ENGLISH TRANSLATION

INTERFACE FOR UHDTV PRODUCTION SYSTEMS

ARIB STANDARD

ARIB STD-B58 Version 1.0

Version 1.0 March 18, 2014

Association of Radio Industries and Businesses

General Notes to the English Translation of ARIB Standards and Technical Reports

1. Notes on Copyright

2. Notes on English Translation

- ARIB Standards and Technical Reports are usually written in Japanese. This document is a translation into English of the original document for the purpose of convenience of users. If there are any discrepancies in the content, expressions, etc. between the original document and this translated document, the original document shall prevail.

- ARIB Standards and Technical Reports, in the original language, are made publicly available through web posting. The original document of this translation may have been further revised and therefore users are encouraged to check the latest version at an appropriate page under the following URL:
http://www.arib.or.jp/english/index.html.

Foreword

The Association of Radio Industries and Businesses (ARIB) investigates and summarizes the basic technical requirements for various radio systems in the form of "ARIB Standards". These standards are developed with the participation of and through discussions amongst radio equipment manufacturers, telecommunication operators, broadcasting equipment manufacturers, broadcasters and users.

ARIB Standards include "government technical regulations" (mandatory standard) that are set for the purpose of encouraging effective use of frequency and preventing interference with other spectrum users, and "private technical standards" (voluntary standards) that are defined in order to ensure compatibility and adequate quality of radio equipment and broadcasting equipment as well as to offer greater convenience to radio equipment manufacturers, telecommunication operators, broadcasting equipment manufacturers, broadcasters and users.

This ARIB Standard is developed for "INTERFACE FOR UHDTV PRODUCTION SYSTEMS". In order to ensure fairness and transparency in the defining stage, the standard was set by consensus at the ARIB Standard Assembly with the participation of both domestic and foreign interested parties from 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.

NOTE:

Although this ARIB Standard contains no specific reference to any essential Industrial Property Rights relating thereto, the holders of such Essential Industrial Property Rights state to the effect that the rights listed in the Attachment 1 and 2, which are the Industrial Property Rights relating to this standard, are held by the parties also listed therein, and that to the users of this standard, in the case of Attachment 1, such holders shall not assert any rights and shall unconditionally grant a license to practice such Industrial Property Rights contained therein, and in the case of Attachment 2, the holders shall grant, under reasonable terms and conditions, a non-exclusive and non-discriminatory license to practice the Industrial Property Rights contained therein. However, this does not apply to anyone who uses this ARIB Standard and also owns and lays claim to any other Essential Industrial Property Rights of which is covered in whole or part in the contents of the provisions of this ARIB Standard.

Attachment 2 (selection of option 2)

PATENT HOLDER	NAME OF PATENT	REGISTRATION NO./ APPLICATION NO.	REMARKS
Sony Corporation (*)	Comprehensive confirmation of ARIB STD-B58 version 1.0 is submitted.		

(*) Received on March 11, 2014

Contents

Chapter 1 : General Descriptions

1.1 Objective

This standard defines the optical interface for transmission of the data specified by ARIB STD-B56 Version 1.1, "UHDTV System Parameters for Programme Production".

1.2 Scope

This standard applies to the input or output interfaces of studio equipment for transmitting or receiving the data specified by ARIB STD-B56 Version 1.1, "UHDTV System Parameters for Programme Production".

1.3 References

1.3.1 Normative References

(1) ARIB STD-B56 Version 1.1, "UHDTV System Parameters for Programme Production"

(2) ANSI INCITS 230-1994 (R1999), "Information Technology - Fibre Channel - Physical and Signaling Interface (FC-PH) "

(3) IEEE 802.3ae-2002, Amendment, "Media Access Control (MAC) Parameters, Physical Layers, and Management Parameters for 10 Gb/s Operation"

(4) JIS C 5964-7:2010, "Fiber optic connector interfaces - Part 7: Type MPO connector family (F13) "

1.4 Bibliography

(1) BTA S-002C, "Digital Representation and Bit-parallel Interface for 1125/60 HDTV Production Systems"

(2) BTA S-004C, "Bit-serial Digital Interface for 1125/60 HDTV Systems"

(3) BTA S-005C, "Ancillary Data Packet and Space Formatting of Bit-serial Digital Interface for 1125/60 HDTV Systems"

(4) BTA S-006C, "Audio Data Format of Bit-serial Digital Interface for 1125/60 HDTV Systems"

1.5 Definition of Terms

Table 1-1 defines the terms in this standard.

Table 1-1 Definition of Terms

8K image	7680 × 4320 pixel image specified by ARIB STD-B56 Version 1.1, “UHDTV System Parameters for Programme Production”
4K image	3840 × 2160 pixel image specified by ARIB STD-B56 Version 1.1, “UHDTV System Parameters for Programme Production”
4K Sub-Image	3840 × 2160 pixel image of each colour component obtained by sub-sampling of an 8K image
Basic image	1920 × 1080 pixel image of each colour component obtained by sub-sampling of a 4K image or 4K Sub-Image
8K/120	8K image with frame frequency of 120 Hz or 120/1.001 Hz
8K/60	8K image with frame frequency of 60 Hz or 60/1.001 Hz
4K/120	4K image with frame frequency of 120 Hz or 120/1.001 Hz
4Ks/120	4K Sub-Image with frame frequency of 120 Hz or 120/1.001 Hz
4K/60	4K image with frame frequency of 60 Hz or 60/1.001 Hz
4Ks/60	4K Sub-Image with frame frequency of 60 Hz or 60/1.001 Hz
2K/120	Basic image with frame frequency of 120 Hz or 120/1.001 Hz
2K/60	Basic image with frame frequency of 60 Hz or 60/1.001 Hz
Basic stream	A 12-bit-word multiplexed data stream which consists of a four-word EAV (End of Active Video) timing reference code, a two-word line number (LN), a two-word CRCC (Cyclic Redundancy Check Code) error detection code, ancillary data or blanking data, a four-word SAV (Start of Active Video) timing reference code, and video data
120 Hz Basic stream	Basic stream generated from 2K/120
60 Hz Basic stream	Basic stream generated from 2K/60
Active line	1920 words of data that constitute one line of a basic image
Active frame	1080 lines that include all active lines
Frame blanking	The 45 lines between an active frame and the next active frame
000h	Hexadecimal 000. In general, hexadecimal digits (0 to 9 and A to F) with “h” represents a hexadecimal number.
Running disparity	A binary parameter indicating the cumulative disparity (positive or negative) of all previously issued transmission characters

Chapter 2 : Data

2.1 Video data

Video data is specified by ARIB STD-B56 Version 1.1, “UHDTV System Parameters for Programme Production”.

2.2 Ancillary data

Ancillary data is specified by other ARIB Standards and Technical Reports.

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Chapter 3 : Mapping to Basic Images

3.1 Overview of mapping from 8K or 4K images to 10G link signals

3.1.1 Mapping of 8K or 4K images with 120 Hz or 120/1.001 Hz frame frequency

The mapping of 8K images with 120 Hz or 120/1.001 Hz frame frequency to multiple 10G link signals is illustrated in Fig. 3-1 and the mapping of 4K images with 120 Hz or 120/1.001 Hz frame frequency is illustrated in Fig. 3-2. The colour components, C1, C2, and C3 of each figure are respectively represented as Y, C_B, and C_R or G, B, and R.

For 8K/120, the three colour components that constitute the image are respectively divided into four to produce N (N = 6, 8, or 12) 4K Sub-Images, each of which is then further divided to produce 4N basic images. Those 4N basic images are converted to 4N basic streams, each two of which are mapped to one 10G link signal to generate 2N 10G link signals.

For 4K/120, the three colour components that constitute the image are respectively divided into four to produce M (M = 6, 8, or 12) basic images. The M basic images are then converted to M basic streams, each two of which are mapped to one 10G link signal to generate four or six 10G link signals. The reason for there being no M/2 is that 10G link signals are generated for each colour component. Detailed specifications are in section 5.2.3.

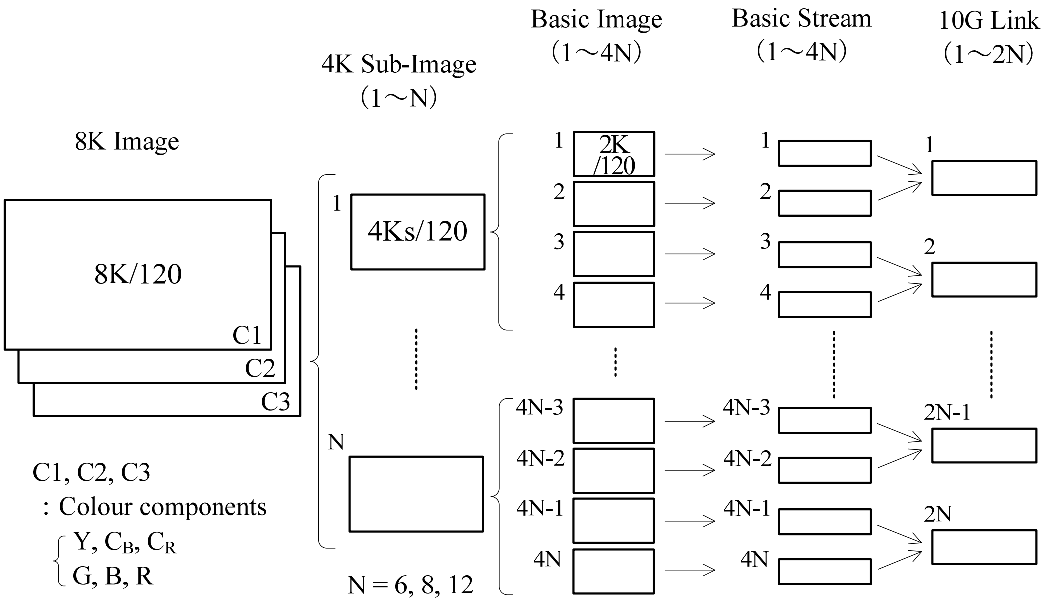

Figure 3-1 Mapping overview of 8K/120

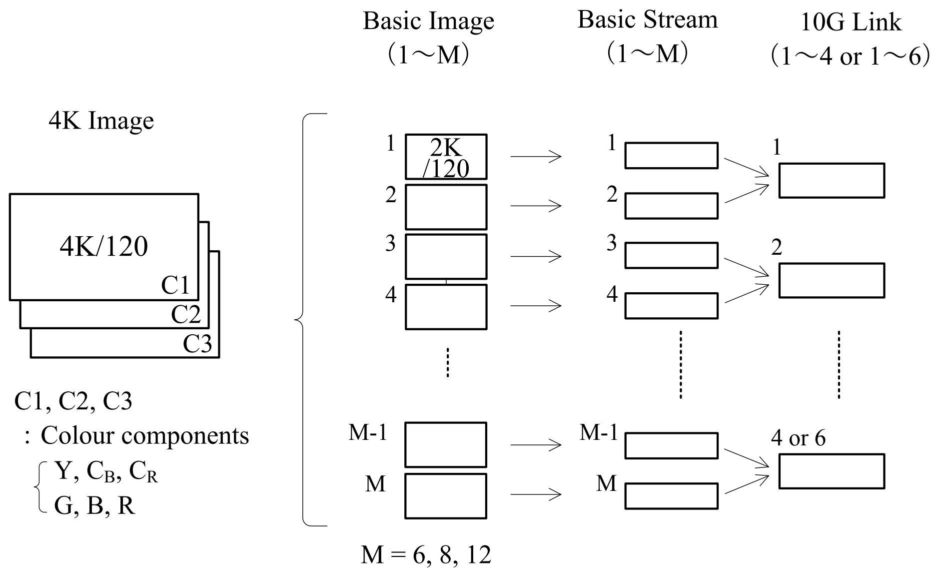

Figure 3-2 Mapping overview of 4K/120

3.1.2 Mapping of 8K or 4K images with 60 Hz or 60/1.001 Hz frame frequency

The mapping of 8K images with 60 Hz or 60/1.001 Hz frame frequency to multiple 10G link signals is illustrated in Fig. 3-3 and the mapping of 4K images with 60 Hz or 60/1.001 Hz frame frequency is illustrated in Fig. 3-4.

For 8K/60, the three colour components that constitute the image are respectively divided into four to produce N (N = 6, 8, or 12) 4K Sub-Images, and then 4N basic images are generated. Next, the 4N basic images are converted to 4N basic streams, each four of which are mapped to one 10G link signal to generate N 10G link signals.

For 4K/60, the three colour components that constitute the image are respectively divided into four to produce M (M = 6, 8, or 12) basic images. The M basic images are then converted to M basic streams, each four of which are mapped to one 10G link signal to generate three 10G link signals. The reason for there being no M/4 is that 10G link signals are generated for each colour component. Detailed specifications are in section 5.2.4.

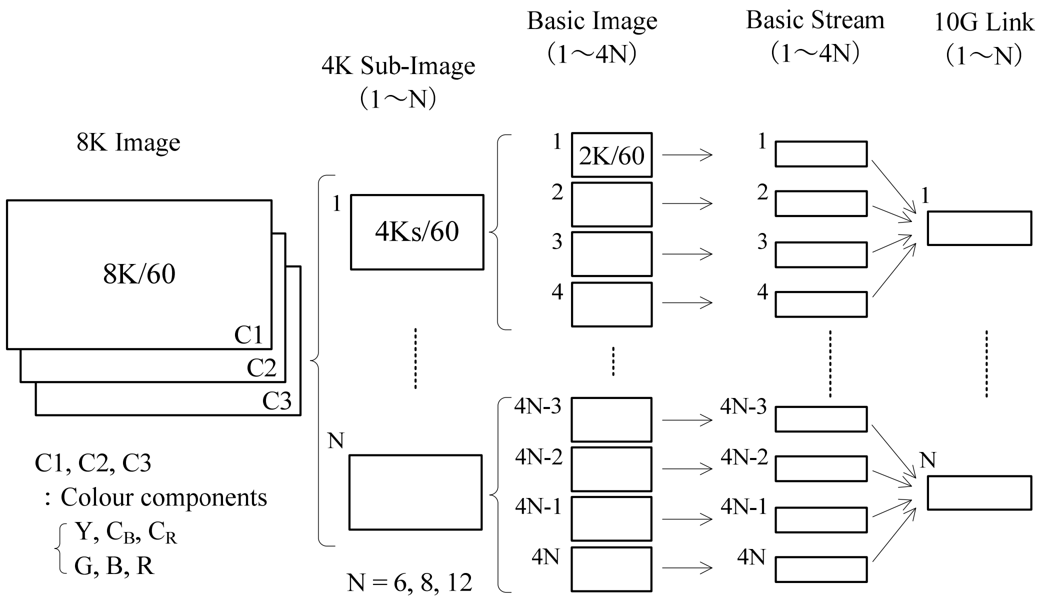

Figure 3-3 Mapping overview of 8K/60

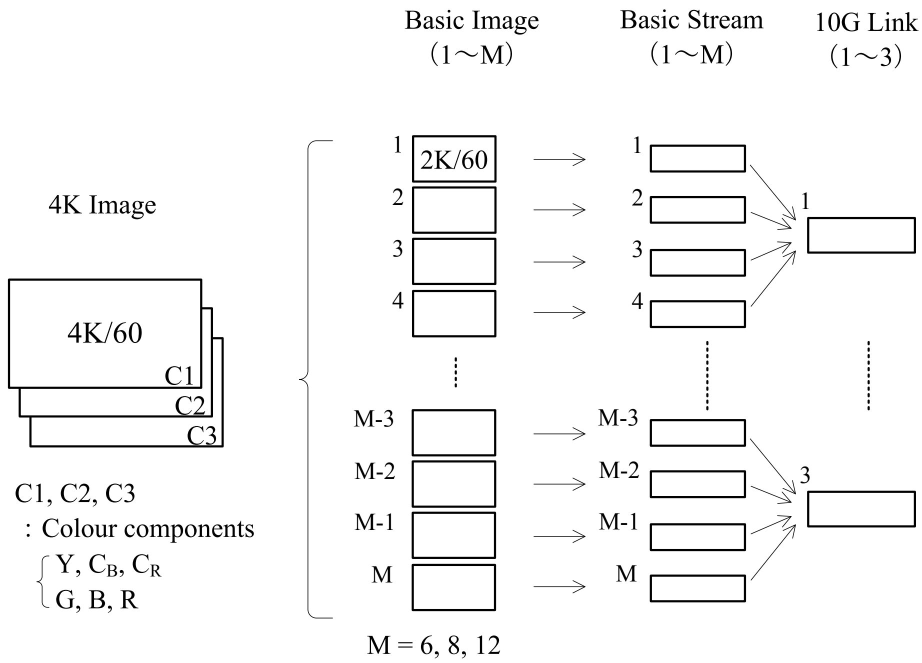

Figure 3-4 Mapping overview of 4K/60

3.1.3 Configuration of colour signal component and system ID

Figure 3-5 illustrates the image division of 8K images into 4K Sub-Images and 4K images into basic images when the sampling structures for 8K images and 4K images are 4:2:2 (YC_BC_R) or 4:2:0 (YC_BC_R).

For the 4:2:2 (YC_BC_R) sampling structure, the colour components of the 4K Sub-Images generated from the 8K images are limited to Y1, Y2, Y3, Y4, C_B1, C_B3, C_R1, and C_R3 and the colour components of the basic images generated from the 4K image are limited to y1, y2, y3, y4, c_B1, c_B3, c_R1, and c_R3.

For the sampling structure 4:2:0 (YC_BC_R), the colour components of the 4K Sub-Images generated from the 8K images are limited to Y1, Y2, Y3, Y4, C_B1, C_R1 and the colour components of the basic images generated from the 4K image are limited to y1, y2, y3, y4, c_B1, and c_R1.

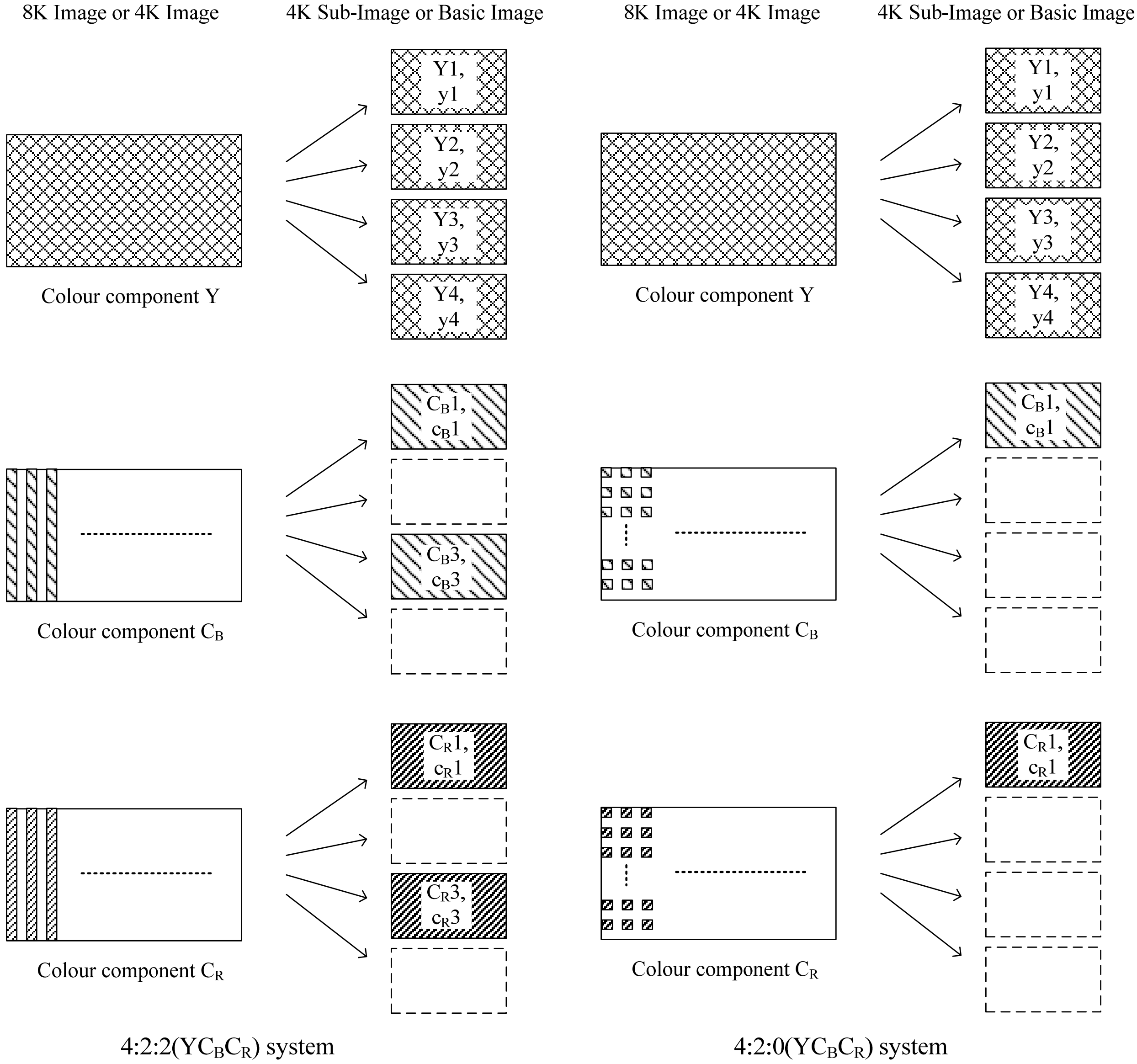

Figure 3-5 Image division of 4:2:2 (YC_BC_R) and 4:2:0 (YC_BC_R) systems

The system numbers for identifying the image format are defined in Table 3-1 for 8K images and in Table 3-2 for 4K images.

Table 3-1 The numbers of 10G links and the system numbers for 8K images

8K Image, Sampling Structure	4K Sub-Image		Frame Frequency (Hz)	Number of 10G Links	System Number
	Number of Sub-Images (N)	Elements of Colour Components			
8K, 4:4:4 (GBR)	12	G1, G2, B1, B2, R1, R2, G3, G4, B3, B4, R3, R4	120, 120/1.001	24	U2.1
			60, 60/1.001	12	U2.3
8K, 4:4:4 (Y$C_B$$C_R$)	12	Y1, Y2, C_B1, C_B2, C_R1, C_R2, Y3, Y4, C_B3, C_B4, C_R3, C_R4	120, 120/1.001	24	U2.8
			60, 60/1.001	12	U2.10
8K, 4:2:2 (Y$C_B$$C_R$)	8	Y1, Y2, C_B1, C_R1, Y3, Y4, C_B3, C_R3	120, 120/1.001	16	U2.15
			60, 60/1.001	8	U2.17
8K, 4:2:0 (Y$C_B$$C_R$)	6	Y1, Y2, C_B1, C_R1, Y3, Y4	120, 120/1.001	12	U2.22
			60, 60/1.001	6	U2.24

Table 3-2 The numbers of 10G links and the system numbers for 4K images

4K Image, Sampling Structure	Basic Image		Frame Frequency (Hz)	Number of 10G Links	System Number
	Number of Basic Images (M)	Elements of Colour Components			
4K, 4:4:4 (GBR)	12	g1, g2, b1, b2, r1, r2, g3, g4, b3, b4, r3, r4	120, 120/1.001	6	U1.1
			60, 60/1.001	3	U1.3
4K, 4:4:4 (Y$C_B$$C_R$)	12	y1, y2, c_B1, c_B2, c_R1, c_R2, y3, y4, c_B3, c_B4, c_R3, c_R4	120, 120/1.001	6	U1.8
			60, 60/1.001	3	U1.10
4K, 4:2:2 (Y$C_B$$C_R$)	8	y1, y2, c_B1, c_R1, y3, y4, c_B3, c_R3	120, 120/1.001	4	U1.15
			60, 60/1.001	3	U1.17
4K, 4:2:0 (Y$C_B$$C_R$)	6	y1, y2, c_B1, c_R1, y3, y4	120, 120/1.001	4	U1.22
			60, 60/1.001	3	U1.24

3.2 Division of 8K images into 4K Sub-Images

The division of 8K images into 4K Sub-Images is illustrated in Fig. 3-6. In the line numbering for each 8K image sample, the uppermost line in the vertical direction is line number 1 and the lowermost line is line number 4320; the leftmost sample in the horizontal direction is sample number 0 and the rightmost sample is sample number 7679. The numbering for each sample of the 4K Sub-Images is done similarly, with the uppermost line in the vertical direction as line number 1 and the lowest line as line number 2160, and the leftmost sample in the horizontal direction as sample number 0 and the rightmost sample as sample number 3839.

The even-numbered samples of the odd lines of the 8K images are mapped to 4K Sub-Image 1 and the odd-numbered samples of the odd lines of the 8K images are mapped to 4K Sub-Image 2; the even-numbered samples of the even lines of the 8K images are mapped to 4K Sub-Image 3 and the odd-numbered samples of the even lines of the 8K images are mapped to 4K Sub-Image 4.

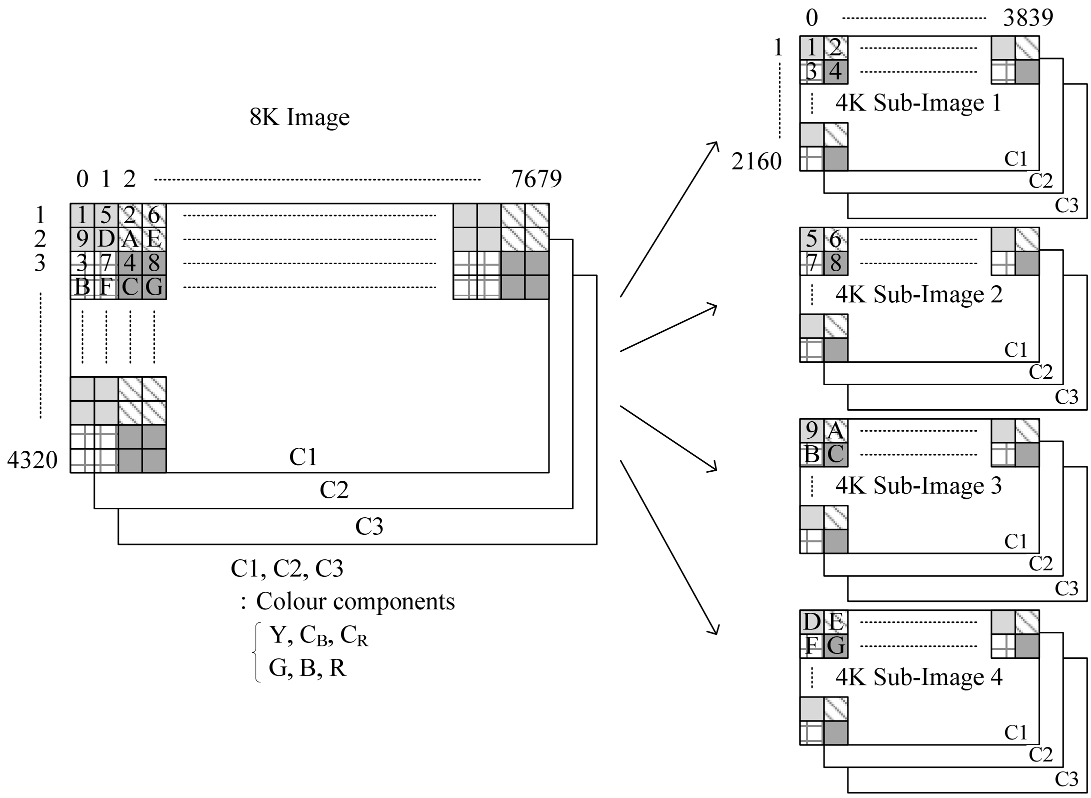

Figure 3-6 Image division from 8K Images to 4K Sub-Images

3.3 Division of 4K images and 4K Sub-Images into basic images

The division of 4K images and 4K Sub-Images into basic images is illustrated in Fig. 3-7. The numbering for each sample of the 4K Sub-Images is done in the same way as for the 4K Sub-Images, with the uppermost line in the vertical direction as line number 1 and the lowest line as line number 2160, and the leftmost sample in the horizontal direction as sample number 0 and the rightmost sample as sample number 3839. The numbering for each sample of the basic images is done similarly, with the uppermost line in the vertical direction as line number 1 and the lowest line as line number 1080, and the leftmost sample in the horizontal direction as sample number 0 and the rightmost sample as sample number 1919.

The even-numbered samples of the odd lines of the 4K images and 4K Sub-Images are mapped to basic image 1 and the odd-numbered samples of the odd lines of the 4K images and 4K Sub-Images are mapped to basic image 2; the even-numbered samples of the even lines of the 4K images and 4K Sub-Images are mapped to basic image 3 and the odd-numbered samples of the even lines of the 4K images and 4K Sub-Images are mapped to basic image 4.

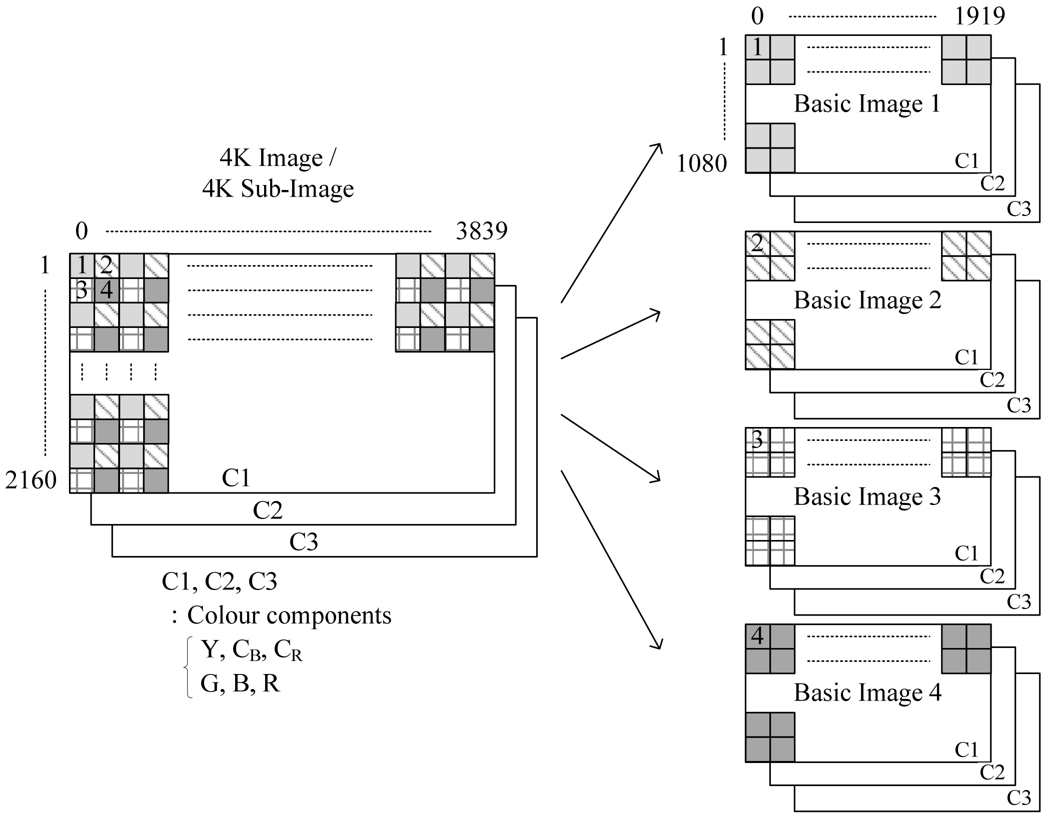

Figure 3-7 Image division of 4K Images or 4K Sub-Image into Basic Images

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Chapter 4 : Basic Stream

4.1 Conversion from basic images to basic streams

The method for converting each line when converting basic images to basic streams is shown in Fig. 4-1. Each sample of the basic image is either 10 bits or 12 bits. For the 10 bit case, a two-bit shift is done to fill the least significant two bits with "00" to produce a 12-bit word so that the word for all of the basic streams is 12 bits.

As shown in Fig. 4-1, the one line period of basic stream consists of a four-word EAV (End of Active Video) timing reference code, a two-word line number (LN), a two-word CRCC (Cyclic Redundancy Check Code) error detection code, ancillary data or blanking data, a four-word SAV (Start of Active Video) timing reference code, and video data. The sample numbers of a basic stream are determined as shown in Table 4-1.

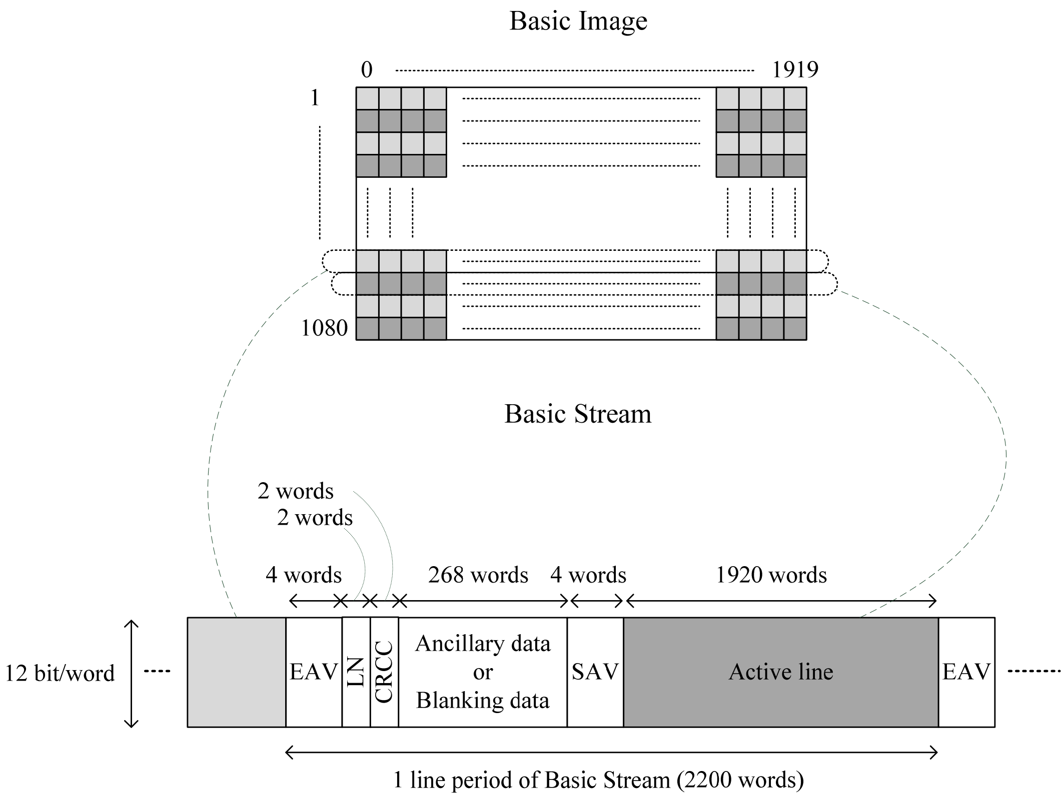

Figure 4-1 Line structure of a basic stream

Table 4-1 Sample numbers of a basic stream

Item	Symbol		Sample number
Active line (video data)	D		0-1919
Timing reference code (EAV)	EAV		1920, 1921, 1922, 1923
Line number data	LN	LN0	1924
		LN1	1925
Cyclic redundancy check codes	CRCC	CRCC0	1926
		CRCC1	1927
Ancillary data or Blanking data	ANC		1928-2195
Timing reference code (SAV)	SAV		2196, 2197, 2198, 2199

The frame structure of a basic stream is shown in Fig. 4-2 and the basic stream line numbering is shown in Table 4-2. A basic stream comprises 1080-line active frame and 45-line frame blanking intervals. The samples from the first line of a basic image to the 1080th line are assigned to ones from line 42 to line 1121 of the basic stream. The frame blanking is assigned to the interval from line 1 to line 41 and from line 1122 to line 1125. The line structure of the frame blanking is same as that of the active frame shown in Fig. 4-1, with a 1920-word region of the active line allocated to the ancillary data or blanking data.

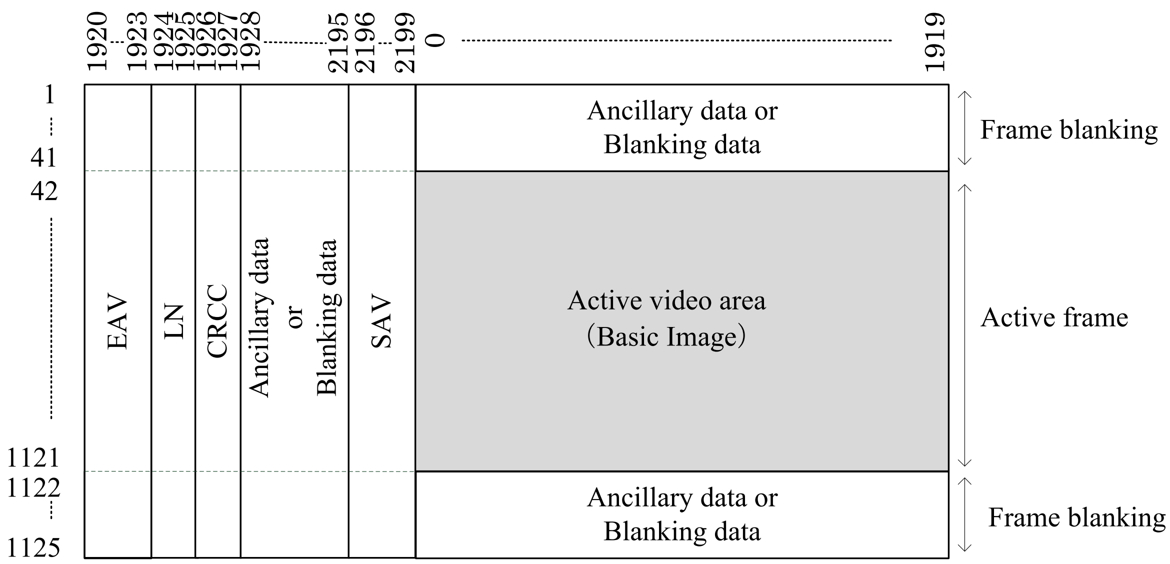

Figure 4-2 Frame structure of a basic stream

Table 4-2 Line numbers of a basic stream

Item	Line number
Frame blanking	1-41, 1122-1125
Active frame	42-1121

4.2 Timing reference codes (SAV and EAV)

The two timing reference codes are the SAV, which is placed immediately before the video data (active line), and the EAV, which is placed immediately after the video data. The bit assignments for the SAV and EAV are shown in Table 4-3 and the protection bit assignments are shown in Table 4-4.

In Table 4-3 and Table 4-4, F is an identification bit for progressive/interlaced (first/second field). The images in this standard are progressive, so the value of F is fixed at 0. The V is an identifier bit for the frame blanking and the active video data. The value of V is 1 in the frame blanking from line 1 to line 41 and from line 1122 to line 1125; the value is 0 in the active video data from line 42 to line 1121. The H is an identifier bit that has a value of 0 for SAV and 1 for EAV. The values P_0 through P_3 are parity bits, which are used for one bit error correction and two bits error detection on the receiving side. The assignment of those bits is defined as shown in Table 4-4.

Table 4-3 Bit assignment for timing reference codes

Word number	Value	Bit number											
		b11 (MSB)	b10	b9	b8	b7	b6	b5	b4	b3	b2	b1	b0 (LSB)
1	FFFh	1	1	1	1	1	1	1	1	1	1	1	1
2	000h	0	0	0	0	0	0	0	0	0	0	0	0
3	000h	0	0	0	0	0	0	0	0	0	0	0	0
4	XYZ	1	F	V	H	P_3	P_2	P_1	P_0	0	0	0	0

Table 4-4 Protection bits for timing reference codes

Bit number	b10	b9	b8	b7	b6	b5	b4
Function	F	V	H	P_3	P_2	P_1	P_0
Bit pattern 0	0	0	0	0	0	0	0
Bit pattern 1	0	0	1	1	1	0	1
Bit pattern 2	0	1	0	1	0	1	1
Bit pattern 3	0	1	1	0	1	1	0

4.3 Line number data

The line numbering of the basic stream uses the line numbers for the basic stream specified in Fig. 4-2 and Table 4-2 rather than the line numbers of the 8K or 4K image. The line number data is represented in binary format using the 11 bits from L0 (LSB) to L10 (MSB). The bit assignment of line number data LN0 and LN1 is shown in Table 4-5. The reserved bits of Table 7 are set to "0" until defined.

Table 4-5 Bit assignment for line number data

Bit number	LN0	LN1
b11 (MSB)	NOT b10	NOT b10
b10	L6	Reserved
b9	L5	Reserved
b8	L4	Reserved
b7	L3	L10 (MSB)
b6	L2	L9
b5	L1	L8
b4	L0 (LSB)	L7
b3	Reserved	Reserved
b2	Reserved	Reserved
b1	Reserved	Reserved
b0 (LSB)	Reserved	Reserved

4.4 Error detection code data

The basic stream error detection code data is represented by the 18 bits from CRCC0 to CRCC17 and is defined as follows.

(1) Error detection code: CRCC (Cyclic Redundancy Check Code)

(2) Polynomial generator equation: $C(X) = X^{18}+X^5+X^4+1$. The initial value is set to 0.

(3) Error detection code generation range:

Start point: The first word after the SAV of the previous line

End point: The last word of the line number data

(4) Error detection code generation sequence:

Begin with the LSB of the first word of the error detection code generation range and end with the MSB of the last word in that range.

(5) Bit assignment:

Table 4-6 specifies the bit assignment. CRCC0 is the MSB of the error detection code. The reserved bits of Table 4-6 are set to "0" until defined.

Table 4-6 Bit assignment for CRCC

Bit number	CRC0	CRC1
b11 (MSB)	NOT b10	NOT b10
b10	CRCC8	CRCC17
b9	CRCC7	CRCC16
b8	CRCC6	CRCC15
b7	CRCC5	CRCC14
b6	CRCC4	CRCC13
b5	CRCC3	CRCC12
b4	CRCC2	CRCC11
b3	CRCC1	CRCC10
b2	CRCC0	CRCC9
b1	Reserved	Reserved
b0 (LSB)	Reserved	Reserved

4.5 Ancillary data

Except for Payload ID specified in section 4.6, ancillary data is specified by other ARIB Standards and Technical Reports.

Until ancillary data for 8K and 4K images is specified, the ancillary data for 1125/P (1125/60 HDTV progressive systems) level A defined by BTA S-004C is applied for basic stream ancillary data. When applying the data, the specification of Y data stream and the C_B/C_R data stream of the 1125/P level A are respectively replaced with basic stream 1 and basic stream 2.

When the ancillary data packet is specified as 10 bits/word, the conversion shown in Fig. 4-3 is performed. In Fig. 4-3, ADF indicates an ancillary data flag, DID indicates a data identifier word, DBN indicates a data block number word, SDID indicates second data identifier word, DC indicates a data count word, UDW indicates a user data word and CS indicates a checksum word. As shown in Fig. 4-3, for ancillary data packets specified as 10 bits/word, excluding ADF and CS, the lowest two bits are filled with "00" to convert to a 12-bit word format and a two bit shift is applied to the bit assignment specified for the 10-bit words. For the three words of the ADF, "00" is appended to the lowest two bits of the first word and "11" is appended to the lowest two bits of the other two words for conversion to 12-bit words. For CS, the lower 11 bits of the sum of the lower 11 bits of the words from DID to the last UDW are assigned as b0 (LSB) to b10 of CS, and b11 (MSB) is set as the reverse of b10.

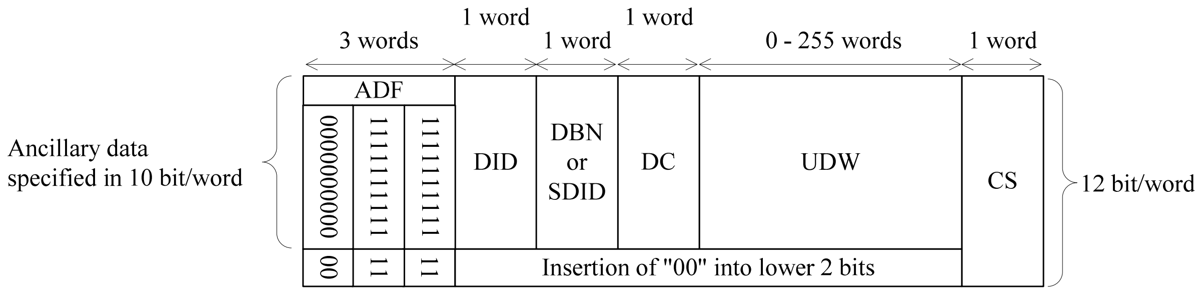

Figure 4-3 Conversion of ancillary data packet from 10 bit/word to 12 bit/word

4.6 Payload ID

The UDW bit assignment of Payload ID packet is shown in Table 4-7. The Payload ID packet must be multiplexed once per frame of the basic stream. The recommended location is immediately after the CRCC of the basic stream in line 10.

Table 4-7 Bit assignment of Payload ID packet

<table>
<tr><th>Bit number</th><th>Word 1</th><th>Word 2</th><th>Word 3</th><th>Word 4</th></tr>
<tr><td>b11 (MSB)</td><td>NOT b10</td><td>NOT b10</td><td>NOT b10</td><td>NOT b10</td></tr>
<tr><td>b10</td><td>EP (Note 1)</td><td>EP</td><td>EP</td><td>EP</td></tr>
<tr><td>b9</td><td>1</td><td>Progressive (1)</td><td rowspan="3">Channel assignment of basic stream
Ch1 (0h), Ch2 (1h),
Ch3 (2h), Ch4 (3h),</td><td rowspan="5">10G link assignment
Ch1 (00h) -
Ch24 (17h)</td></tr>
<tr><td>b8</td><td>0</td><td>Progressive (1)</td></tr>
<tr><td>b7</td><td>1</td><td>0</td></tr>
<tr><td>b6</td><td>0</td><td>0</td><td>0</td></tr>
<tr><td>b5</td><td>0</td><td rowspan="4">Picture rate
60/1.001 Hz (Ah),
60 Hz (Bh),
120/1.001 Hz (Eh)
120 Hz (Fh)</td><td rowspan="4">Sampling structure identification
4:2:2 (YC_BC_R) (0h),
4:4:4 (YC_BC_R) (1h),
4:4:4 (GBR) (2h),
4:2:0 (YC_BC_R) (3h),</td></tr>
<tr><td>b4</td><td>1</td><td>0</td></tr>
<tr><td>b3</td><td rowspan="2">4K/8K
4K (1h),
8K (2h)</td><td rowspan="2">Bit depth
10-bit (1h),
12-bit (2h)</td></tr>
<tr><td>b2</td></tr>
<tr><td>b1</td><td>0</td><td>0</td><td>0</td><td>0</td></tr>
<tr><td>b0 (LSB)</td><td>0</td><td>0</td><td>0</td><td>0</td></tr>
<tr><td colspan="5">Note 1: EP = Even parity for b0 through b9.</td></tr>
</table>

4.7 Blanking data

The blanking data words occurring during blanking intervals that are not used for the timing reference codes (SAV and EAV), line number data, error detection codes or ancillary data are set as listed below.

(1) Basic streams for colour components Y, G, B, R: 100h

(2) Basic streams for colour components C_B, C_R: 800h

<Blank Page>

Chapter 5 : Generation of 10G link signals

5.1 Generating 10G link signals from basic streams

5.1.1 Generating 10G link signals from 120 Hz basic streams

The method for converting two 120 Hz basic streams to one 10G link signal is shown in Fig. 5-1 to Fig. 5-4. First, two 120 Hz basic streams are multiplexed word-by-word and converted to a multiplexed data stream. Adding 880-word stuffing data to the two 120 Hz basic streams as shown in Fig. 5-1 results in a data stream that has 5280 words per line period. That stuffing data, until defined, are filled with 100h.

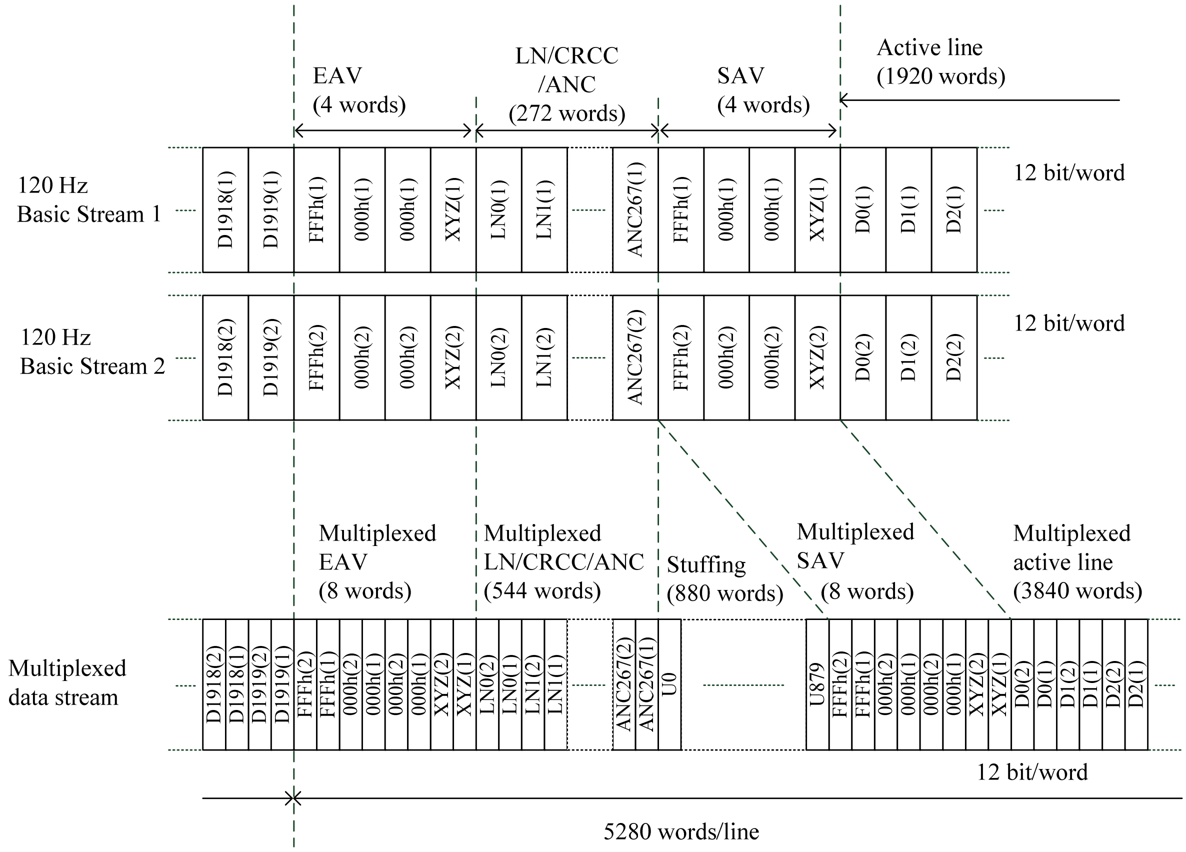

Figure 5-1 Multiplexing of two 120 Hz basic streams

Next, the word-multiplexed data stream is coded by 8B/10B encoding as specified by ANSI INCITS 230. The multiplexed data stream consisting of 12-bit words is first converted to a byte series as shown in Fig. 5-2, and then coded as 8B/10B encoded data.

The conversion to byte series is done in order from the beginning word of the active line, D0(2), and every two words as shown in Fig. 5-3. After the conversion to byte series, the first two bytes and the next two bytes of the multiplexed SAV and EAV are replaced with synchronization blocks and content IDs as shown in Fig. 5-4, respectively. The content ID bit assignment is shown in Table 5-1 and the bit assignment of the system ID, which is part of the content ID, is shown in Table 5-2.

When doing 8B/10B coding, the synchronization blocks of the multiplexed SAV are replaced with K28.5 special characters and those of the multiplexed EAV are replaced with K29.7 special characters defined by ANSI INCITS 230. The 8B/10B encoding process starts at the first K28.5 special character with a negative running disparity. The 8B/10B encoding process is done in accordance with current running disparity at all the lines that follow.

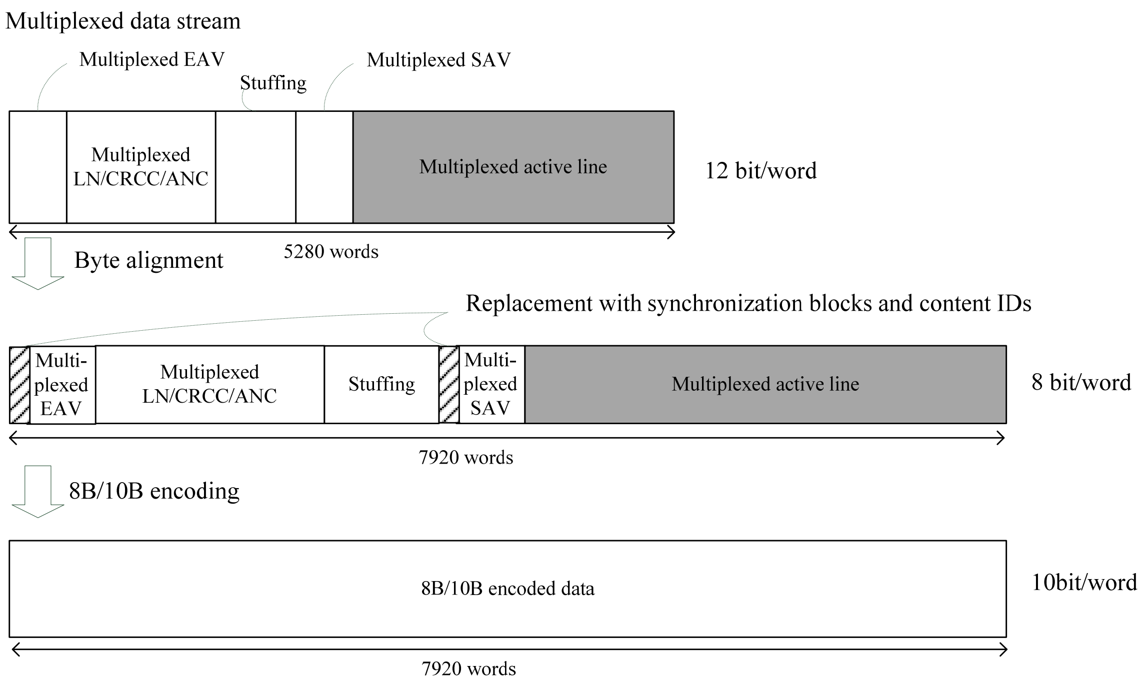

Figure 5-2 8B/10B encoding of multiplexed data stream generated from 120 Hz basic streams

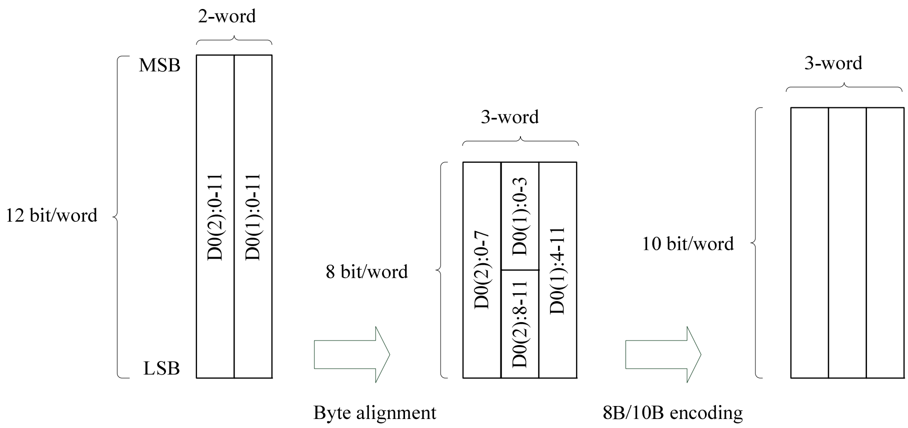

Figure 5-3 Data alignment and 8B/10B encoding of 2-word data block

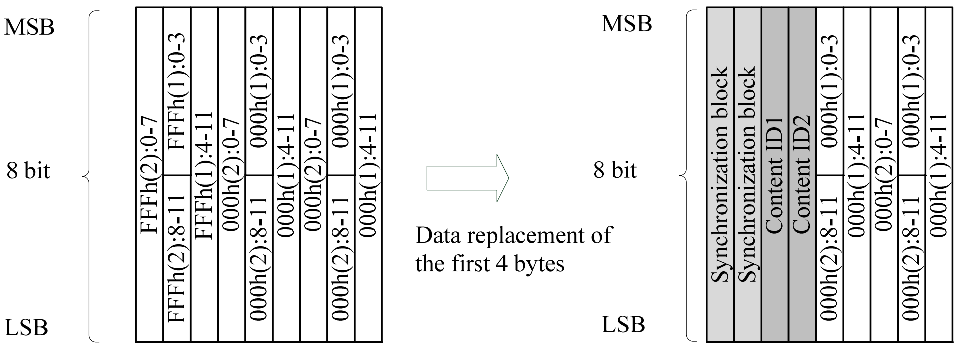

Figure 5-4 Synchronization header generation by replacement of multiplexed SAV and EAV data generated from 120 Hz basic streams

Table 5-1 Content ID bit assignment

<table>
<tr><th>Bit</th><th>Content ID1</th><th>Content ID2</th></tr>
<tr><td>b7 (MSB)</td><td rowspan="2">Reserved
(0h)</td><td rowspan="3">Reserved
(0h)</td></tr>
<tr><td>b6</td></tr>
<tr><td>b5</td><td rowspan="6">System ID</td></tr>
<tr><td>b4</td><td rowspan="5">10G link assignment
Ch.1(00h) to Ch.24(17h)</td></tr>
<tr><td>b3</td></tr>
<tr><td>b2</td></tr>
<tr><td>b1</td></tr>
<tr><td>b0 (LSB)</td></tr>
</table>

Table 5-2 System ID bit assignment

System ID (b5 to b0)	System Number	System ID (b5 to b0)	System Number	System ID (b5 to b0)	System Number	System ID (b5 to b0)	System Number
000000	U1.1	001110	U1.15	100000	U2.1	101110	U2.15
000001	Reserved	001111	Reserved	100001	Reserved	101111	Reserved
000010	U1.3	010000	U1.17	100010	U2.3	110000	U2.17
000011 ~ 000110	Reserved	010001 ~ 010100	Reserved	100011 ~ 100110	Reserved	110001 ~ 110100	Reserved
000111	U1.8	010101	U1.22	100111	U2.8	110101	U2.22
001000	Reserved	010110	Reserved	101000	Reserved	110110	Reserved
001001	U1.10	010111	U1.24	101001	U2.10	110111	U2.24
001010 ~ 001101	Reserved	011000 ~ 011111	Reserved	101010 ~ 101101	Reserved	111000 ~ 111111	Reserved

Next, the 8B/10B coded data is serialized in order from the least significant bit (LSB) into the serial stream of the 10G link signal. The speed of the 10G link signals generated as described above for 120 Hz frame frequency is 7920 (words/line) × 10 (bits/word) × 1125 (lines) × 120 (1/second), or 10.692 Gbit/s. For the frame frequency of 120/1.001 Hz, the speed is 7920 (words/line) × 10 (bits/word) × 1125 (lines) × 120/1.001 (1/second), or 10.692/1.001 Gbit/s.

5.1.2 Generating 10G link signals from 60 Hz basic streams

The method for converting four 60 Hz basic streams to one 10G link signal is shown in Fig. 5-5 and Fig. 5-7. First, four 60 Hz basic streams are multiplexed word by word and converted to a multiplexed data stream. Adding 1760-word stuffing data to the four 60 Hz basic streams as shown in Fig. 5-5 results in a data stream that has 10560 words per line period. The stuffing data, until defined, are filled with 100h.

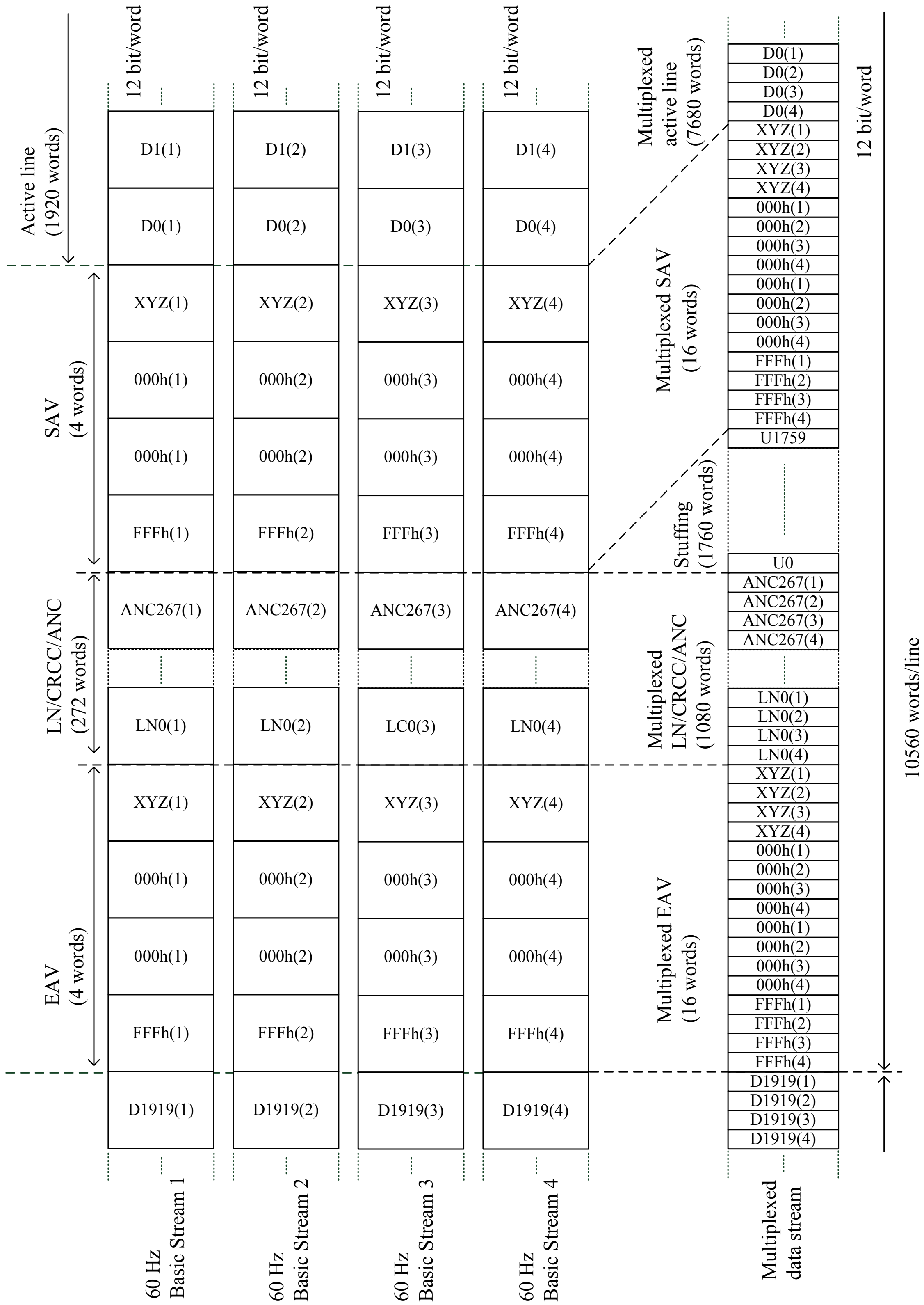

Figure 5-5 Multiplexing of four 60 Hz Basic Streams

Next, the word-multiplexed data stream is coded by 8B/10B encoding as specified by ANSI INCITS 230. The multiplexed data stream consisting of 12-bit words is first converted to a byte series as shown in Fig. 5-6, and then coded as 8B/10B encoded data.

The conversion to byte series is done in order from the beginning word of the active line, D0(4), and every two words in the same way as shown in Fig. 5-3. After the conversion to byte series, the first two bytes and the next two bytes of the multiplexed SAV and EAV are replaced with synchronization blocks and content IDs as shown in Fig. 5-7, respectively. The content ID bit assignment is shown in Table 5-1 and Table 5-2.

When doing 8B/10B coding, the synchronization blocks of the multiplexed SAV are replaced with K28.5 special characters and those of the multiplexed EAV are replaced with K29.7 special characters defined by ANSI INCITS 230. The 8B/10B encoding process starts at the first K28.5 special character with a negative running disparity. The 8B/10B encoding process is done in accordance with current running disparity at all the lines that follow.

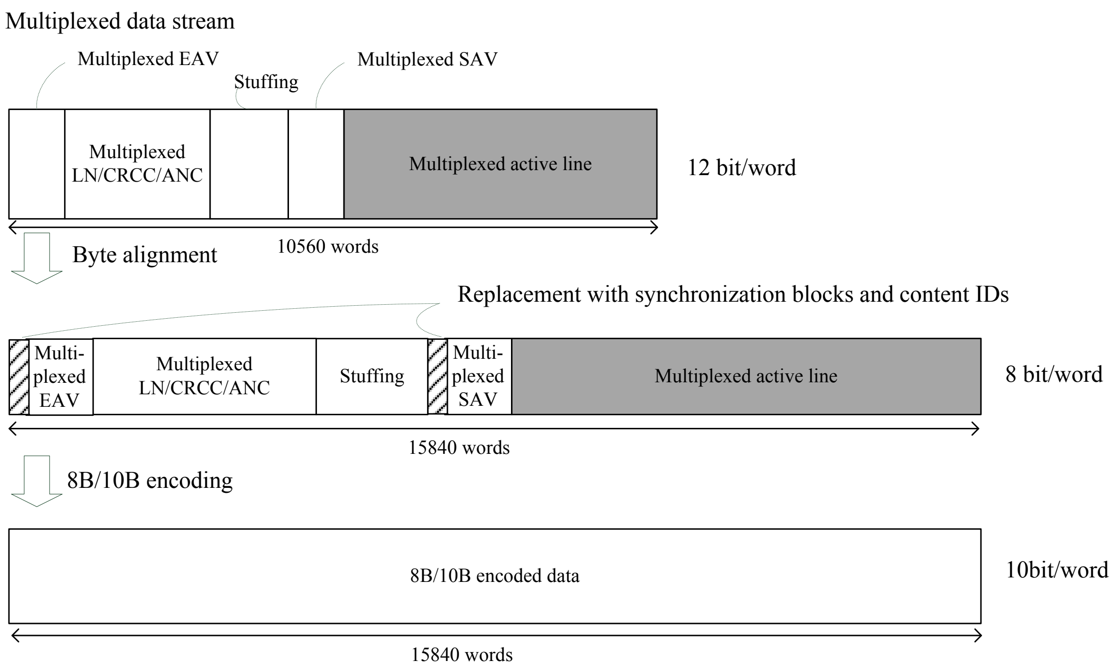

Figure 5-6 8B/10B encoding of multiplexed data stream generated from 60 Hz basic streams

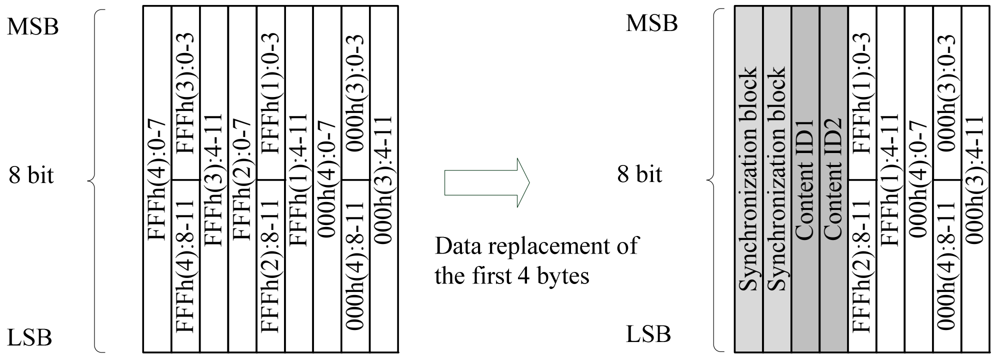

Figure 5-7 Synchronization header generation by replacement of multiplexed SAV and EAV data generated from 60 Hz basic streams

Next, the 8B/10B coded data is serialized in order from the least significant bit (LSB) into the serial stream of the 10G link signal. The speed of the 10G link signals generated as described above for 60 Hz frame frequency is 15840 (words/line) × 10 (bits/word) × 1125 (lines) × 60 (1/seconds), or 10.692 Gbit/s. For the frame frequency of 60/1.001 Hz, the speed is 15840 (words/line) × 10 (bits/word) × 1125 (lines) × 60/1.001 (1/second), or 10.692/1.001 Gbit/s.

5.2 Mapping of 8K or 4K image to 10G link signals

5.2.1 8K/120

The mapping of the 8K/120 images listed below to the 10G link signals is illustrated in Fig. 5-8 and Fig. 5-9.

- U2.1 (8K/120, GBR, 4:4:4)
- U2.8 (8K/120, YC_BC_R, 4:4:4)
- U2.15 (8K/120, YC_BC_R, 4:2:2)
- U2.22 (8K/120, YC_BC_R, 4:2:0)

The SIp.q (p is an integer greater than or equal to 1 and less than or equal to 4; q is an integer greater than or equal to 1 and less than or equal to 3) represents the 4K Sub-Image p for colour component Cq generated by division of the 8K images and is mapped as shown in Fig. 3-6. The BIu.p.q (u is an integer greater than or equal to 1 and less than or equal to 4) represents the basic image u generated by further division of 4Ks/120 SIp.q and is mapped as shown in Fig. 3-7. BS1/120 and BS2/120 respectively represent the 120 Hz basic stream 1 and 120 Hz basic stream 2 specified in Fig. 5-1. For the 8K/120 mapping, one 10 GHz link signal is generated from the two 120 Hz basic streams. As shown in Fig. 3-5, fewer 4K Sub-Images are generated from the 8K image for 4:2:2 or 4:2:0 (both YC_BC_R) than for 4:4:4 (GBR or YC_BC_R). In Fig. 5-8, the 4K Sub-Images that are appended with *1 are generated with 4:4:4 and 4:2:2, and those appended with *2 are generated with only 4:4:4.

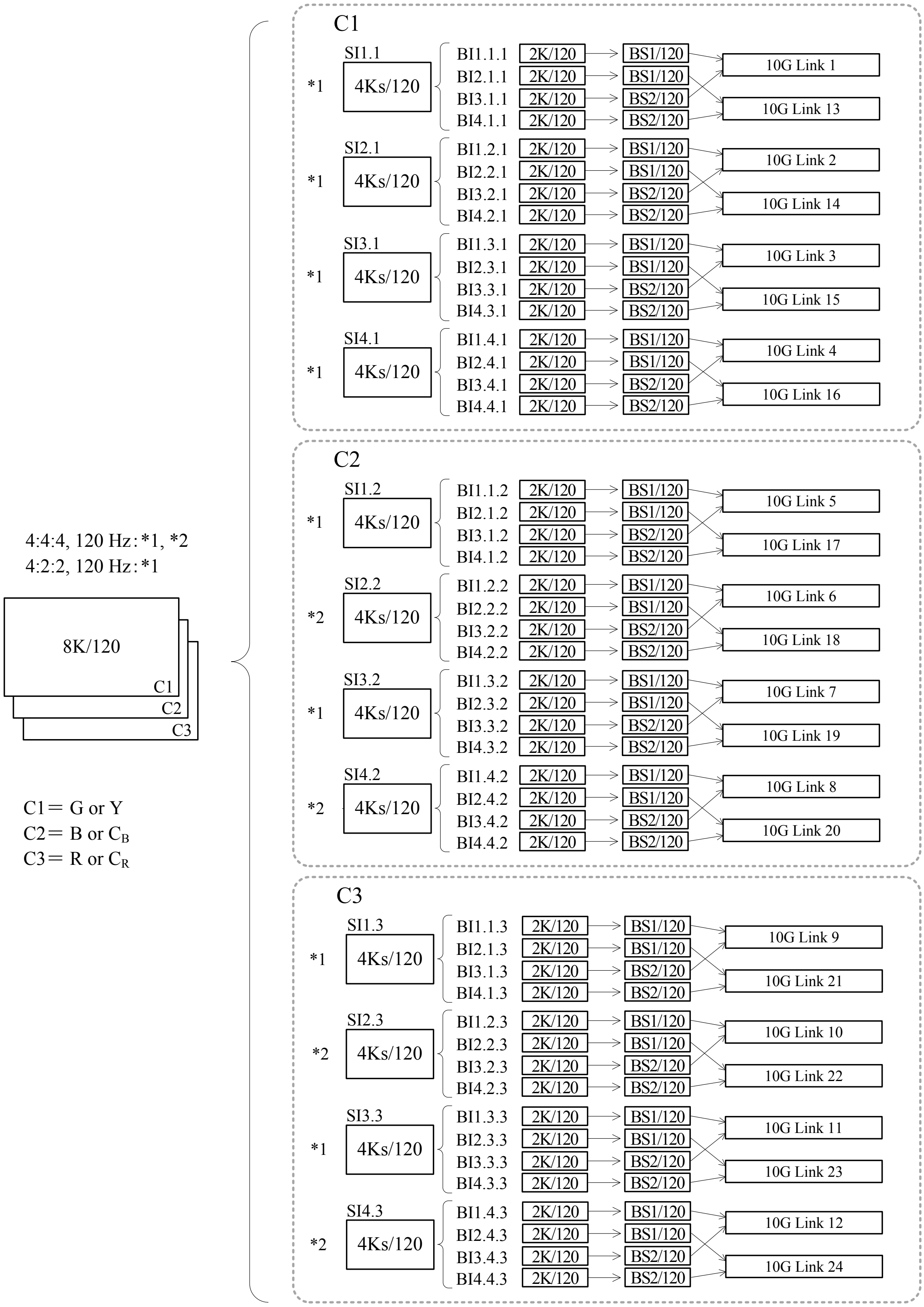

Figure 5-8 Mapping to 10G links for 8K/120 with 4:4:4(GBR or YC_BC_R) or 4:2:2 (YC_BC_R)

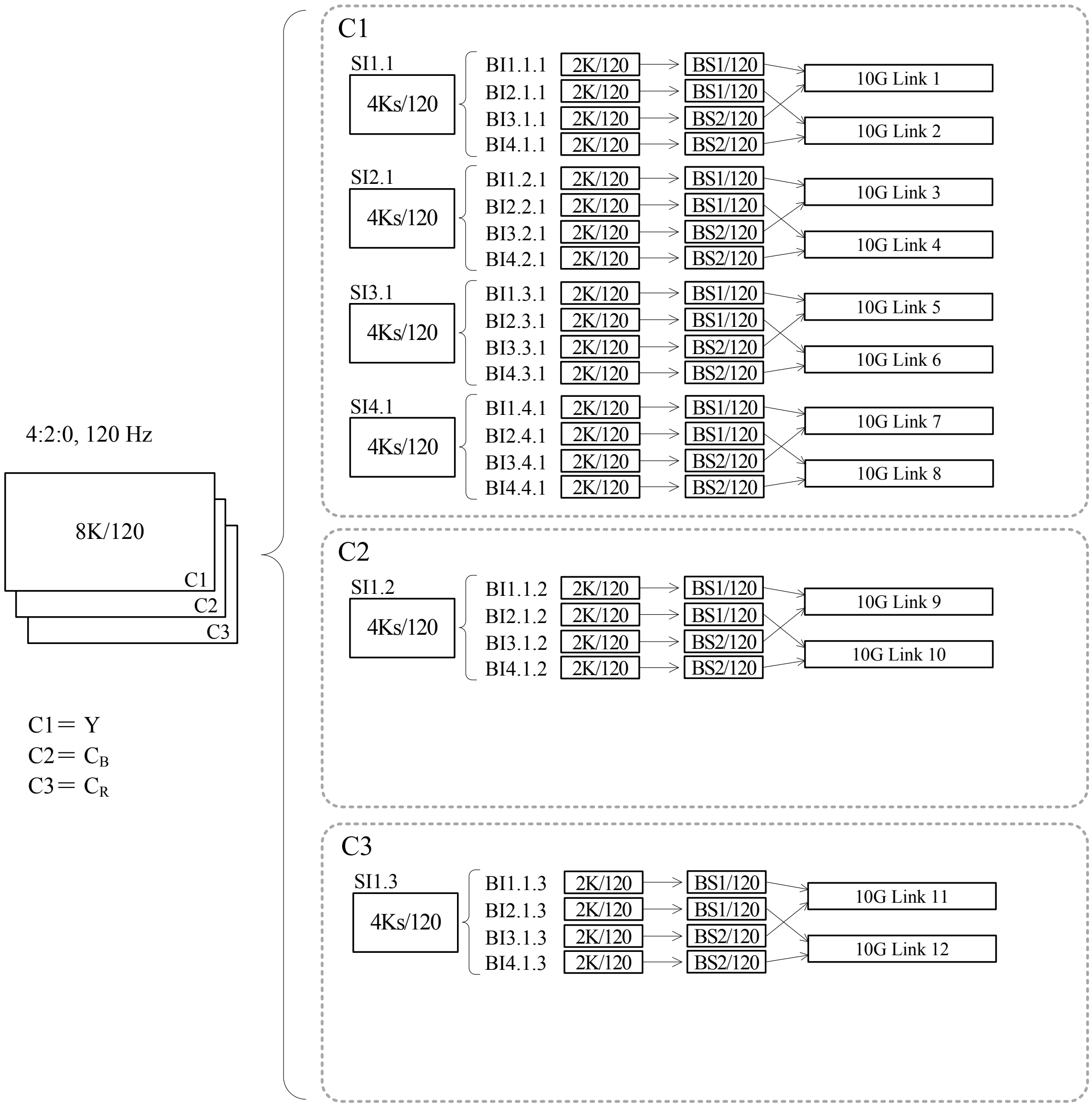

Figure 5-9 Mapping to 10G links for 8K/120 with 4:2:0 (YC_BC_R)

5.2.2 8K/60

The mapping of the 8K/60 images listed below to the 10G link signals is illustrated in Fig. 5-10.

- U2.3 (8K/60, GBR, 4:4:4)
- U2.10 (8K/60, YC_BC_R, 4:4:4)
- U2.17 (8K/60, YC_BC_R, 4:2:2)
- U2.24 (8K/60, YC_BC_R, 4:2:0)

SIp.q and BIu.p.q are as defined in section 5.2.1. BS1/60 to BS4/60 respectively represents the 60 Hz basic streams 1 to 4 specified in Fig. 5-5. For the 8K/60 mapping, one 10 GHz link signal is generated from four basic streams. In Fig. 5-10, the 10G link signals that are appended with *1 are generated with the entire 8K sampling structure, those appended with *2 are generated with only 4:4:4 and 4:2:2, and those appended with *3 are generated with only 4:4:4.

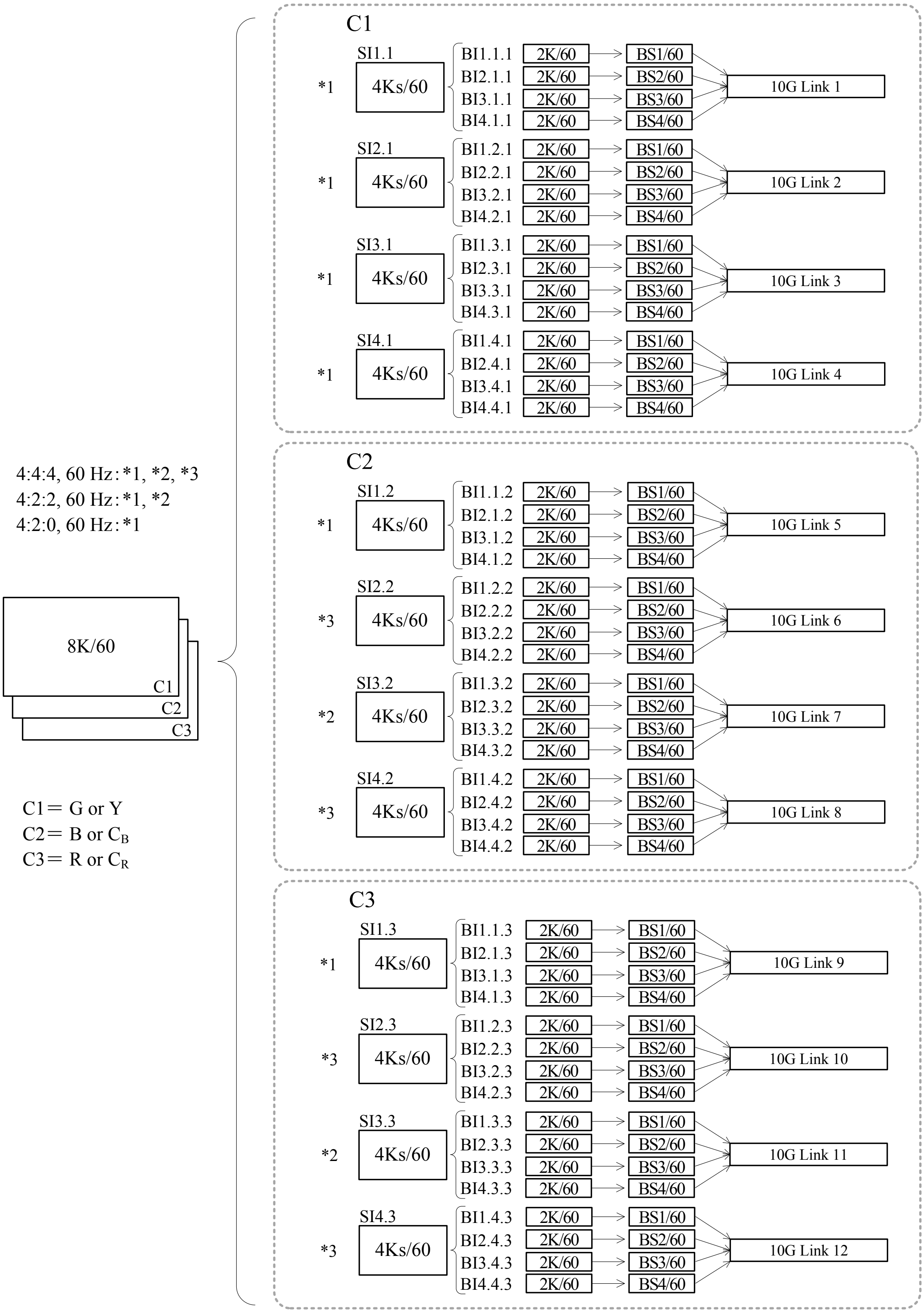

Figure 5-10 Mapping to 10G links for 8K/60

5.2.3 4K/120

The mapping of the 4K/120 images listed below to the 10G link signals is illustrated in Fig. 5-11.

- U1.1 (4K/120, GBR, 4:4:4)
- U1.8 (4K/120, YC_BC_R, 4:4:4)
- U1.15 (4K/120, YC_BC_R, 4:2:2)
- U1.22 (4K/120, YC_BC_R, 4:2:0)

The BIu.q (u is an integer greater than or equal to 1 and less than or equal to 4; q is an integer greater than or equal to 1 and less than or equal to 3) represents basic image u for colour component Cq generated by dividing the 4K images and is mapped as shown in Fig. 3-7. BS1/120 and BS2/120 represent the 120 Hz basic streams 1 and 2 that are defined in Fig. 5-1. For the 4K/120 mapping, one 10G link signal is generated from the two 120 Hz basic streams.

For the case of 4:2:0, less than two 120 Hz basic streams are generated from each C_B and C_R colour component of a 4K image. For that case, a 120 Hz basic stream is generated from a basic image for which the 12-bit data of the entire sample is 800h, and the stream is assigned to BS2/120 to generate the 10G link signal.

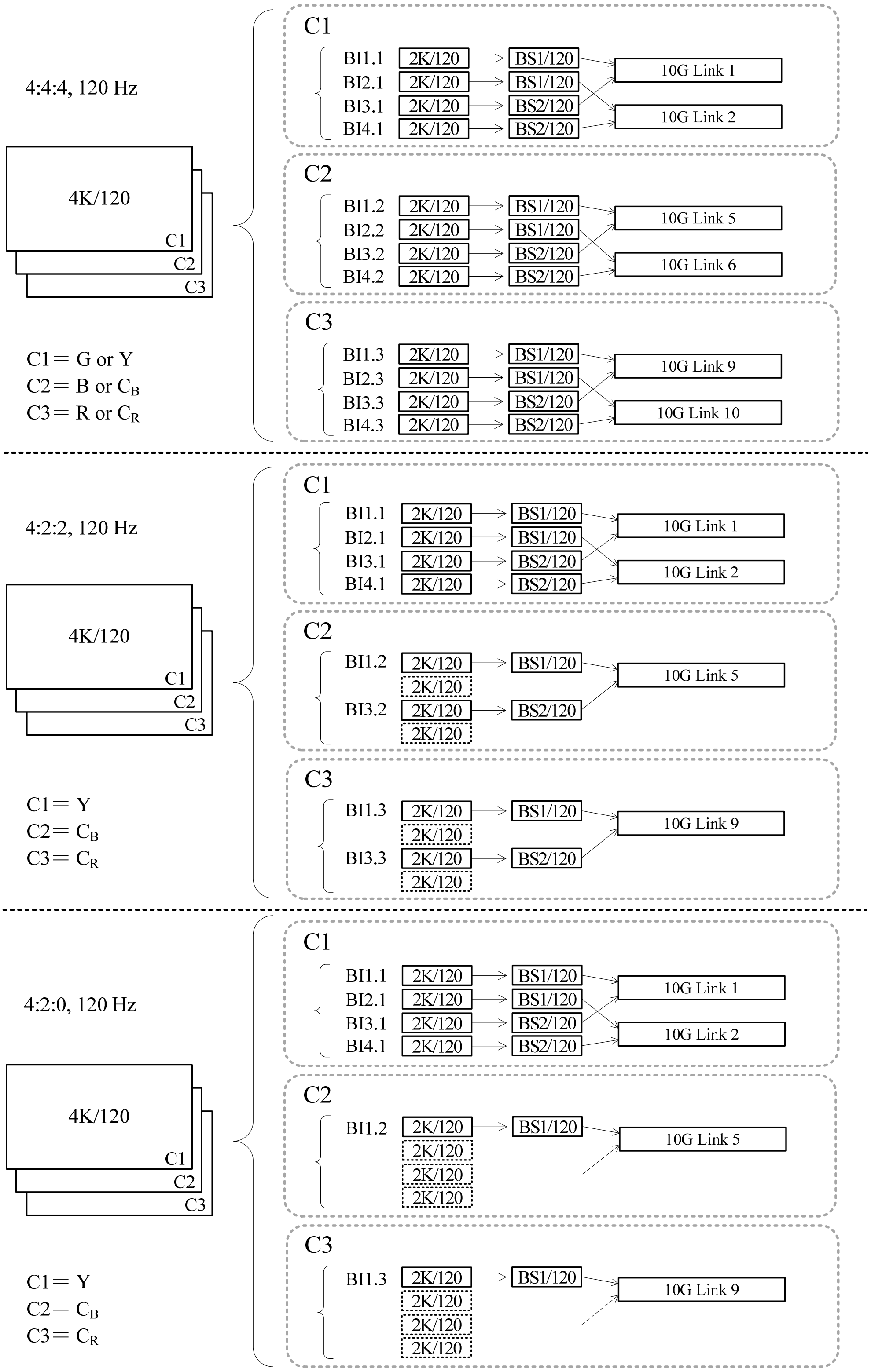

Figure 5-11 Mapping to 10G links for 4K/120

5.2.4 4K/60

The mapping of the 4K/60 images listed below to the 10G link signals is illustrated in Fig. 5-12.

- U1.3 (4K/60, GBR, 4:4:4)
- U1.10 (4K/60, YC_BC_R, 4:4:4)
- U1.17 (4K/60, YC_BC_R, 4:2:2)
- U1.24 (4K/60, YC_BC_R, 4:2:0)

BIu.q is as defined in section 5.2.3. BS1/60 to BS4/60 respectively represents the 60 Hz basic stream 1 to 4 specified in Fig. 5-5. For the 4K/60 mapping, one 10 GHz link signal is generated from four basic streams.

For the case of 4:2:2 and 4:2:0, less than four basic streams are generated from each C_B and C_R colour component of a 4K image, so basic streams are generated from basic images for which the 12-bit data of the entire sample is 800h, and those streams are assigned to BS2/60 and BS4/60 for 4:2:2 and to BS2/60, BS3/60, and BS4/60 for 4:2:0 to generate 10G link signals.

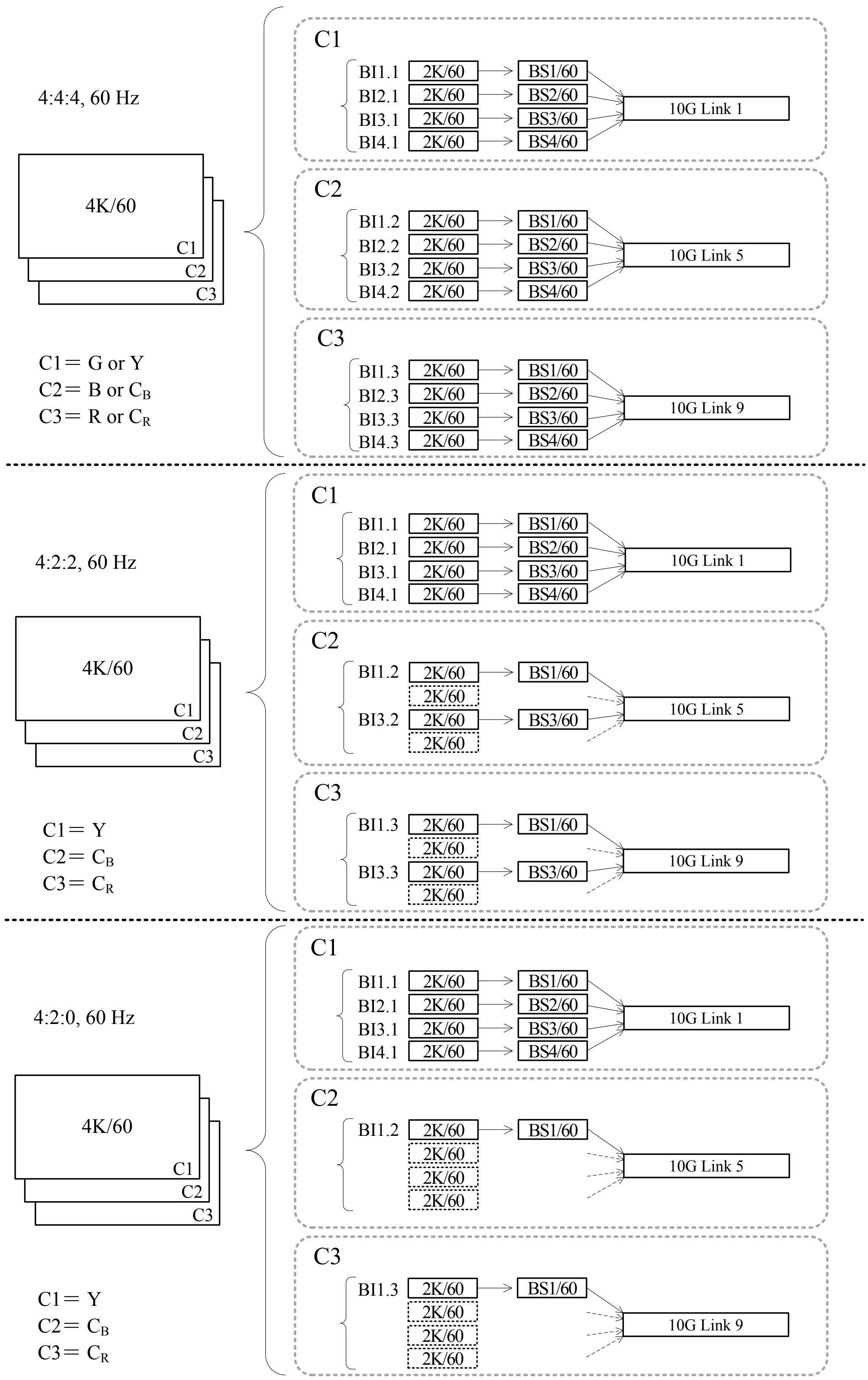

Figure 5-12 Mapping to 10G links for 4K/60

Chapter 6 : Physical Layer

6.1 Transmitter characteristics

The transmitter characteristics of each 10G link are defined in Table 6-1 and the transmitter output optical eye mask is defined in Fig. 6-1. In Fig. 6-1, normalized amplitudes of 0 and 1 represent the amplitudes of logic ZERO and ONE respectively. These are defined by the means of the lower and upper halves of the central 0.2 UI of the eye. A UI is the period of one clock cycle of a 10G link signal. The eye pattern is measured with respect to the mask of the eye using a receiver with a fourth-order Bessel-Thomson response with a 3 dB frequency of 0.75 × 10.692 GHz = 8 GHz.

Table 6-1 Transmitter characteristics

Parameter	Value
Optical Wavelength	840 nm to 860 nm
RMS spectral width (max) (Note 1)	0.65 nm
Signal rate	10.692 GBd ±10 ppm, or 10.692/1.001 GBd ±10 ppm
Average launch power (max)	+2.4 dBm
Average launch power (min)	-7.6 dBm
Extinction Ratio (min)	3 dB
Maximum reflected power	-12 dB
Eye mask (Note 2)	See Fig. 6-1
Jitter	See Section 6.3
Electrical/optical transfer function	Logic ”1” = Higher optical power Logic “0” = Lower optical power

Note 1: RMS spectral width is the standard deviation of the spectrum.

Note 2: One thousand accumulated waveforms are recommended for transmitter optical output eye mask compliance test.

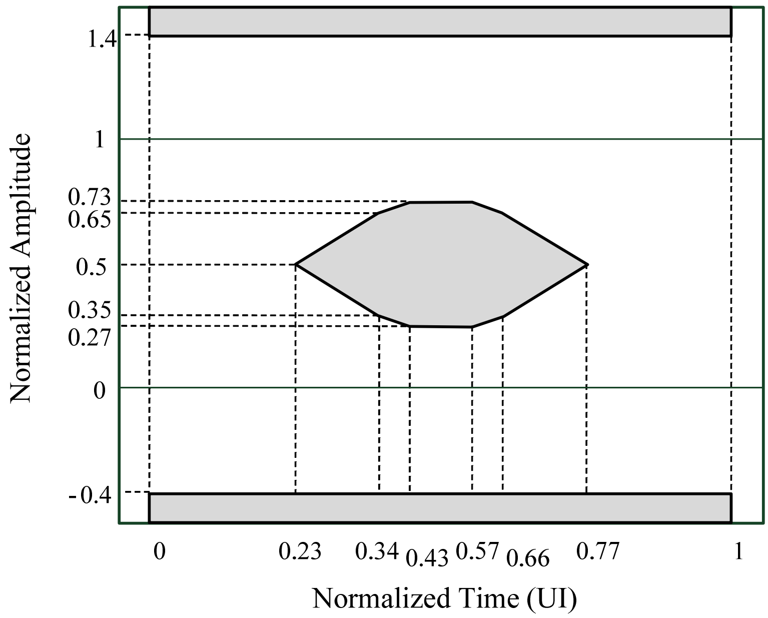

Figure 6-1 Transmitter output optical eye mask

6.2 Receiver characteristics

Receiver characteristics of each 10G link are defined in Table 6-2. Within the receiver input range a BER < 10^{-12} should be achieved with 8K or 4K colour bar signals, specified by other ARIB Standards and Technical Reports, or PRBS-31 pattern. The BER < 10^{-14} is recommended. BER measurement for 5 minutes is recommended. The PRBS-31 pattern is defined in IEEE 802.3ae–2002 listed in Annex A.

Table 6-2 Receiver characteristics

Parameter	Value
Average receive power (max)	+2.4 dBm
Average receive power (min)	-9.5 dBm
Detector damage threshold	+3.4 dBm
Jitter	See Section 6.3
Optical/electrical transfer function	Higher optical power = Logic “1” Lower optical power = Logic “0”

6.3 Jitter specifications

Jitter specifications are defined in Table 6-3. Jitter is defined as the variation of a digital signal's transitions from their ideal positions in time, and is specified as peak-to-peak quantities in unit UI. Bandpass slopes of timing jitter and alignment jitter are at least 20 dB/decade. Stop band rejections are at least 20 dB. Pass band ripples are less than ± 1 dB.

Table 6-3 Receiver characteristics

Parameter	Value	Description
f1	10 Hz	Low-frequency specification limit
f2	20 kHz	Upper band edge for A1
f3	4 MHz	Lower band edge for A2
f4	> 1/10 the clock rate	High-frequency specification limit
A1	10 UI	Timing jitter: Sinusoidal jitter amplitude shall be less than $2 \times 10^5 / f + 0.1$ UI at 20 kHz $< f \leq$ 4 MHz.
A2	0.15 UI	Alignment jitter: Sinusoidal jitter amplitude shall be less than 0.15 UI at $f >$ 4 MHz.
Error Criterion	BER = 10^{-12}	Criterion for onset of errors
Test signal	PRBS-31 or Colour bar	Data rate of PRBS-31: 10.692 Gbit/s or 10.692/1.001 Gbit/s. Colour bar: specified by other ARIB Standards or Technical Reports

6.4 Timing difference between 10G link signals

The timing difference between 10G link signals should not exceed 400 ns.

6.5 Connector

Connector characteristics are defined in Table 6-4. A receptacle connector with equipment is shown in Fig. 6-2 and the dimensions of the receptacle are defined in Table 6-5. A geometric array of the 24 fibres for the receptacle connector complies with JIS C5964-7.

Table 6-4 Connector characteristics

Parameter	Value, description
Number of fibres	24
Fibre type	Multi mode fibre
Connection loss	Less than 0.75 dB
Insertion/withdrawals	More than 5000 times
Equilibrium tensile loading of connectors	250 N
Other requirements	Lock mechanism Dustproof structure

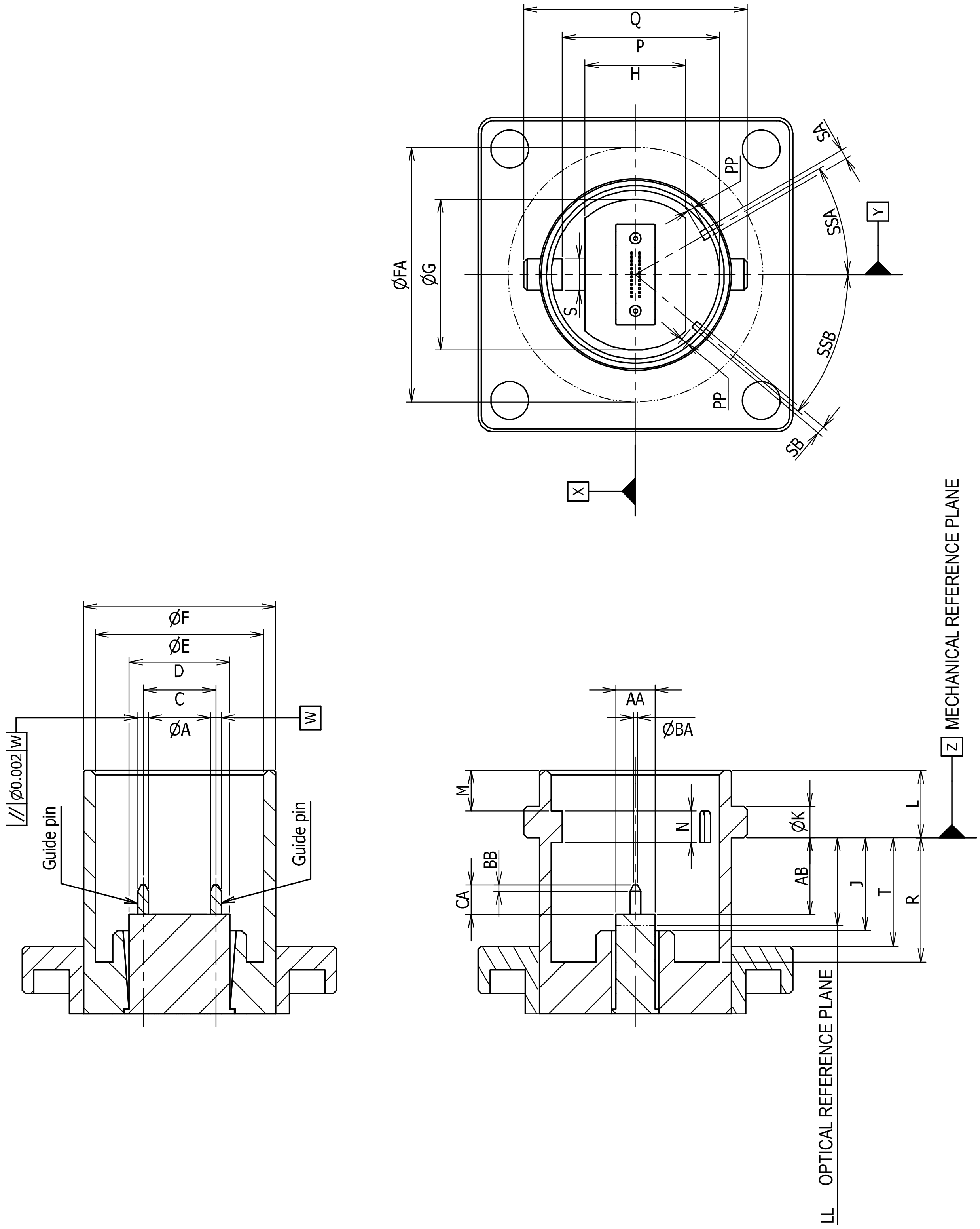

Figure 6-2 Receptacle connector with equipment

Table 6-5 Connector characteristics

Reference	Dimensions	
	minimum	maximum
A	0.697 mm	0.699 mm
C	4.597 mm	4.603 mm
D	6.3 mm	6.5 mm
E	10.7 mm	10.8 mm
F	12.2 mm	12.4 mm
G	-	9.6 mm
H	-	6.4 mm
J	5.7 mm	-
K	1.8 mm	2.2 mm
L	4.3 mm	4.5 mm
M	1.7 mm	4.0 mm
N	1.0 mm	-
P	9.9 mm	10.1 mm
Q	14.2 mm	14.36 mm
R	9.7 mm	-
S	1.95 mm	2.0 mm
T	6.7 mm	-
AA	2.4 mm	2.5 mm
AB	4.7 mm	5.1 mm
BA	0 mm	0.4 mm
BB	0.2 mm	0.5 mm
CA	1.6 mm	3.3 mm
FA	16.2 mm	-
SA	-	0.6 mm
SB	-	0.5 mm
PP	-	0.45 mm
SSA	29°	31°
SSB	39°	41°

6.6 Assignment of 10G link signals to a receptacle connector

The assignment of 10G link signals to an output receptacle connector is shown in Fig. 6-3, and the assignment of 10G link signals to an input receptacle connector is shown in Fig. 6-4. Each number in Fig. 6-3 and Fig. 6-4 represents the number of a 10G link signal. Symbol X and Y in Fig. 6-3 and Fig. 6-4 correspond to symbol X and Y respectively in Fig. 6-2.

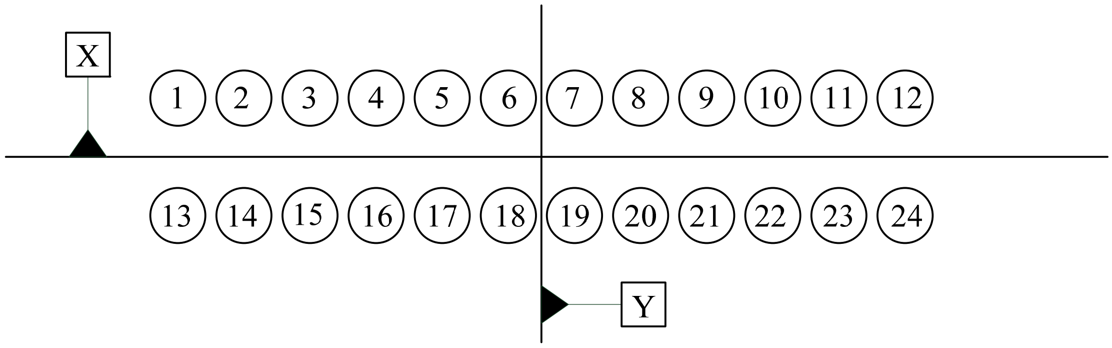

Figure 6-3 Assignment of 10G link signals to an output receptacle connector with equipment

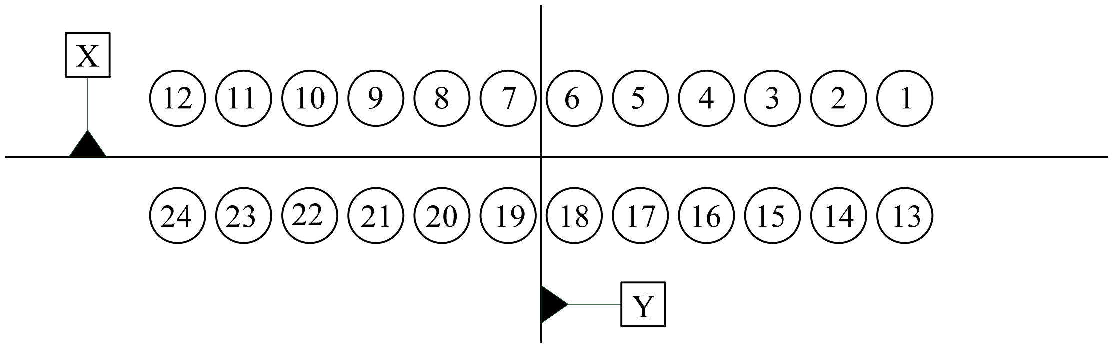

Figure 6-4 Assignment of 10G link signals to an input receptacle connector with equipment

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INTERFACE FOR UHDTV PRODUCTION SYSTEMS

ARIB STANDARD

ARIB STD-B58　Version 1.0-E1

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