RP 219-2002

SMPTE RECOMMENDED PRACTICE

High-Definition, Standard-Definition Compatible Color Bar Signal

1 Scope

This practice specifies a color bar pattern compatible with both high- and standard-definition environments. The multi-format color bar signal is originated as an HDTV signal with an aspect ratio of 16:9 and may be down converted to an SDTV color bar signal with an aspect ratio of either 4:3 or 16:9.

The color bar signal is generated with unconventionally slow rise and fall time value, and is therefore only intended to facilitate video level control and monitor color adjustments (see note) of HDTV and SDTV equipment. It can be applied to HDTV video productions, especially in a multi-format environment where HDTV video sources are frequently converted and used as SDTV video content either in 525 or 625 environment with same frame frequencies as in the original HDTV signal.

NOTE – This signal should not be used to set luminance level or black or white color balance on monitors. The small size and off-center locations of the black and white bars are not suitable for this purpose, especially on CRT-based displays

2 Color bar signal structure

The multi-format color bar signal shall be composed of four specific patterns, shown in figure 1.

Arrangement of patterns

The first part of the color bar signal represents a signal for the 4x3 aspect ratio; a second part of the total signal adds additional side panels for the 16x9 aspect ratio. A third part adds black and white ramps and additional color information, and the last part completes the total signal by adding white and black bars, in addition to a set of near-black-level steps for monitor black level adjustment.

Pattern 1 shall consist of a 75% color bar signal within a 4:3 aspect ratio area, with 40% gray signals (see note 1) positioned on either side of the 4:3 area. (sub-pattern *1 in figure 1).

Pattern 2 shall consist of the chroma setting signal (75% white) within the 4:3 area, with 100% cyan and 100% blue signals to the left and right sides respectively. Additionally, a signal in the sub-pattern area marked *2 in figure 1 shall be selectable from 75% white, 100% white, + I signal and -I signal options, according to the user's operational preference (see note 4)

The + I signal shall have the following component values:
R = 41.2545 [IRE], G= 16.6946 [IRE] and B= 0 [IRE] (see note 6)

The –I signal shall have the following component values:
R = 0 [IRE], G= 24.5600 [IRE] and B= 41.2545 [IRE]

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Pattern 3 shall consist of a ramp signal, with 100% yellow and 100% red signals to the left and right sides respectively. The ramp signal is designed for checking specific bit failures that may occur in digital processing. The ramp shall be a linear slope of luminance from 0% to 100% white.

Additionally a signal in the sub-pattern area marked *3 in figure 1 shall be selectable from 0% black and +Q signal options, according to the user's operational preference (see note 5).

The + Q signal shall have the following component values:
R = 25.3605 [IRE], G= 0 [IRE] and B= 47.0286 [IRE]

Pattern 4 shall consist of a 100% white signal, a 0% black signal and a set of near-black signals for HDTV and SDTV monitor black level adjustment [see note 3]. The 15% gray signal panels are then added at each end of pattern 4 (see note 2).

NOTES

1 The sub-pattern area marked *1 within pattern 1 in figure 1 (single bar on right and left of pattern 1) shall be set to 40% gray as a default value. This value can be optionally adjustable to any other value in accordance with the operational requirements of the user.

2 The sub-pattern area marked *4 within pattern 4 in figure 1 (single bar on right and left of pattern 4) shall be set to 15% gray as a default value. This value can be optionally adjustable to any other value in accordance with the operational requirements of the user

3 These signals are known collectively as PLUGE (PLUGE: Picture Line Up Generating Equipment). For specific instruction see SMPTE EG 1, section 4.2

4 When the -I signal is selected in sub-pattern *2, it is required that a +Q signal be simultaneously selected in sub-pattern *3.

5 When the +Q signal is selected in sub-pattern *3, it is required that a –I signal be simultaneously selected in sub-pattern *2.

6 For explanation of IRE see SMPTE 170M, annex B

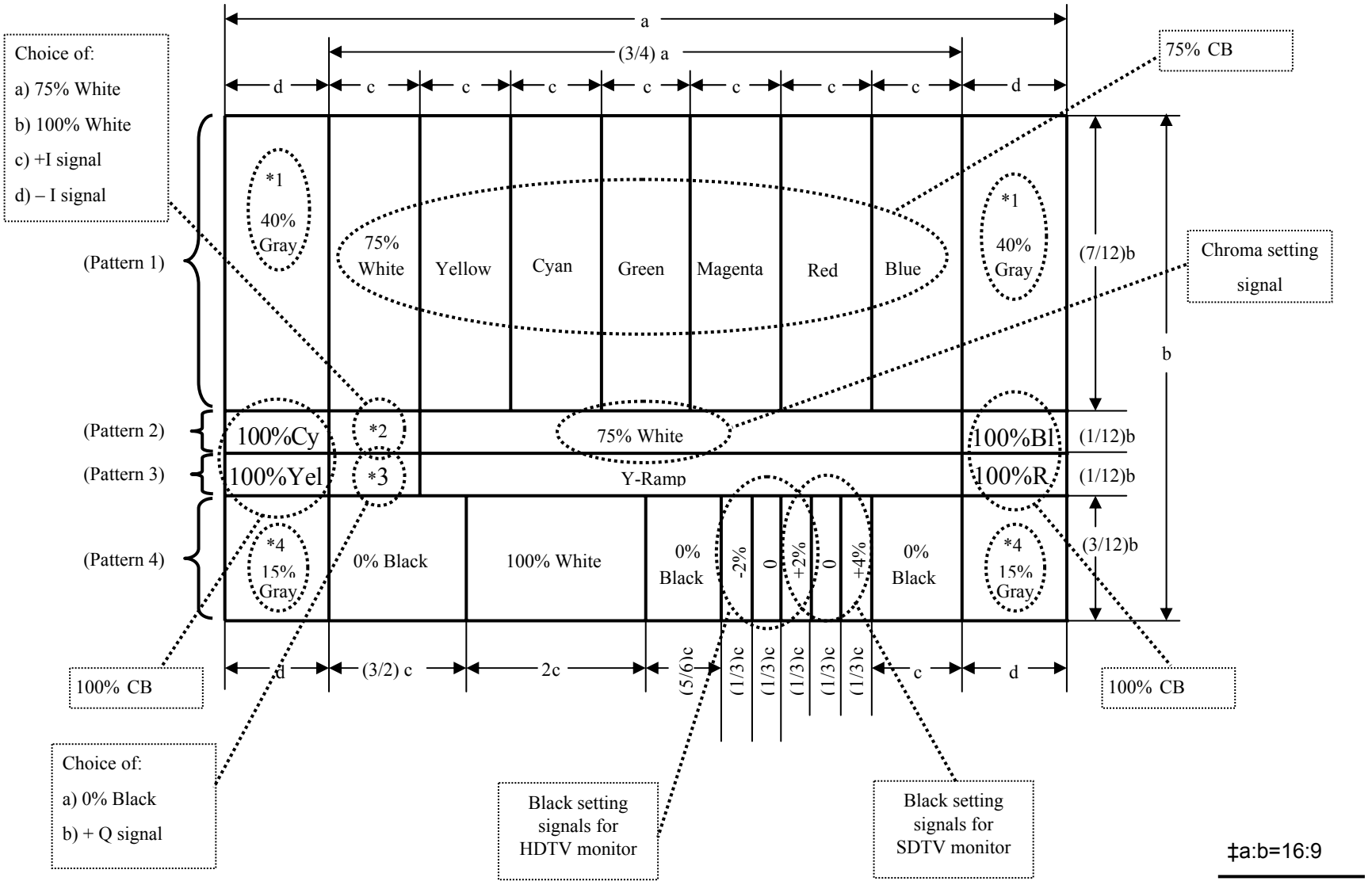

Figure 1 – A structure of the multi-format color bar signal

2.1 Rise and fall times of bar transitions

It is required that implementers of this standard follow practices of proper shaping (rise and fall times for bar transitions) for individual bars.

Nominal values for rise and fall time of the HDTV color bars shall be identical for luminance and P_R / P_B signals, and set to 55 nsec. These rise and fall time definitions are based on a transition from 10% to 90%. The tolerance on the rise/fall times is set to ± 10% of the nominal value. The actual shape of the transition should be similar to integrated sine-squared pulse shape.

The rise and fall times of the down converted SDTV color bar signal may follow the recommendation of either ITU R BT.801-1 or SMPTE 170M.

2.2 Waveforms

NOTE – Values shown in figures 2 through 9 are associated with a 10-bit digital system; values shown in parentheses are associated with an 8-bit digital system.

2.2.1 Pattern 1

Waveforms defining pattern 1 are shown in figure 2.

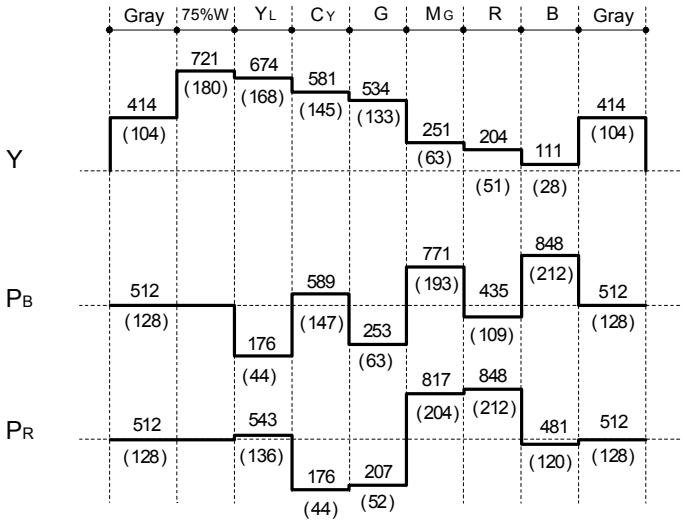

Figure 2 – Pattern 1 waveforms

2.2.2 Pattern 2

Waveforms defining pattern 2 are shown in figures 3 through 6.

(a) Sub-pattern *2 set to 75% white signal

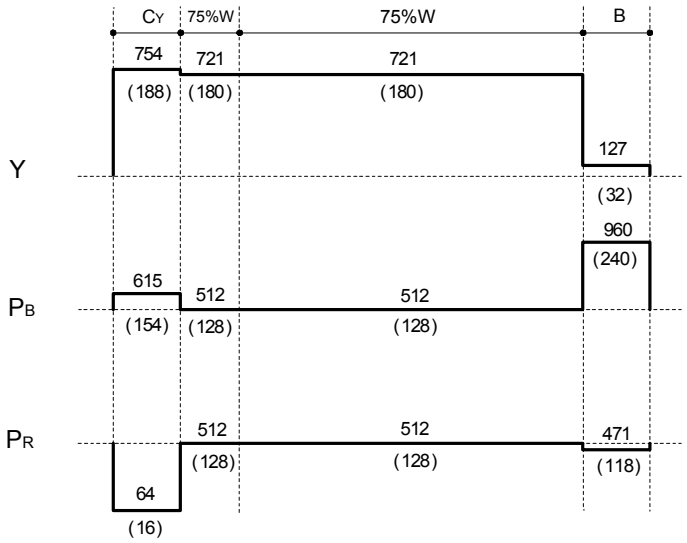

Figure 3 – Pattern 2 waveforms with 75% white signal (in *2 sub-pattern)

(b) Sub-pattern *2 set to 100% white signal:

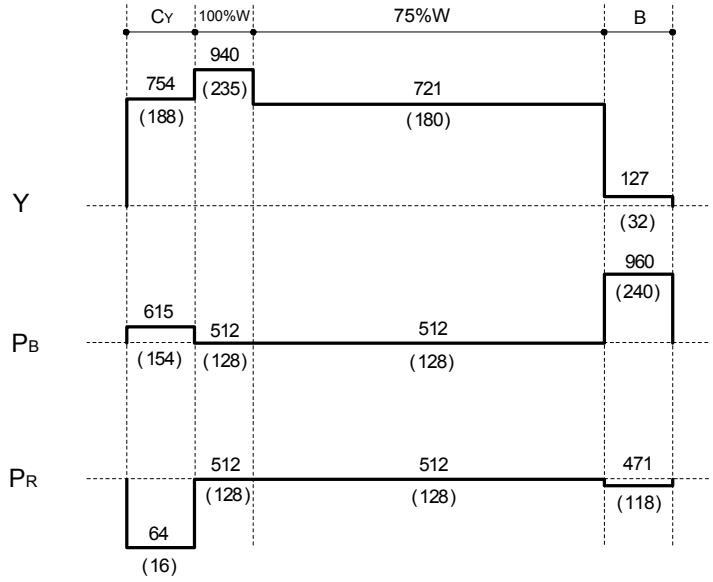

Figure 4 – Pattern 2 waveforms with 100% white signal (in *2 sub-pattern)

(c) Sub-pattern *2 set to +I signal:

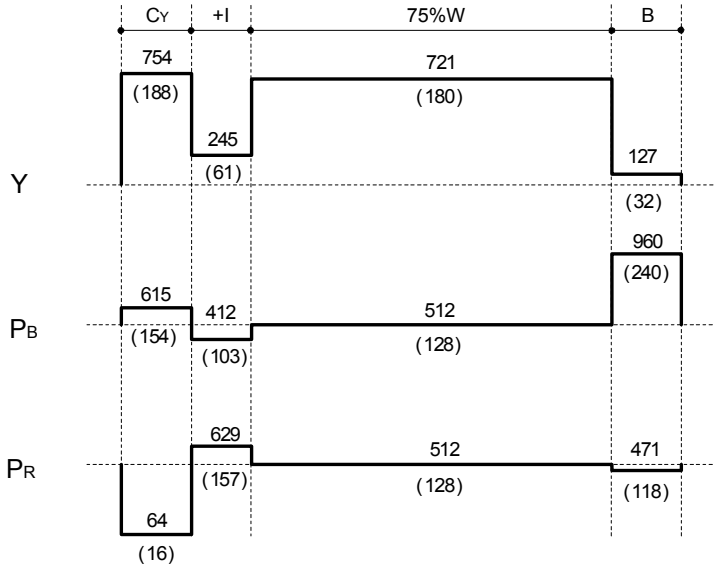

Figure 5 – Pattern 2 waveforms with +I signal (in *2 sub-pattern)

(d) Sub-pattern *2 set to - I signal:

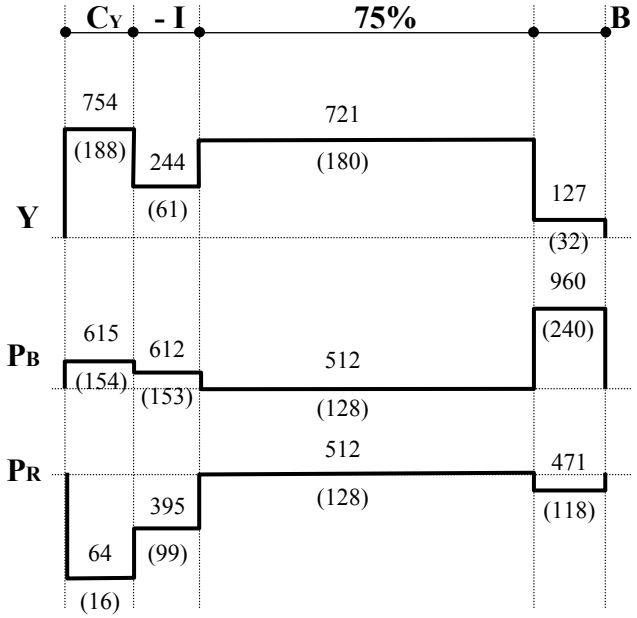

Figure 6 – Pattern 2 waveforms with - I signal (in *2 sub-pattern)

2.2.3 Pattern 3

Waveforms defining pattern 3 are shown in figures 7 and 8.

a) Sub-pattern *3 set to black signal:

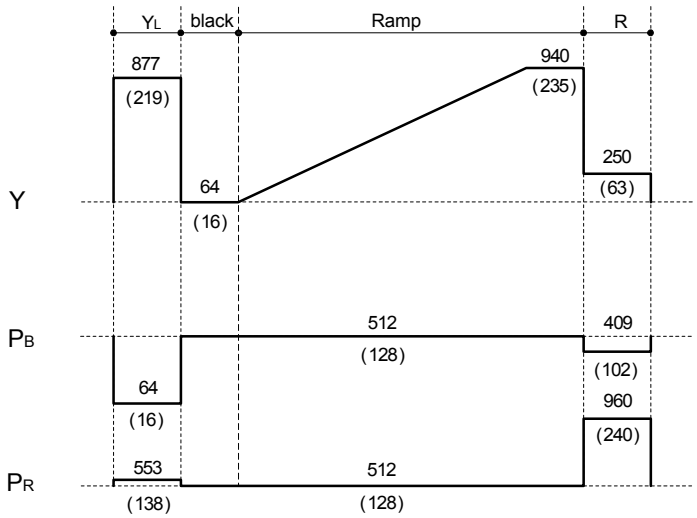

Figure 7 – Pattern 3 waveforms with black signal (in *3 sub-pattern)

b) Sub-pattern *3 set to +Q signal:

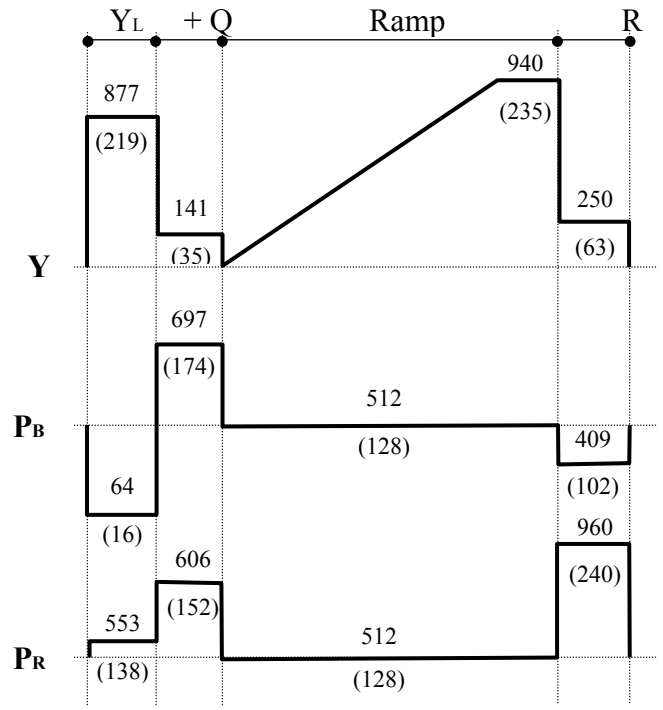

Figure 8 – Pattern 3 waveforms with +Q signal (in *3 sub-pattern)

2.2.4 Pattern 4

Waveforms defining pattern 4 are shown in figure 9.

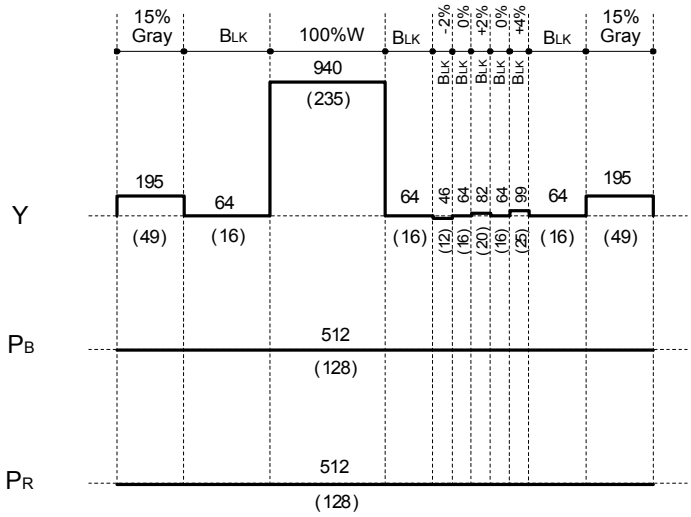

Figure 9 – Waveforms for pattern 4

3 Use of the color bar signal

The multi-format color bar signal embodies a single signal constructed from the combination of a 100% color bar signal used in HDTV and a 75% color bar signal used in SDTV. Based on the difference in aspect ratio between HDTV and SDTV, a 4:3 aspect ratio center section is utilized as a common area for both SDTV and HDTV signals, while the outside of this area is utilized for HDTV only. This color bar signal format therefore serves both HDTV and SDTV systems,. Additionally, it provides facilities for easy control of video source level and other operations such as monitor adjustments.

NOTE - Values associated with % are related to a full value of the signal based on 100% of a full digital signal, defined in a relevant signal format document.

3.1.1 Adjustment of a composite picture monitor

Turning on the blue channel only in the monitor, chroma gain and chroma phase are adjusted to give the same brightness level in each main blue bar and the 75% white signal below, in a manner similar to the use of SMPTE color bars as defined in EG 1.

3.1.2 Adjustment of a component picture monitor

Turning on the blue channel only in the monitor, P_B gain is adjusted to give the same brightness level in the blue bars and the 75% white signal area located below the blue bars.

Turning on the red channel only in the monitor, P_R gain is adjusted to give the same brightness level in the red bars and the 75% white signal area located below the red bars.

3.2 Ramp signal

A “Y ramp signal” located in the middle of the screen as part of pattern 3 allows easy monitoring of specific bit failures in a luminance signal.

3.3 PLUGE signals for picture monitor black level setup

The PLUGE signals (note 3) in pattern 4 (-2, 0, +2, 0 and +4%) are a combination of signal sequences for HDTV and for SDTV monitor use. The sequence (-2, 0, +2%) is intended for HDTV use and the sequence (+2, 0, +4%) is intended for SDTV use.

3.3.1 Adjustment of black level in an HDTV picture monitor

To set the black level in an HDTV picture monitor, the brightness control is adjusted until the +2% step is visible with respect to the black surround but the -2% step is not visible (note 7).

3.3.2 Adjustment of black level in an SDTV monitor

To set the black level in an SDTV picture monitor, the monitor brightness control is adjusted until the +2% and +4% steps are visible with respect to the black surround but the -2% step is not visible (note 8).

3.4 100% white signal (pattern 4)

This signal provides the standard level of 100% brightness and is also used for the white balance adjustment of a picture monitor.

3.5 User-selectable bar (75% white, or 100% white, or + or- I signal (sub-pattern *2)

The selection is based on individual operating practices and environments as follows:

3.5.1 75% white

This signal is used when neither a +(-) I signal nor 100% white is required.

3.5.2 100% white

This signal is used to facilitate level setting: the amplitude of the chroma in the 75% color bar signal is adjusted to be equal to the level of the 100% white signal in the waveform of an NTSC composite signal (displayed at V rate).

3.5.3 + I or - I signal

This signal is located on the I axis of an NTSC vector-scope; its amplitude is equal to the burst level in the composite signal. Since skin tone colors are located in the neighborhood of the +I axis, the +I signal may be used as a reference skin color signal with HDTV systems, providing a color reference similar to that available in NTSC or PAL systems.

NOTES

7 The signal sequence of [-2%, 0 and +2%] was adopted in accordance with ARIB TR-B10.

8 The signal sequence of [+2%, 0 and +4%] is in harmony with SMPTE EG 1. Although SMPTE EG 1 recommends ±4% for the black level setting signal, this sequence was adopted considering the current environment where negative signal excursions are often clipped in the process of down conversion from HDTV to SDTV.

Annex A (informative)
Setup and colorimetry

A.1 Setup for composite signals

The composite encoded color bar signal of a 525-line television system used in American broadcasting shall contain a “set up” signal. However, this set up signal is not present in 525-line composite encoded signal television systems used in Japan or in a 625-line television system used in Europe.

SMPTE 170M defines parameters of all elements present in a composite encoded signal, including the set up signal. Set up is an offset signal of 7.5 IRE units amplitude, which is added to the black level of the luminance channel in the composite encoded signal during the final stages of the encoding process.

The purpose of the set up signal is to ensure proper representation of image information close to black level in a television monitor, by avoiding non-linearity near the cut off point of a CRT-based television display.

A.2 Colorimetry of the direct and down-converted color bar signals

Reference should be made to published signal standards for HDTV and SDTV for definitions of the colorimetry relevant to the respective signal formats.

Equipment designers should be aware that an appropriate colorimetry conversion process between the HDTV and the down-converted SDTV color bar signals is recommended (refer to SMPTE EG 6).

Annex B (informative)
Digital coding values for 8-, 10- or 12-bit implementation of color bar signal

The following are the tabulated recommended digital coding values for 8-, 10-, or 12-bit implementations of the color bar signal. (The calculated tabulated values are based on formulas of the SMPTE 274M.)

Pattern 1

		75%W	YL	CY	G	MG	R	B	40%GY
Y	8-bit	180	168	145	133	63	51	28	104
	10-bit	721	674	581	534	251	204	111	414
	12-bit	2884	2694	2325	2136	1004	815	446	1658
C_B	8-bit	128	44	147	63	193	109	212	128
	10-bit	512	176	589	253	771	435	848	512
	12-bit	2048	704	2356	1012	3084	1740	3392	2048
C_R	8-bit	128	136	44	52	204	212	120	128
	10-bit	512	543	176	207	817	848	481	512
	12-bit	2048	2171	704	827	3269	3392	1925	2048

Pattern 2

(a) 75% White signal selected:

		CY	75%W	B
Y	8-bit	188	180	32
	10-bit	754	721	127
	12-bit	3015	2884	509
C_B	8-bit	154	128	240
	10-bit	615	512	960
	12-bit	2459	2048	3840
C_R	8-bit	16	128	118
	10-bit	64	512	471
	12-bit	256	2048	1884

(b) 100% White signal selected:

		CY	100%W	75%W	B
Y	8-bit	188	235	180	32
	10-bit	754	940	721	127
	12-bit	3015	3760	2884	509
C_B	8-bit	154	128	128	240
	10-bit	615	512	512	960
	12-bit	2459	2048	2048	3840
C_R	8-bit	16	128	128	118
	10-bit	64	512	512	471
	12-bit	256	2048	2048	1884

(c) +I signal selected:

		CY	+I	75%W	B
Y	8-bit	188	61	180	32
	10-bit	754	245	721	127
	12-bit	3015	982	2884	509
C_B	8-bit	154	103	128	240
	10-bit	615	412	512	960
	12-bit	2459	1648	2048	3840
C_R	8-bit	16	157	128	118
	10-bit	64	629	512	471
	12-bit	256	2516	2048	1884

(d) -I signal selected:

		CY	-I	75%W	B
Y	8-bit	188	61	180	32
	10-bit	754	244	721	127
	12-bit	3015	976	2884	509
C_B	8-bit	154	153	128	240
	10-bit	615	612	512	960
	12-bit	2459	2448	2048	3840
C_R	8-bit	16	99	128	118
	10-bit	64	395	512	471
	12-bit	256	1580	2048	1884

Pattern 3

(a) Black signal selected:

		YL	Black	Ramp 100%	R
Y	8-bit	219	16	235	63
	10-bit	877	64	940	250
	12-bit	3507	256	3760	1001
C_B	8-bit	16	128	128	102
	10-bit	64	512	512	409
	12-bit	256	2048	2048	1637
C_R	8-bit	138	128	128	240
	10-bit	553	512	512	960
	12-bit	2212	2048	2048	3840

(b) +Q signal selected:

		YL	+Q	Ramp 100%	R
Y	8-bit	188	35	235	63
	10-bit	754	141	940	250
	12-bit	3015	564	3760	1001
C_B	8-bit	154	174	128	102
	10-bit	615	697	512	409
	12-bit	2459	2787	2048	1637
C_R	8-bit	16	152	128	240
	10-bit	64	606	512	960
	12-bit	256	2425	2048	3840

Pattern 4

		15%GY	0%Black	100%W	-2%	+2%	+4%
Y	8-bit	49	16	235	12	20	25
	10-bit	195	64	940	46	82	99
	12-bit	782	256	3760	186	326	396
C_B	8-bit	128	128	128	128	128	128
	10-bit	512	512	512	512	512	512
	12-bit	2048	2048	2048	2048	2048	2048
C_R	8-bit	128	128	128	128	128	128
	10-bit	512	512	512	512	512	512
	12-bit	2048	2048	2048	2048	2048	2048

Annex C (Informative)
Values for construction of color bar signal

The following are recommended values for construction of the color bar signal.

a) Bar widths:

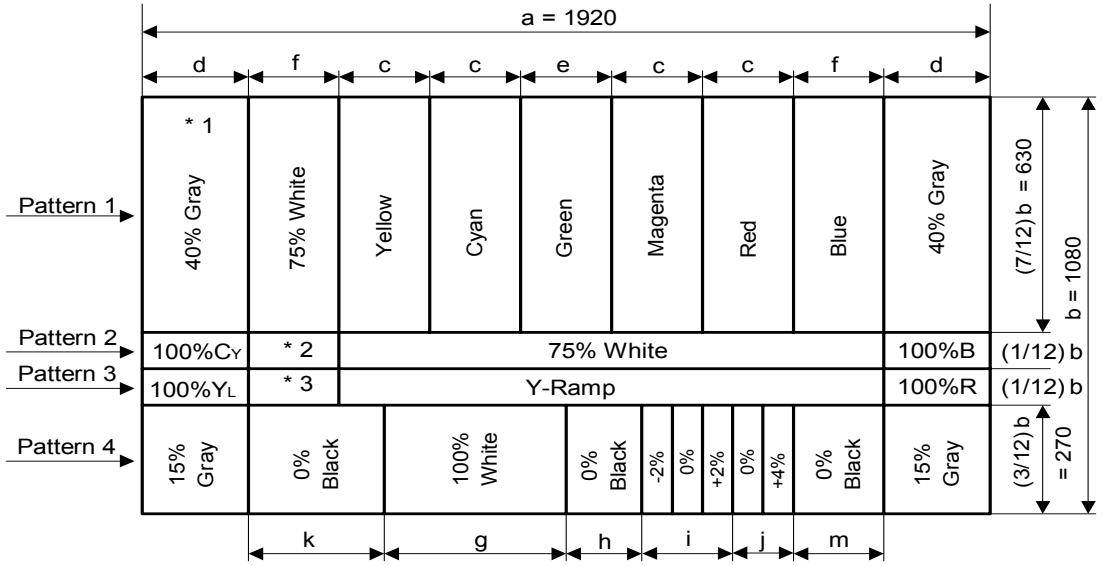

Figure C.1 – Reference diagram for tables C.1 and C.2

Table C.1 – Bar widths for pattern 1 (see note 9)

Basic Pattern 1 in figure C.1	d GY	f 75%W	c YL	c CY	e G	c MG	c R	f B	d GY
(a) Ideal width (1920)	240	205	206	206	206	206	206	205	240
(b) Recommended width (1920)	240	206	206	206	204	206	206	206	240
(c) Optional modified width (1920)	236	210	206	206	204	206	206	210	236

Table C.2 – Bar widths for pattern 4 (see note 9)

Pattern 4 in figure C.1	k 0%BLK	g 100%W	h 0%BLKh	i -2 / 0 /+2	j 0 / +4	m 0%BLK
(a) Ideal width (1440)	309	411	171	69/68/69	68/69	206
(b) Recommended width (1440)	308	412	170	68/70/68	70/68	206
(c) Optional modified width (1448)	312	412	170	68/70/68	70/68	210

Note 9 – Equipment designers to be aware that suggested bar widths serve only as a guide. Due to actual rise and fall time implementations, it may be required that the bar width in pixels of "f to f" in table C.1 and "k to m" in table C.2 may be higher than theoretical value of 1440 pixels for 4x3 aspect ratio.

b) Pattern heights

The heights of the patterns in the color bar signal are specified as integer multiples of a common factor equal to the total number of vertical samples divided by 12. In the 1080 line HDTV system this factor is therefore 90; in the 720-line system it is 60. Heights of patterns 1 through 4 will therefore be: 630, 90, 90, and 270 samples respectively (1080-line system) or 420, 60, 60, and 180 samples respectively (720-line system).

Annex D (informative)
Bibliography

ANSI/IEEE STD-511 1979, IEEE Standard on Video Signal Transmission Measurement of Linear Waveform Distortion.

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ARIB TR-B10, HDTV Multi-Pattern (Version 2.0 Oct.1999)

ITU-R BT.801-1, Test Signals for Digitally Encoded Color Television Signals Conforming with ITU-R BT.601 (Part A) and ITU-R BT.656