{Argentina 625 PAL – Future use of this standard as a production standard is not recommended. Values in brackets {}}					
10a	Assumed chromaticity coordinates (CIE, 1931) for primary colours of receiver ⁽¹⁾		x	y	x	y					
		Red	0.630	0.340	0.64	0.33					
		Green	0.310	0.595	0.29	0.60					
		Blue	0.155	0.070	0.15	0.06					
10b	Chromaticity coordinates for equal primary signals $E'_R = E'_G = E'_B$ (reference white)		(Illuminant C) $x = 0.3101$ $y = 0.3162$			(Illuminant D65) $x = 0.3127$ $y = 0.3290$					
10c	Attenuation of colour difference signals		$E'_U < 2$ dB at 1.3 MHz $E'_V > 20$ dB at 3.6 MHz			$E'_U < 3$ dB at 1.3 MHz $E'_V > 20$ dB at 4 MHz { $E'_V > 20$ dB at 3,6 MHz}					
10d	Equation of composite colour signal		$E_M = E'_Y + E'_U \sin (2\pi f_{sc} t) + E'_V \cos (2\pi f_{sc} t)$ where: E'_Y see item 8 E'_U and E'_V see item 9 f_{sc} see item 5 The sign of the E'_Y component is the same as that of the sub-carrier burst (changing for each line) (see item 10f)								
10e	Amplitude of chrominance sub-carrier		$G = \sqrt{E'^2_U + E'^2_V}$								
10f	Phase of chrominance sub-carrier burst (see Fig. 2)		135° relative to E'_U axis with the following polarity								
			Field	1	2	3	4	5	6	7	8
			Burst blanking sequence (see Figs. 8 and 9)	I	II	III	IV	I	II	III	IV
			Even line	–	–	+	+	–	–	+	+
			Odd line	+	+	–	–	+	+	–	–

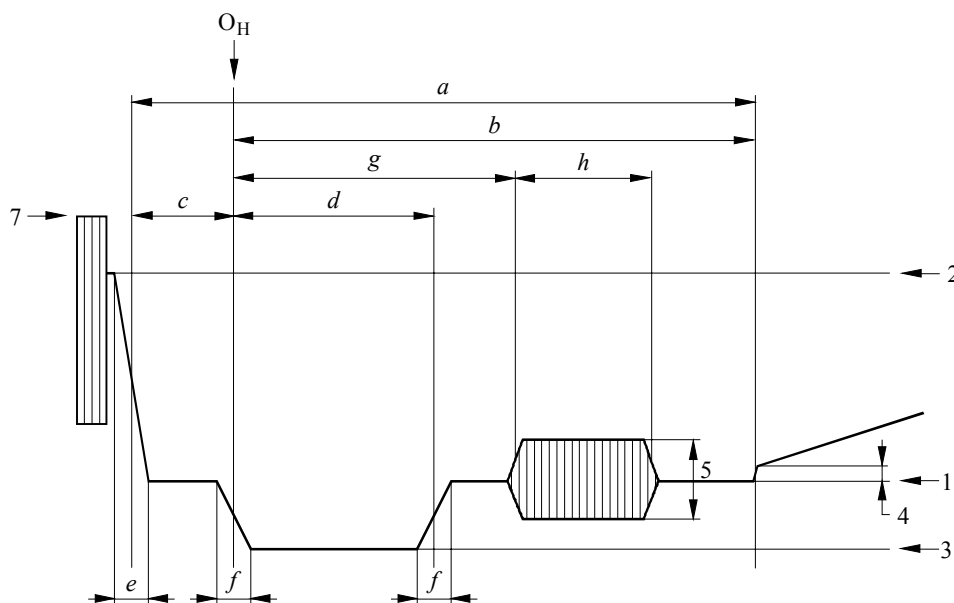
TABLE 1

Item	Characteristic	525 PAL NOTE – Future use of 525 PAL as a production standard is not recommended	625 PAL {Argentina 625 PAL – Future use of this standard as a production standard is not recommended. Values in brackets { }}
10g	Synchronization of chrominance sub-carrier	By chrominance sub-carrier reference signals on the line-blanking back porch	
10h	Synchronization of chrominance sub-carrier switching during line blanking	By E'_V chrominance component of sub-carrier burst	
11	Line synchronization	See Table 2	
12	Field synchronization	See Table 3	

* This PAL recommendation provides information concerning signal level, timing, modulation characteristics, and bandwidth characteristics. Although there may be different emission standards using the 625 PAL system, there is only one studio/production format.

- (1) Field 1 of the sequence of eight colour fields is defined as that field, where the phase $\varphi_{E'_U}$ of the extrapolated E'_U component (see item 9) of the video burst at the half amplitude point of the leading edge of the line synchronizing pulse of line 1 is in the range $-90^\circ \leq \varphi_{E'_U} < 90^\circ$.

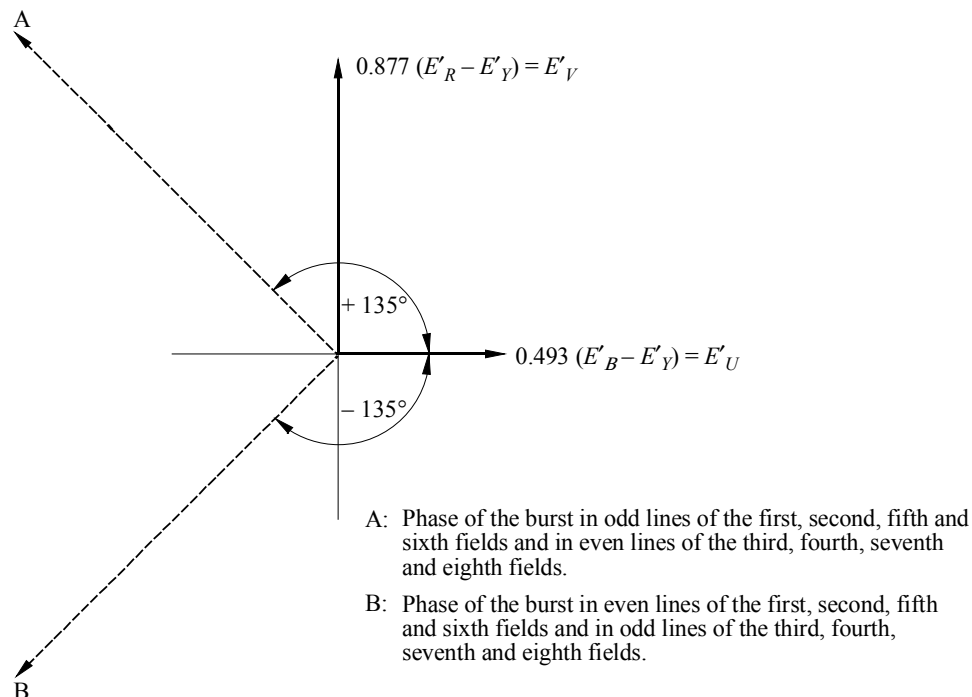
FIGURE 1
Line synchronization detail



1700-01

FIGURE 2

Chrominance axes and phase of the sub-carrier synchronization burst



1700-02

TABLE 2

Details of line synchronizing signals (see Fig. 1)

Symbol	Characteristic	525 PAL NOTE – Future use of 525 PAL as a production standard is not recommended	625 PAL {Argentina 625 PAL – Future use of this standard as a production standard is not recommended. Values in brackets { }}
H	Nominal line period	$1/f_H$ Nominally 63.555 μs	$1/f_H$ Nominally 64 μs
a	Line-blanking interval	10.5-11.0 μs	12 + 0 –0.3 μs
b	Interval between time datum (O_H) and back edge of line-blanking pulse	9.2 + 0.2 –0.1 μs	10.5 μs
c	Interval between time datum (O_H) and front porch	1.5 $\pm$ 0.1 μs	1.2 + 0.32 –0.0 μs {1.5 $\pm$ 0.3 μs }
d	Duration of synchronizing pulse	4.7 $\pm$ 0.1 μs	4.7 $\pm$ 0.2 μs
e	Rise time (10 to 90%) of the edges of the line-blanking pulse	140 $\pm$ 20 ns	300 $\pm$ 100 ns