

SMPTE RECOMMENDED PRACTICE

Ultra High-Definition, 2048 x 1080 and 4096 x 2160 Compatible Color Bar Signal



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Foreword

SMPTE (the Society of Motion Picture and Television Engineers) is an internationally-recognized standards developing organization. Headquartered and incorporated in the United States of America, SMPTE has members in over 80 countries on six continents. SMPTE's Engineering Documents, including Standards, Recommended Practices, and Engineering Guidelines, are prepared by SMPTE's Technology Committees. Participation in these Committees is open to all with a bona fide interest in their work. SMPTE cooperates closely with other standards-developing organizations, including ISO, IEC and ITU.

SMPTE Engineering Documents are drafted in accordance with the rules given in its Standards Operations Manual.

SMPTE RP 219-2 was prepared by Technology Committee 10E.

Intellectual Property

At the time of publication no notice had been received by SMPTE claiming patent rights essential to the implementation of this Engineering Document. However, attention is drawn to the possibility that some of the elements of this document may be the subject of patent rights. SMPTE shall not be held responsible for identifying any or all such patent rights.

Introduction

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

This recommended practice describes color bar signals for 2048 x 1080 formats, 3840 x 2160 formats, 4096 x 2160 formats and 7680 x 4320 formats having standard dynamic range.

The color bar signals are based on the high-definition, standard-definition compatible color bar signal defined in SMPTE RP 219-1. The structure of the high definition, standard definition compatible color bar signal is maintained, including the central 4:3 aspect ratio part, so that a familiar signal will be generated if these signals are down converted or divided by 2-sample interleave division to HDTV signals, or further down converted and aspect ratio converted to SDTV signals. The +/- I and +Q options from SMPTE RP 219-1 are not included as it is considered unlikely that these signals will be converted to NTSC. The 2048 x 1080 format color bars differ from the 1920 x 1080 format color bars defined in SMPTE RP 219-1 in that they have wider left hand side and right hand side bars. The 3840 x 2160 and the 7680 x 4320 color bars differ from the 1920 x 1080 format color bars defined in SMPTE RP 219-1 in their spatial scaling.

1 Scope

This recommended practice specifies color bar patterns compatible with 2048 x 1080 formats, 3840 x 2160 formats, 4096 x 2160 formats and 7680 x 4320 formats having standard dynamic range.

The 2048 x 1080 and 4096 x 2160 color bar signals have default R'G'B' colorimetry as defined in SMPTE ST 2048-1 "R'G'B' Colorimetry".

The 3840 x 2160 color bar signal can have conventional colorimetry or UHDTV colorimetry as defined in SMPTE ST 2036-1 "System Colorimetry".

The 7680 x 4320 color bar signal has UHDTV colorimetry.

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 engineering document. At the time of publication, the editions indicated were valid. All standards are subject to revision, and parties to agreements based on this engineering document are encouraged to investigate the possibility of applying the most recent edition of the standards indicated below.

SMPTE ST 352:2013, Payload Identification Codes for Serial Digital Interfaces

SMPTE ST 2036-1:2014, Ultra High Definition Television — Image Parameter Values for Program Production

SMPTE ST 2048-1:2011, 2048 × 1080 and 4096 × 2160 Digital Cinematography Production Image Formats FS/709

4 Color Bar Signal Structure

Each color bar signal shall be composed of four specific patterns, as shown in Figure 1.

Figure 1 shows the four patterns and their locations within the image format.

The dimensions a, b, c and d in Figure 1 are ideal dimensions, and can be calculated from the image format. For example, a 3840 × 2160 image format would have dimension a = 3840, dimension b = 2160, dimension c = $(2160 \times 4/3 \times 1/7) = 411 \frac{3}{7}$, and dimension d = $((3840 - (2160 \times 4/3))) / 2 = 480$.

In order to use integer dimensions, the widths of parts of the test pattern are modified from the ideal widths. Annex C defines values for a, b, c and d in Figure 1 for each image format, and introduces widths e, f, h, i, j, k and m for the modified widths.

4.1 Arrangement of Patterns

Pattern 1 shall consist of a 75% color bar signal within a 4:3 aspect ratio area, with 40% gray signals positioned on either side of the 4:3 area. The sub-pattern areas marked *1 within pattern 1 in Figure 1 (single bars on far left and far right of pattern 1) shall extend the 4:3 aspect ratio area to 16:9 for the 3840 × 2160 signal, and to 256:135 for the 2048 × 1080 and 4096 × 2160 signals. They shall be set to 40% gray as a default value. They may be set to any other value.

Pattern 2 shall consist of the color difference/chroma setting reference signal (75% white) within the 4:3 area, with 100% cyan and 100% blue signals to the far left and far right sides respectively. Additionally, a signal in the sub-pattern area marked *2 in Figure 1 shall be 75% white or 100% white.

Note: The signal in the sub-pattern area marked *2 in Figure 1 can also be +I or –I in the high-definition, standard-definition compatible color bar signal defined in SMPTE RP 219-1:2014. This is not an option for the color bar signals in this RP.

Pattern 3 shall consist of a ramp signal with 0% black and 100% white signals to the immediate left and right respectively within the 4:3 area, and 100% yellow and 100% red signals to the far left and far right sides respectively. The ramp signal is designed for checking specific bit failures that can occur in digital processing. The ramp shall be a linear slope of luminance code values from 0% to 100% white.

Note: The fact that the ramp is linear does not mean that it changes by a value of 1 for every pixel.

Additionally a signal in the sub-pattern area marked *3 in Figure 1 shall be 0% black.

Note: The signal in the sub-pattern area marked *3 in Figure 1 can also be +Q in the high-definition, standard-definition compatible color bar signal defined in SMPTE RP 219-1:2014. This is not an option for the color bar signals in this RP.

Pattern 4 shall consist of a 0% black signal divided vertically into three equal parts, a 100% white signal divided vertically into three equal parts, and a set of near-black signals for picture monitor black level adjustment, within the 4:3 area. The sub-pattern area marked *4 within pattern 4 in Figure 1 (single bars on far left and far right of pattern 4) shall be set to 15% gray as a default value. This value may be set to any other value.

Note: The set of near-black signals are known collectively as PLUGE (PLUGE: Picture Line Up Generating Equipment). For specific instructions see Section 5.3 and SMPTE EG 1, Section 4.2.

Additionally a signal in the sub-pattern area marked *5 in Figure 1 shall be a 0% black or a sub-black valley signal. The sub-black valley signal shall begin at the 0% black level, shall decrease in a linear ramp to the minimum permitted level at the mid-point, and shall increase in a linear ramp to the 0% black level at the end of the black bar. When the sub-black valley signal is selected in sub-pattern *5, the super-white peak signal shall be simultaneously selected in sub-pattern *6.

Additionally a signal in the sub-pattern area marked *6 in Figure 1 shall be a 100% white or a super-white peak signal. The super-white peak signal shall begin at the 100% white level, shall increase in a linear ramp to the maximum permitted level at the midpoint, and shall decrease in a linear ramp to the 100% white level at the end of the white bar. When the super-white peak signal is selected in sub-pattern *6, the sub-black valley signal shall be simultaneously selected in sub-pattern *5.

a:b = 16:9 for 3840 x 2160 and 7680 x 4320 formats

a:b = 256:135 for 2048 x 1080 and 4096 x 2160 formats

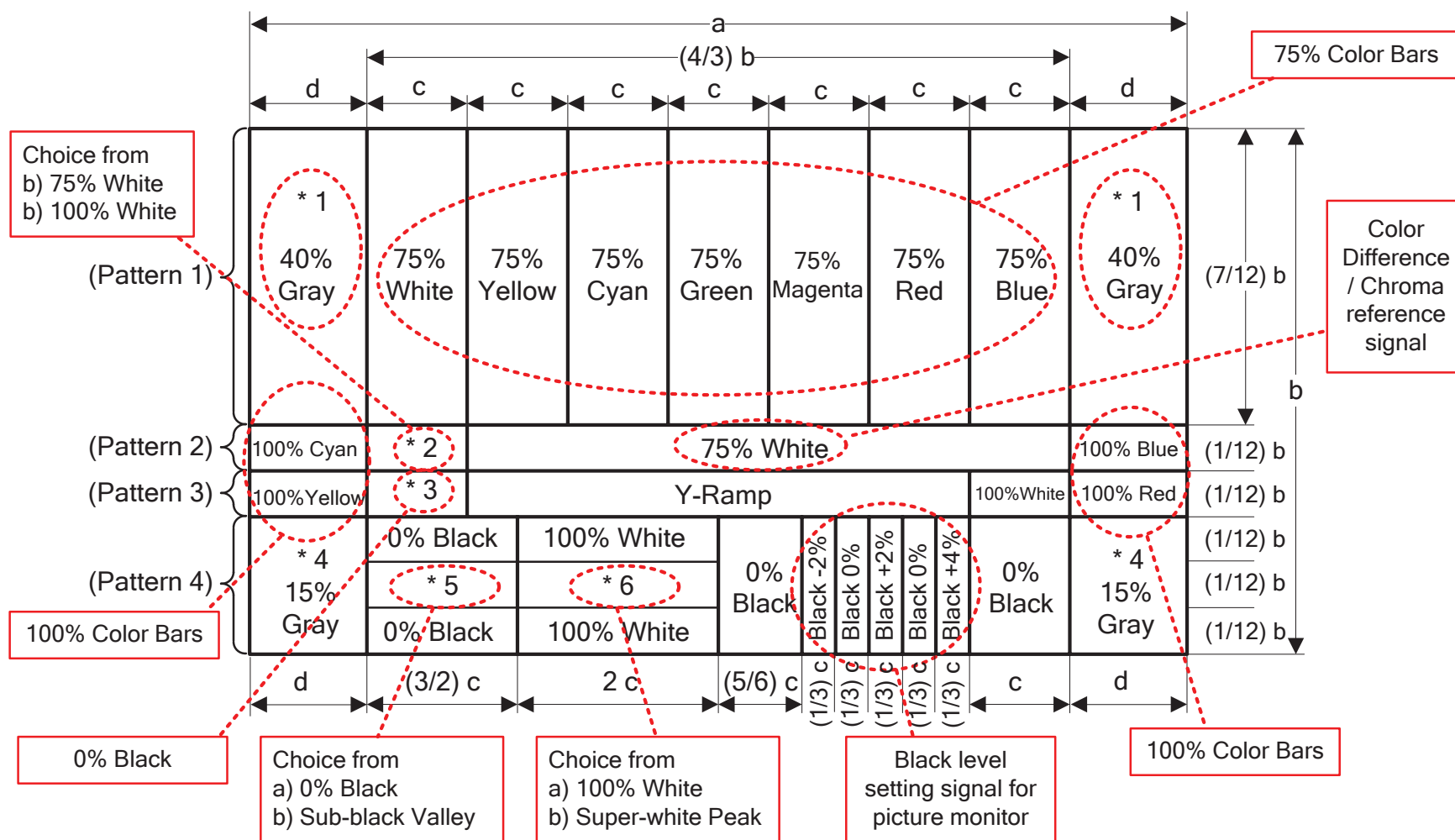


Figure 1 – Structure of the color bar signals

Note: This diagram shows the ideal widths and heights of each part of the test signal. In practice the widths of parts of the test pattern are modified from the ideal widths to fit the image format structure. Annex C defines actual values for a, b, c and d in Figure 1 for each image format, and introduces widths e, f, h, i, j, k and m for the modified widths.

4.2 Colorimetry

There are two colorimetries used in this Recommended Practice, one based on UHDTV reference primaries and one based on conventional reference primaries.

These two colorimetries are defined in SMPTE ST 2036-1.

Either colorimetry may be used for UHDTV1. UHDTV colorimetry is mandated for UHDTV2 signals

Conventional colorimetry shall be used for 2048 x 1080 and 4096 x 2160 signals.

Note: The R'G'B' values are the same independent of the colorimetry, but the $Y'C'_B C'_R$ values used to represent the R'G'B' values are different, as the R'G'B' to $Y'C'_B C'_R$ matrix equations are different for the two colorimetries.

The colorimetry shall be indicated in the SMPTE ST 352 payload identifier (PID) accompanying the color bar signal.

Note: If UHDTV color bars using UHDTV colorimetry are to be down-converted to HDTV, an appropriate colorimetry conversion process between the UHDTV and the down-converted HDTV color bar signals is suggested. See SMPTE RP 219-1 for details about further down conversion to SDTV.

4.3 Rise and Fall Times of Bar Transitions

Implementers of this Recommended Practice shall follow practices of proper shaping (rise and fall times for bar transitions) for individual bars.

Nominal values for rise and fall time of the color bars shall be identical for luminance and C'_B / C'_R signals, and set to 4 luminance sample periods, which does not exercise the full bandwidth capability of the system. These rise and fall time definitions are based on a transition from 10% to 90%. The tolerance on the rise/fall times shall be $\pm 10\%$ of the nominal values. The actual shape of the transition should be similar to integrated sine-squared pulse shape.

4.4 Waveforms

Note: Values shown in Figure 2 through Figure 5 are associated with a 10-bit digital system with conventional colorimetry. Values shown in Figure 6 and Figure 7 are associated with a 10-bit digital system with either colorimetry. See Annex B for a complete listing of coding values for 10-bit and 12-bit digital systems with both conventional and UHDTV colorimetries.

4.4.1 Pattern 1

Waveforms defining pattern 1 are shown in Figure 2.