ENGLISH TRANSLATION

UHDTV MULTIFORMAT COLOR BAR

ARIB STANDARD

ARIB STD-B66 Version 1.2

Version 1.2 July 6, 2016

Association of Radio Industries and Businesses

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Foreword

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This ARIB Standard was developed for Ultra-High Definition Television (UHDTV) color bar signal for video format as specified in the ARIB standard STD-B56. In order to ensure fairness and transparency in the defining stage, the standard was set by consensus at the ARIB Standard Assembly. This was accomplished with the participation of both domestic and foreign interested parties including radio equipment manufacturers, telecommunication operators, broadcasting equipment manufacturers, broadcasters, and users.

ARIB sincerely hopes that this ARIB Standard will be widely used by radio equipment manufacturers, telecommunication operators, broadcasting equipment manufacturers, broadcasters and users.

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ARIB STD-B66
Version 1.2-E1

Attachment 1 (Selection of Option 1)
(N/A)

Attachment 2 (Selection of Option 2)

PATENT HOLDER	NAME OF PATENT	REGISTRATION NO./ APPLICATION NO.	REMARKS
Nippon Hoso Kyokai (NHK)	Submitted comprehensive confirmation of patents for ARIB STD-B66 Ver1.0 Note1		

Note 1 : Valid for ARIB STD-B66 Ver1.0 (received on July 26, 2015)

Contents

Chapter 1: General Descriptions

1.1 Objective

This standard establishes a color bar signal for the UHDTV video format specified in ARIB standard STD-B56 to facilitate video level control and monitor adjustment.

1.2 Scope

This standard applies to the color bar signal for UHDTV programme production, especially in multi-format environment.

1.3 References

1.3.1 Normative References

(1) ARIB STANDARD　BTA S-001 Version C1.0, “1125/60 HDTV Production Systems”

(2) ARIB STD-B56 Version 1.1 (2014), “UHDTV System Parameters for Programme Production”

(3) Recommendation ITU-R BT.814-2 (2007), “Specifications and alignment procedures for setting of brightness and contrast of displays”

1.3.2 Informative References

(1) Recommendation ITU-R BT.709-6 (2015), “Parameter values for the HDTV standards for production and international programme exchange”

(2) Recommendation ITU-R BT.2020-2 (2015), ”Parameter values for ultra-high definition television systems for production and international programme exchange”

(3) ARIB STD-B58 Version 1.1 (2015), “Interface for UHDTV Production Systems”

(4) ARIB STD-B28 Version 1.0 (2000), “Multi-format Color Bar”

(5) Recommendation ITU-R BT.2087-0 (2015), “Colour conversion from Recommendation ITU-R BT.709 to Recommendation ITU-R BT.2020”

1.4 Terminology

Table 1-1 defines the terms in this standard.

Table 1-1 Definitions

8K system	A system that uses the 7680 × 4320 pixel video format as specified by ARIB STD-B56.
4K system	A system that uses the 3840 × 2160 pixel video format as specified by ARIB STD-B56.
4:2:2 system	A video system in which sampling is carried out with the sample points of the chromatic aberration signals C'_B and C'_R in a 2:1 ratio with the Y′ sample points only in the horizontal direction.
4:2:0 system	A video system in which sampling is carried out with the sample points of the chromatic aberration signals C'_B and C'_R in a 2:1 ratio with the Y′ sample points in the horizontal and vertical directions.

1.5 Conformance Notation

Values shown in this standard document are associated with a 12-bit digital system; however, values shown in parentheses are associated with a 10-bit digital system.

Chapter 2: Color Bar Signal Structure

2.1 Arrangement of Patterns

The UHDTV multi-format color bar signal shall be composed of the four signal patterns shown in Fig. 2-1. The sampling structure is defined as R´G´B´4:4:4.

Pattern 1 shall comprise a 75% color bar signal between two 40% gray signals.

Pattern 2 shall comprise the HDTV chroma set color bar signal, which is specified by ITU-R Recommendation BT.709, converted to a UHDTV chroma set color bar signal as specified by ITU-R Recommendation BT.2020, and is situated between a 100% cyan signal and a 100% blue signal.

Pattern 3 shall comprise a 100% yellow signal, a ramp signal to check for signal bit loss, and a 100% red signal. The center of the ramp signal (50% level) shall be positioned at the horizontal center.

Pattern 4 shall comprise an 8K pattern signal, a 100% white signal, a 0% black signal, a monitor black-level setting signal (PLUGE signal: Picture Line-up Generating Equipment) and a 4K pattern signal. The -2% and +2% values of the PLUGE signal shall be 12-bit values obtained by multiplying the 10-bit values specified in ITU-R Recommendation BT.814-2 by 4.

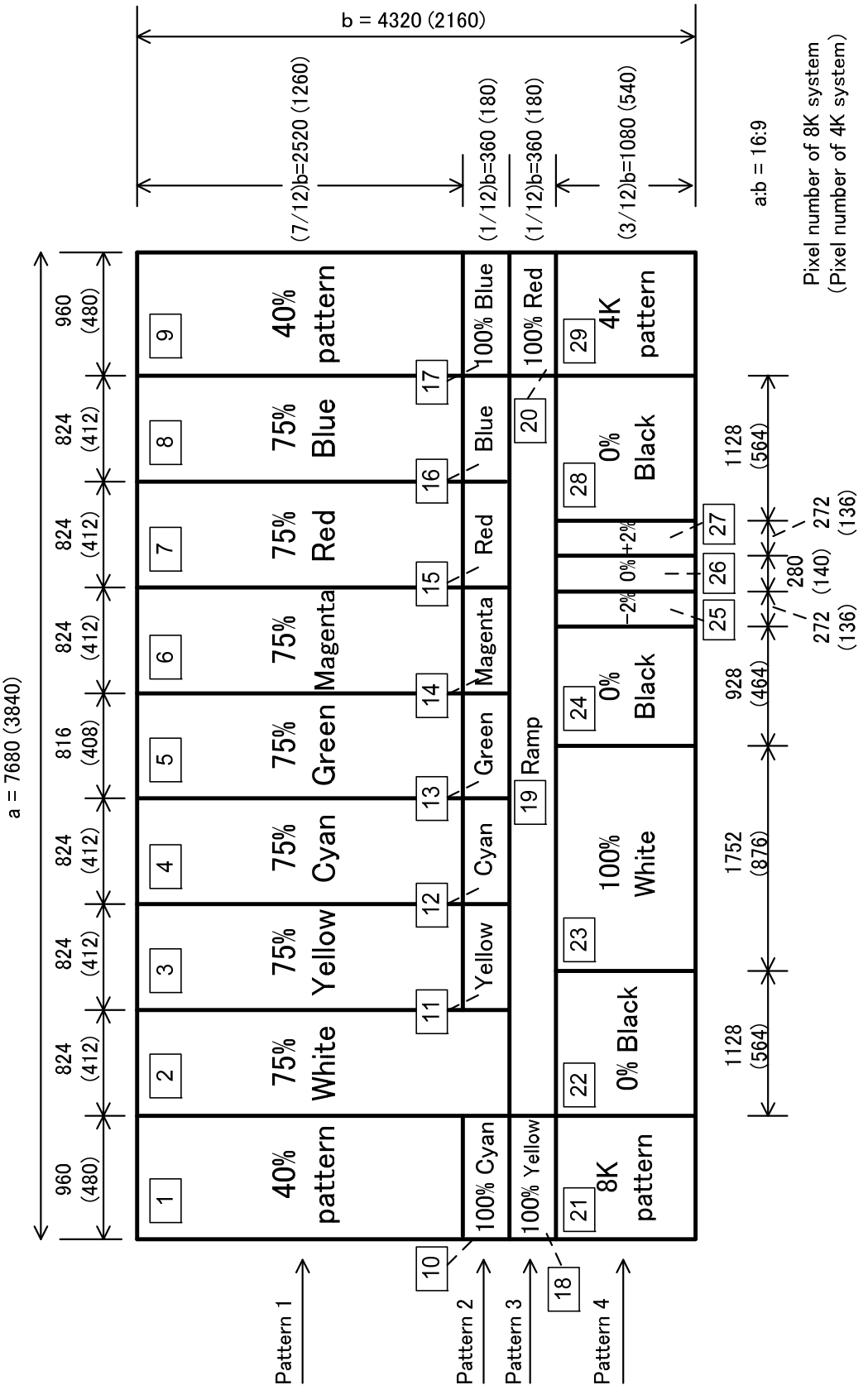

Fig. 2-1 A structure of the UHDTV Multi-format Color Bar Signal

2.2 Digital Code Value

Table 2-1 presents the digital coding values that shall be used for 10-bit or 12-bit implementations of the color bar signal.

Table 2-1 Digital Coding Values

	Signal Name	R´	G´	B´
1	40% pattern		Specified in section 2.6	
2	75% White	2884 (721)	2884 (721)	2884 (721)
3	75% Yellow	2884 (721)	2884 (721)	256 (64)
4	75% Cyan	256 (64)	2884 (721)	2884 (721)
5	75% Green	256 (64)	2884 (721)	256 (64)
6	75% Magenta	2884 (721)	256 (64)	2884 (721)
7	75% Red	2884 (721)	256 (64)	256 (64)
8	75% Blue	256 (64)	256 (64)	2884 (721)
9	40% pattern		Specified in Section 2.6	
10	100% Cyan	256 (64)	3760 (940)	3760 (940)
11	$Yellow_{709}$	2828 (707)	2868 (717)	1104 (276)
12	$Cyan_{709}$	1860 (465)	2792 (698)	2864 (716)
13	$Green_{709}$	1764 (441)	2776 (694)	1036 (259)
14	$Magenta_{709}$	2408 (602)	1000 (250)	2764 (691)
15	Red_{709}	2336 (584)	948 (237)	592 (148)
16	$Blue_{709}$	804 (201)	536 (134)	2744 (686)
17	100% Blue	256 (64)	256 (64)	3760 (940)
18	100% Yellow	3760 (940)	3760 (940)	256 (64)
19	Ramp		Specified in Section 2.3	
20	100% Red	3760 (940)	256 (64)	256 (64)
21	8K pattern		Specified in Section 2.4	
22	0% Black	256 (64)	256 (64)	256 (64)
23	100% White	3760 (940)	3760 (940)	3760 (940)
24	0% Black	256 (64)	256 (64)	256 (64)
25	- 2%	192 (48)	192 (48)	192 (48)
26	0% Black	256 (64)	256 (64)	256 (64)
27	+ 2%	320 (80)	320 (80)	320 (80)
28	0% Black	256 (64)	256 (64)	256 (64)
29	4K pattern		Specified in Section 2.5	

2.3 Ramp Signal

The R´, G´, and B´ pixel values of the ramp signal are presented on Fig. 2-2.

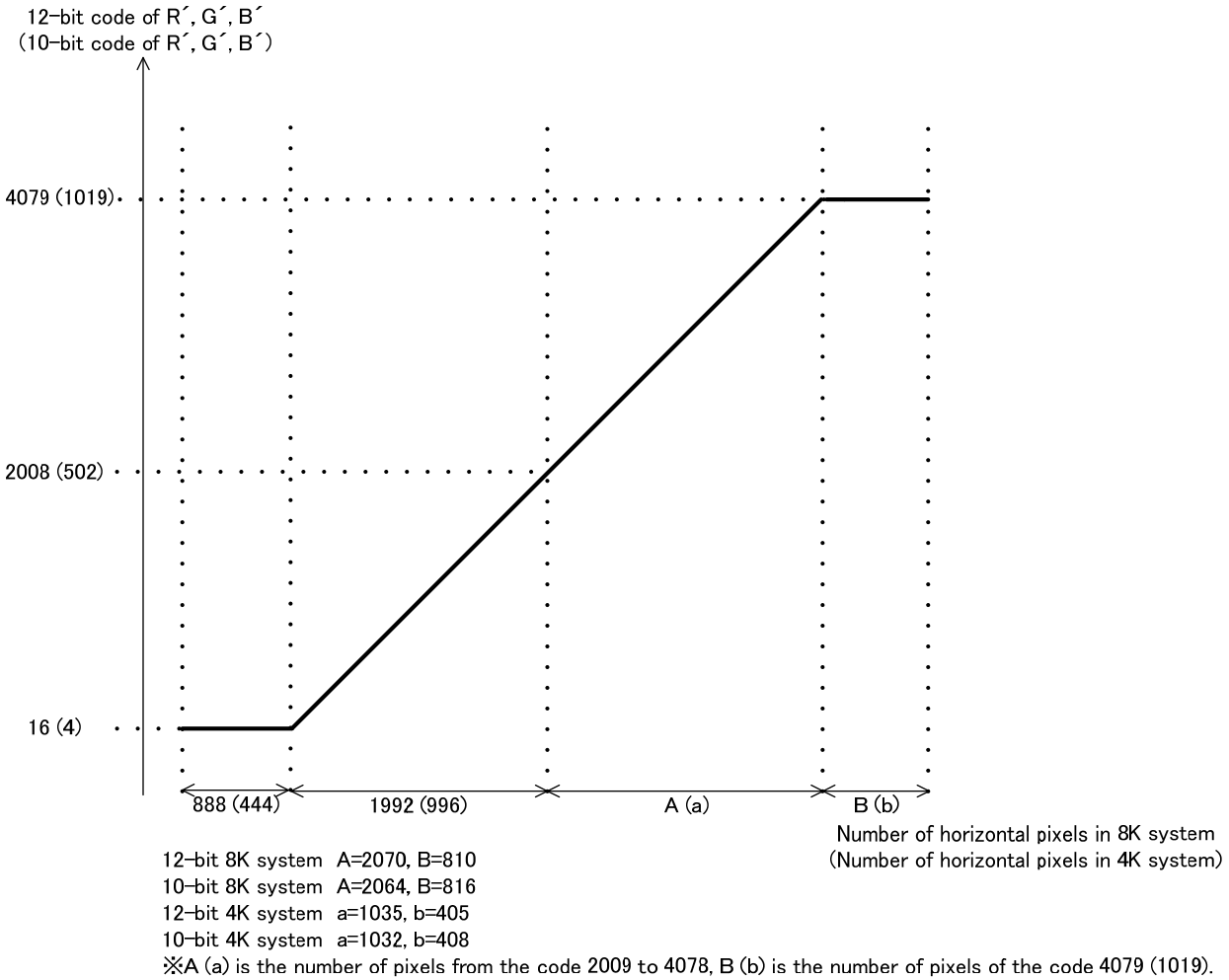

Fig. 2-2 Ramp Signal Waveform

2.4 8K Pattern

An 8K pattern signal is shown on Fig. 2-3. The signal levels to be used for the 8K pattern signal are listed in Table 2-2. This pattern shall comprise a vertical magenta stripe, horizontal magenta stripe, light and dark magenta areas, and a cyclone pattern. This signal is characteristic for the 8K system and it is not defined for the 4K system. The vertical magenta stripe alternates between 100% magenta and 100% white, pixel-by-pixel, in the horizontal direction. The horizontal magenta stripe alternates between 100% magenta and 100% white, pixel-by-pixel, in the vertical direction.

For the 8K system, the cyclone pattern shall comprise a total of 5760 contiguous blocks (96 horizontal and 60 vertical), with each block defined as 10 horizontal pixels and 9 vertical pixels (Fig. 2-4). The pixel values of the cyclone pattern shall be 100% white and 0% black.

Table 2-2 Digital Coding Values for the 8K Pattern

Signal Name	R´	G´	B´
0% Black	256 (64)	256 (64)	256 (64)
100% White	3760 (940)	3760 (940)	3760 (940)
100% Magenta	3760 (940)	256 (64)	3760 (940)
Light magenta	3760 (940)	2008 (502)	3760 (940)
Dark magenta	3168 (792)	2008 (502)	3168 (792)

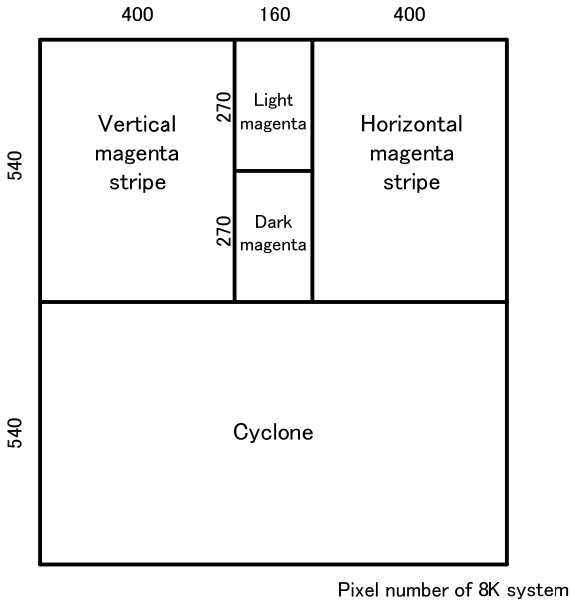

Fig. 2-3 8K Pattern Diagram

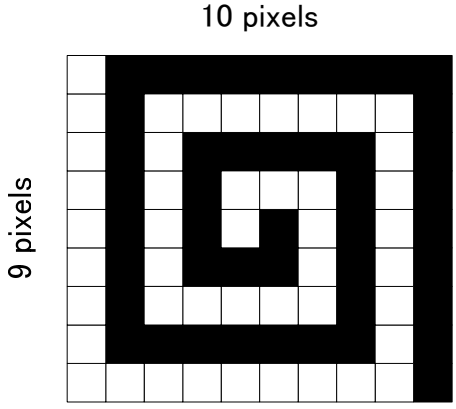

Fig. 2-4 Cyclone Pattern Diagram

2.5 4K Pattern

A 4K pattern signal is shown on Fig. 2-5. The signal levels used for the 4K pattern signal are listed in Table 2-2. This pattern shall comprise a vertical magenta stripe with a two-pixel structure, a horizontal magenta stripe with a two-pixel structure, a light magenta and dark magenta pattern, and a cyclone pattern. The two-pixel vertical magenta stripe structure alternates between 100% magenta and 100% white for every two pixels in the horizontal direction. The horizontal magenta stripe alternates between 100% magenta and 100% white for every two pixels in the vertical direction.

The two-pixel structure cyclone pattern for the 8K system shall comprise 1440 contiguous blocks (48 horizontal and 30 vertical), with each block defined as 20 horizontal pixels and 18 vertical pixels (Fig. 2-6). The pixel values of the cyclone pattern shall be 100% white and 0% black.

For the 4K system, the two-pixel structure cyclone pattern shall comprise 1440 contiguous blocks (48 horizontal and 30 vertical), with each block defined as 10 horizontal pixels and 9 vertical pixels, obtained by interleaving the pattern shown on Fig. 2-6 for each pixel, yielding the same shape as shown on Fig. 2-4.

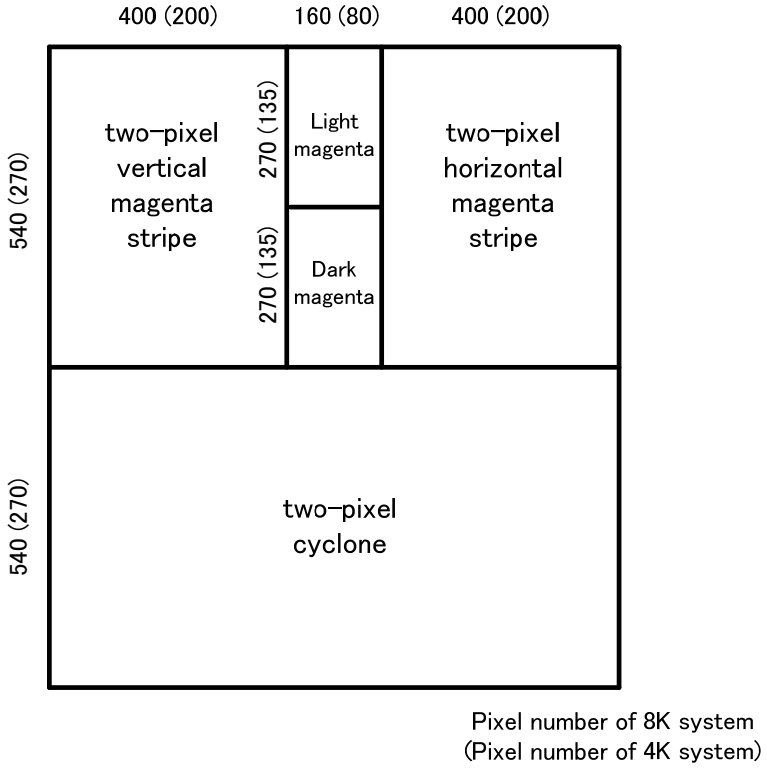

Fig. 2-5 4K Pattern Diagram

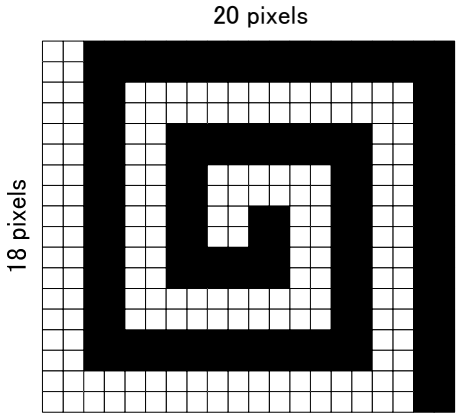

Fig. 2-6 Two-Pixel Cyclone Pattern Diagram

2.6 Middle Tone Pattern

The middle tone pattern signal shall comprise 40% gray and yellow, cyan, green, magenta, red, and blue at 40% luminance (Fig. 2-7). The signal levels are listed in Table 2-3.

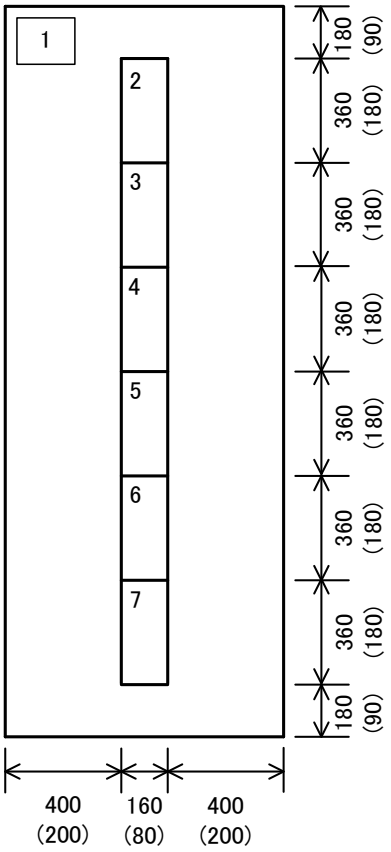

Fig. 2-7 Middle Tone Pattern Diagram

Table 2-3 Digital Coding Values for Middle Tone Pattern

	Signal Name	R´	G´	B´	Y´	C´B	C´R
1	Y40% Gray	1656 (414)	1656 (414)	1656 (414)	1656 (414)	2048 (512)	2048 (512)
2	Y40% Yellow	1656 (414)	1704 (426)	1132 (283)	1656 (414)	1760 (440)	2048 (512)
3	Y40% Cyan	1244 (311)	1816 (454)	1656 (414)	1656 (414)	2048 (512)	1760 (440)
4	Y40% Green	1244 (311)	1864 (466)	1132 (283)	1656 (414)	1760 (440)	1760 (440)
5	Y40% Magenta	2072 (518)	1452 (363)	2184 (546)	1656 (414)	2332 (584)	2332 (584)
6	Y40% Red	2072 (518)	1496 (374)	1656 (414)	1656 (414)	2048 (512)	2332 (584)
7	Y40% Blue	1656 (414)	1612 (403)	2184 (546)	1656 (414)	2332 (584)	2048 (512)

Note: The "Y40%" indicates that the luminance level for the signal is 40%.
The Y´, C´B, C´R values are the reference values.

Chapter 3: Simplified Format

3.1 Arrangement of Patterns

A simplified form is specified in which the 8K pattern, 4K pattern, and middle tone pattern signals in the color bar, specified in Chapter 2, are set to 40% gray. The simplified format is shown in Fig. 3-1.

The R′, G′, and B′ signal levels of the parts on the figure that are labeled as 1, 9, 21, and 29 are 1656 (414). The signal levels for the other parts are listed in Table 2-1.

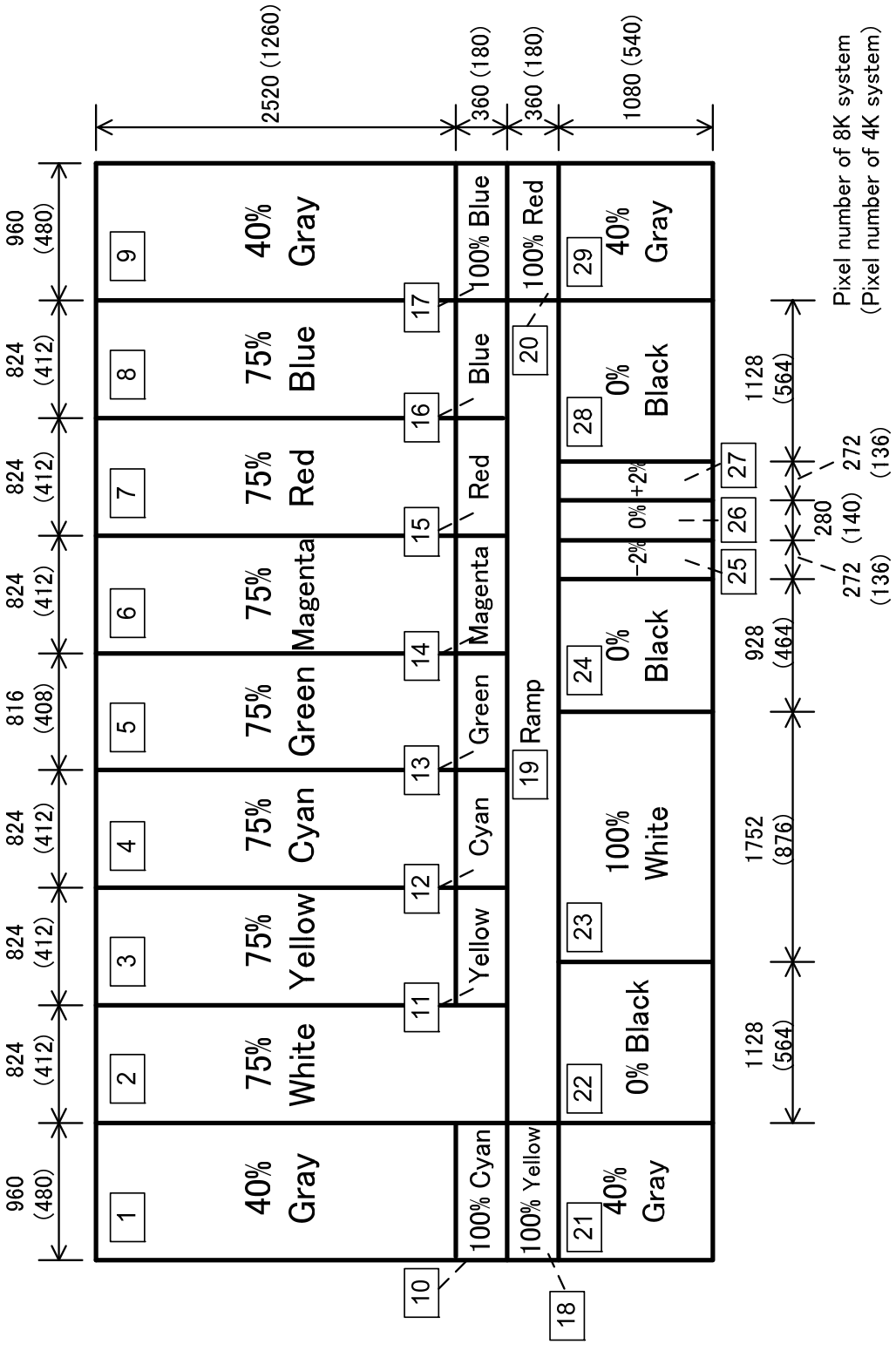

Fig. 3-1 Structure of the Simplified UHDTV Multi-format Color Bar Signal

Description 1

1 Summary

The UHDTV multi-format color bar signal is configured to follow the basic structure and functions of the multi-format color bar signal used for HDTV. In addition, level adjustment function signals are also provided.

1.1 Parameter

The digital values listed in Table 2-1 and within this document are 12-bit values with 10-bit values as a base. Thus, inconsistencies can occur with the strict 75% analog signal levels, for example, in the areas from 2 to 6.

The stripe width and split width are shown in Fig. 2-1 of Chapter 2. Taking into consideration that the video interface is one of 4:4:4, 4:2:2 and 4:2:0, the number of pixels should be even, such that the chromatic aberration signal is an integer value. In addition, the value is multiplied by 8, so the number of pixels is even after down-conversion to HDTV.

1.2 Color Bar Signal for HDTV Colorimetry

In the UHDTV studio standards, the colorimetry parameters of ITU-R Recommendation BT.2020 (referred as Rec. 2020 in the following) are applied. In the 1125/60 HDTV studio standards, the colorimetry parameters of ITU-R Recommendation BT.709 (referred as Rec. 709 in the following) continued to be used. Accordingly, studio equipment applies both the Rec. 2020 colorimetry parameters and the Rec. 709 colorimetry parameters. Thus, the Rec. 709 color band patterns from 11 to 16 were introduced into the color bar. The calculation method was standardized in Recommendation ITU-R BT.2087 Case 2.

For more information regarding the calculation of the values, see the Attachment 1.

1.3 Ramp Signal

A ramp signal was introduced to facilitate observation of the luminance signal bit dropping and insufficiency of the monitor gradation, which have the greatest visual effects.

The slope of the ramp signal is one level per pixel for a 12-bit 8K system, one level per four pixels for a 10-bit 8K system, two levels per pixel for a 12-bit 4K system, and one level per two pixels for a 10-bit 4K system.

1.4 Signals for Picture Monitor Black Level Setup

The signal for setting the black level (-2, 0, and +2%) serves as a compound monitor adjustment signal. If a difference is seen between 2% and 0%, the monitor luminance is adjusted so that no difference can be seen between -2% and 0%.

1.5 8K Pattern Signal

Because the 8K pattern signal uses a one-pixel structure, it is not correctly reproduced by the devices that do not satisfy the 8K resolution. Therefore, the signal type for 4K systems is not defined for this area.

In addition to the 4:4:4 sampling structure, 4:2:2 and 4:2:0 were also specified for the UHDTV studio standard. A pattern that has vertical and horizontal magenta stripe structures is introduced to determine the sampling structure of the system.

The horizontal stripe structure does not change even if there is a return to a 4:4:4 system via 4:2:2 system. However, if the transition is through a 4:2:0 system, the white parts blend with the magenta parts, reducing the pattern contrast. The vertical stripe structure undergoes the pattern change (contrast reduction) for both the 4:2:2 system and 4:2:0 pattern intermediaries. For a 12-bit system, the pixel values are taken to be R′ = 3760, G′ = 2008, and B′ = 3760 for light magenta and R′ = 3168, G′ = 2008, and B′ = 3168 for dark magenta; however, the average values for the respective stripe structures and the average values for the contrast reduction are given as examples.

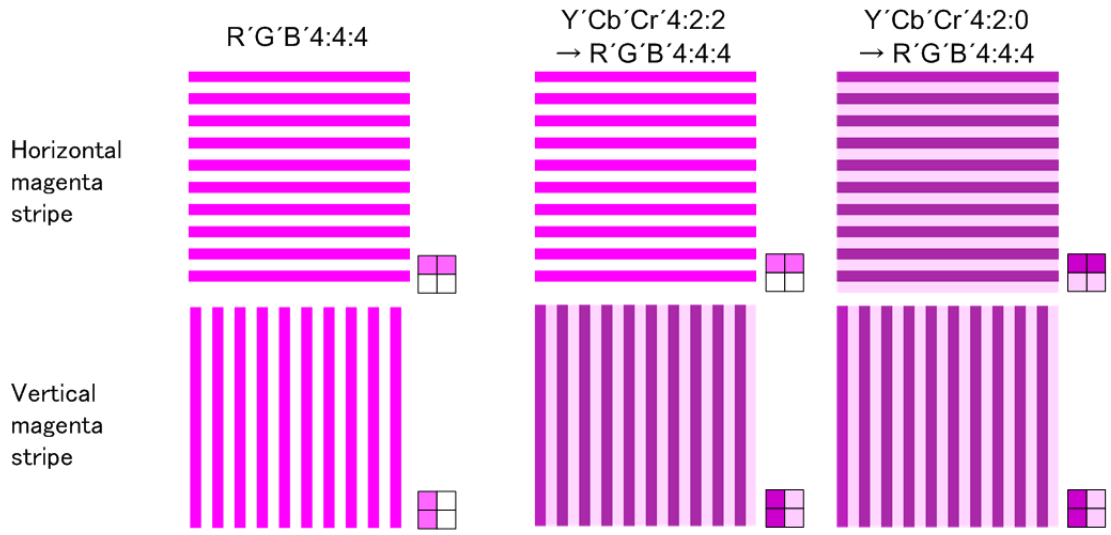

Fig. D1-1 Contrast Reduction due to Differences in Magenta Stripe Structure and Sampling Structure

For easy visual verification whether the system can keep having 8K resolution, the cyclone structure pattern is introduced. The cyclone pattern can also be used to check incorrect channel switching visually for the pixel interleave method, and two-sample pixel interleave method, used by the ultra-high-definition video transmission interface.

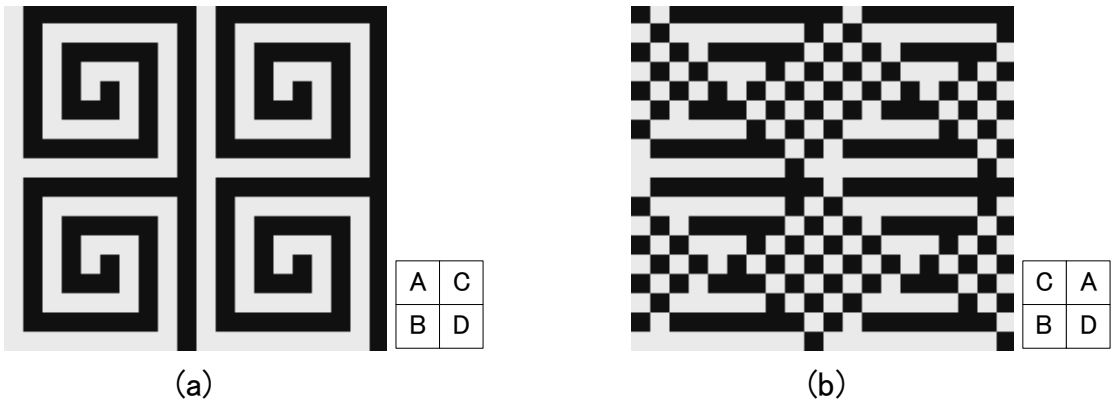

Fig. D1-2 Case of Pixel Interleave Transmission (a)Correct Pixel Arrangement and (b) Incorrect Pixel Arrangement (Replacing Channel A and Channel C)

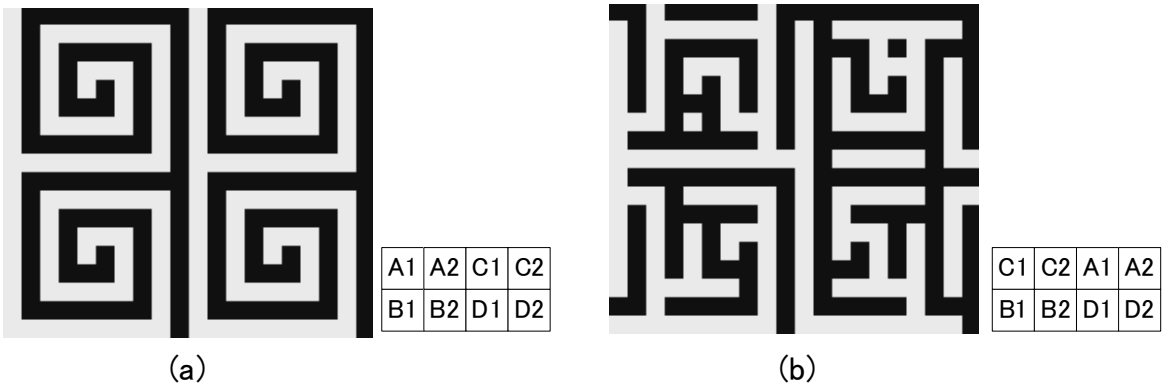

Fig. D1-3 Case of Two-sample Pixel Interleave Transmission (a) Correct Pixel Arrangement and (b) Incorrect Pixel Arrangement (Replacing Channel A and Channel C)

1.6 4K Pattern Signal

This signal has one-pixel structure for 8K systems and a two-pixel structure for 4K systems. The patterns of this area are not reproduced correctly when the system has a resolution below 4K.

1.7 Middle Tone Pattern

This pattern facilitates color conversion checking processes. For a luminance level of 40%, the signal level corresponds to the chromatic aberration value of ±20%. Because the luminance and chromatic aberration values for near the middle of the transmission level range are selected, effects resulting from clipping or other such processing are unlikely to occur.

It is also possible to check for a step response such as a low-pass filter, for chromatic aberration used with the $Y'C'_BC'_R$ 4:2:0 format, because there is a small amplitude transition of C'_B and C'_R in the vertical direction.

This pattern has vertically arranged color bars that have a uniform luminance value of 40%. Therefore, if the measurement of the luminance values for all colors of the color bar can be shown to be the same, with a waveform monitor or other such device, the setting can be judged as appropriate.

As an example, the luminance values become different if there is an error in the conversion matrix coefficients when repeating the process of the color conversion of chromatic aberration → RGB → chromatic aberration. In addition, it is necessary to compare with the expected values in the documentation to check for the correctness of the processing when other patterns are used. However, this checking can be done easily through a visual assessment for this pattern.

1.8 Simplified Format

A simplified format is specified for the development of hardware designs and various applications that require lower cost.

Attachment 1

Fig. G1-1 shows a block diagram of the colorimetry conversion from Recommendation ITU-R BT.709 (Rec. 709) to Recommendation ITU-R BT.2020 (Rec. 2020). The method was standardized in Recommendation ITU-R BT.2087.

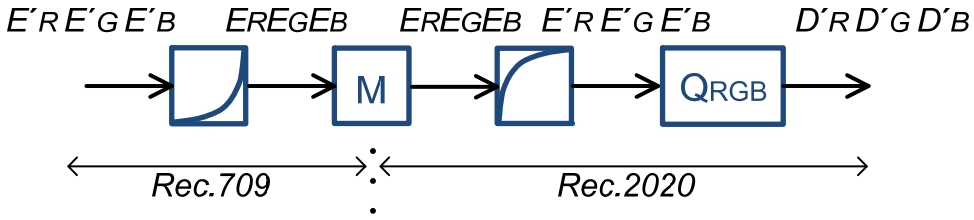

Fig. G1-1 Block Diagram of Colorimetry Conversion from Rec. 709 to Rec. 2020

The functions and equations of each block in Fig. G1-1 are as follows:


Linear conversion from $E'_R E'_G E'_B$ (Rec. 709) to $E_R E_G E_B$ (Rec. 709)

$$E = (E')^2 \quad , \quad 0 \le E' \le 1$$

Conversion from $E_R E_G E_B$ (Rec. 709) to $E_R E_G E_B$ (Rec. 2020)

$$\begin{bmatrix} E_R \\ E_G \\ E_B \end{bmatrix}_{2020} = \begin{bmatrix} 0.6370 & 0.1446 & 0.1689 \\ 0.2627 & 0.6780 & 0.0593 \\ 0 & 0.0281 & 1.0610 \end{bmatrix}^{-1} \begin{bmatrix} 0.4124 & 0.3576 & 0.1805 \\ 0.2126 & 0.7152 & 0.0722 \\ 0.0193 & 0.1192 & 0.9505 \end{bmatrix} \begin{bmatrix} E_R \\ E_G \\ E_B \end{bmatrix}_{709}$$

$$= \begin{bmatrix} 1.7167 & -0.3557 & -0.2534 \\ -0.6667 & 1.6165 & 0.0158 \\ 0.0176 & -0.0428 & 0.9421 \end{bmatrix} \begin{bmatrix} 0.4124 & 0.3576 & 0.1805 \\ 0.2126 & 0.7152 & 0.0722 \\ 0.0193 & 0.1192 & 0.9505 \end{bmatrix} \begin{bmatrix} E_R \\ E_G \\ E_B \end{bmatrix}_{709}$$

$$= \begin{bmatrix} 0.6274 & 0.3293 & 0.0433 \\ 0.0691 & 0.9195 & 0.0114 \\ 0.0164 & 0.0880 & 0.8956 \end{bmatrix} \begin{bmatrix} E_R \\ E_G \\ E_B \end{bmatrix}_{709}$$


Non-linear conversion from $E_R E_G E_B$ (Rec. 2020) to $E'_R E'_G E'_B$ (Rec. 2020)

$$E' = E^{1/2} \quad , \quad 0 \le E \le 1$$

Quantization of $E'_R E'_G E'_B$ (Rec. 2020) to $D'_R D'_G D'_B$ (Rec. 2020) in the bit depth of N_{2020} bits.

$$D'_R = \mathrm{INT}[(219 \times E'_R + 16) \times 2^{N_{2020}-8}]$$
$$D'_G = \mathrm{INT}[(219 \times E'_G + 16) \times 2^{N_{2020}-8}]$$
$$D'_B = \mathrm{INT}[(219 \times E'_B + 16) \times 2^{N_{2020}-8}]$$

In the above, INT[x] is a function that returns the integer which is nearest to x.

For example, E'_R=0.75, E'_G=E'_B=0 for the 75% red of Rec. 709, so the conversion of G1-1 results in D'_R= 2336, D'_G= 948, D'_B = 592 in the Rec. 2020 color space (12-bit system, adjusted to an integer when converted to 10 bit).

Attachment 2

Image files for the UHDTV multi-format color bar and the simplified format for 8K systems with a 12-bit depth are appended to the PDF file of this standard specification. An application program that can display 16-bit Tagged Image File Format (TIFF) images is needed to view the files.

Sample image file of UHDTV multi-format color bar

ARIB_UHDMFCB_12bit8K_1_r2.tif

Sample image file of simplified UHDTV multi-format color bar

ARIB_UHDMFCB_12bit8K_2_r2.tif

UHDTV MULTIFORMAT COLOR BAR

ARIB STANDARD

ARIB STD-B66 VERSION 1.2-E1
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