SMPTE 435-1-2009
Revision of
SMPTE 435-1-2007

SMPTE STANDARD

10 Gb/s Serial Signal/Data Interface — Part 1: Basic Stream Distribution

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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 Part XIII of its Administrative Practices.

SMPTE 435-1 was prepared by Technology Committee N26.

Intellectual Property

SMPTE draws attention to the fact that it is claimed that compliance with this Standard may involve the use of one or more patents or other intellectual property rights (collectively, "IPR"). The Society takes no position concerning the evidence, validity, or scope of this IPR.

Each holder of claimed IPR has assured the Society that it is willing to License all IPR it owns, and any third party IPR it has the right to sublicense, that is essential to the implementation of this Standard to those (Members and non-Members alike) desiring to implement this Standard under reasonable terms and conditions, demonstrably free of discrimination. Each holder of claimed IPR has filed a statement to such effect with SMPTE. Information may be obtained from the Director, Standards & Engineering at SMPTE Headquarters.

Attention is also drawn to the possibility that elements of this Standard may be subject to IPR other than those identified above. The Society shall not be responsible for identifying any or all such IPR.

1 Scope

This Standard defines the basic stream distribution for applicable image systems. The basic stream complies with the interleaved data stream defined in SMPTE 292 and is utilized for the input streams to the mapping part of this standard. The source image data for the interface are defined in SMPTE 274M, SMPTE 296M, SMPTE 428-1 and ITU-R BT.1769. The interface also supports transmission of the embedded audio, payload ID and the ancillary data defined in SMPTE 291M in the source stream.

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.

3 Normative References

The following standards contain provisions which, through reference in this text, constitute provisions of this recommended practice. At the time of publication, the editions indicated were valid. All standards are subject to revision, and parties to agreements based on this recommended practice are encouraged to investigate the possibility of applying the most recent edition of the standards indicated below.

SMPTE 274M-2008, Television — 1920 × 1080 Image Sample Structure, Digital Representation and Digital Timing Reference Sequences for Multiple Picture Rates

SMPTE 291M-2006, Television — Ancillary Data Packet and Space Formatting

SMPTE 292-2008, 1.5 Gb/s Signal/Data Serial Interface

SMPTE 296M-2001, Television — 1280 × 720 Progressive Image Sample Structure — Analog and Digital Representation and Analog Interface

SMPTE 299M-2004, Television — 24-Bit Digital Audio Format for SMPTE 292 Bit-Serial Interface

SMPTE 372-2009, Dual Link 1.5 Gb/s Digital Interface for 1920 × 1080 and 2048 × 1080 Picture Formats

SMPTE 425-2008, 3 Gb/s Signal/Data Serial Interface — Source Image Format Mapping

SMPTE 428-1-2006, D-Cinema Distribution Master (DCDM) — Image Characteristics

SMPTE 428-9-2008, Digital Cinema Distribution Master(DCDM) Image Pixel Structure Level 3 — Serial Digital Interface Signal Formatting

ITU-R BT.1769, Parameter Values for an Expanded Hierarchy of LSDI Image Formats for Production and International Programme Exchange

4 Definition of Terms

Basic stream: A 10-bit parallel stream which has the same structure as the source data defined in SMPTE 292.

CRC: Cyclic Redundancy Codes defined in SMPTE 292.

EAV: The term EAV used in this standard designates all of timing information around an end of active video area. i.e. EAV bytes plus line number and CRC defined in SMPTE 292.

HANC Data: Data included in a digital line blanking interval.

LN: Line Number data defined in SMPTE 292.

LSDI: Large Screen Digital Imagery

SAV: Timing information around a start of active video area defined in SMPTE 292.

5 System Overview

The source data of the 10 Gb/s data stream shall be composed of multiple basic streams that each comply with the 1.5 Gb/s SDI source data stream defined in SMPTE 292. When embedding ancillary data on HANC area of a basic stream, the data shall comply with SMPTE 291M. Particularly in case of ancillary audio data, it shall comply with SMPTE 299M. Basic streams are multiplexed and serialized into single 10 Gb/s data stream as defined in the mapping part of this standard. Consequently, the 10 Gb/s stream has affinities with 1.5 Gb/s SDI family interfaces and the structure facilitates interconnection with established high rate interface formats. Physical interface specification is defined in the interface part of this standard.

The basic stream structure is shown in Figure 1, which is a quotation from Figure 3 in SMPTE 292.

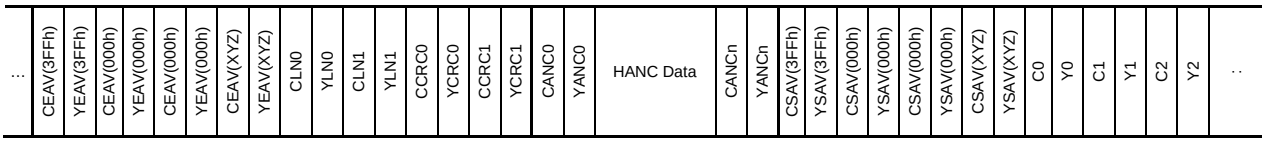


Figure 1 – Structure of 1.5 Gb/s Basic Stream (Informative)

6 Source Signal Formats

6.1 1.5 Gb/s Class

Table 1 defines the image formats that have an interleaved stream structure compliant with SMPTE 292. The interleaved stream derived from each image format shall be assigned to a basic stream defined in this standard.

Table 1 – Source Image Formats

System Number	Reference SMPTE Standard	Picture Format	Signal Format sampling structure/pixel Depth	Frame/Field Rates
1.1	274M	1920 × 1080	4:2:2 ($Y'C'_BC'_R$)/10-bit	24, 25 and 30 Frames/s Progressive, PsF 50 and 60 Fields/s Interlace
				23.98 and 29.97 Frames/s Progressive, PsF 59.94 Fields/s Interlace
1.2	296M	1280 × 720	4:2:2 ($Y'C'_BC'_R$)/10-bit	50 and 60 Frames/s Progressive
				59.94 Frames/s Progressive

6.2 Dual Link 1.5 Gb/s Class

Table 2 defines the image formats that shall be mapped into two basic streams. A source stream is divided into two 1.5 Gb/s streams which have the same structure as dual link stream defined in SMPTE 372, or the same structure as a pair of 10-bit virtual data streams defined in SMPTE 425. Each digital stream derived shall be assigned to a basic stream defined in this standard.

Table 2 – Source Image Formats

System Number	Reference SMPTE Standard	Picture Format	Signal Format sampling structure/pixel Depth	Frame/Field Rates
2.1	274M	1920 × 1080	4:2:2 ($Y'C'_BC'_R$)/10-bit	50 and 60 Frames/s Progressive
				59.94 Frames/s Progressive
2.2	274M	1920 × 1080	4:4:4 (R'G'B'), 4:4:4:4 (R'G'B'+A)/10-bit	24, 25,and 30 Frames/s Progressive, PsF 50 and 60 Fields/s Interlace
				23.98 and 29.97 Frames/s Progressive, PsF 59.94 Fields/s Interlace
2.3	274M	1920 × 1080	4:4:4 (R'G'B')/12-bit	24, 25 and 30 Frames/s Progressive, PsF 50 and 60 Fields/s Interlace
				23.98 and 29.97 Frames/s Progressive, PsF 59.94 Fields/s Interlace
2.4	274M	1920 × 1080	4:4:4 ($Y'C'_BC'_R$)/10-bit, 4:4:4:4 ($Y'C'_BC'_R$+A) /10-bit	24, 25 and 30 Frames/s Progressive, PsF 50 and 60 Fields/s Interlace
				23.98 and 29.97 Frames/s Progressive, PsF 59.94 Fields/s Interlace
2.5	274M	1920 × 1080	4:2:2 ($Y'C'_BC'_R$), 4:4:4 ($Y'C'_BC'_R$) /12-bit	24, 25 and 30 Frames/s Progressive, PsF 50 and 60 Fields/s Interlace
				23.98 and 29.97 Frames/s Progressive 59.94 Fields/s Interlace
2.6	296M	1280 × 720	4:4:4 (R'G'B')/10-bit, 4:4:4:4 (R'G'B'+A)/10-bit	50 and 60 Frames/s Progressive
				59.94 Frames/s Progressive
2.7	428-9	2048 × 1080	4:4:4 (*X'Y'Z'*)/12-bit	24 Frames/s Progressive, PsF[1]

Note: System 2.6 stream can be embedded to dual basic streams as the same structure as the definition of SMPTE 372, § 4.2.

[1] May also include 24/1.001 F/sec.

6.3 Quad Link 1.5 Gb/s Class

Table 3 defines the image formats that shall be mapped into four basic streams as defined in § 6.3.1.

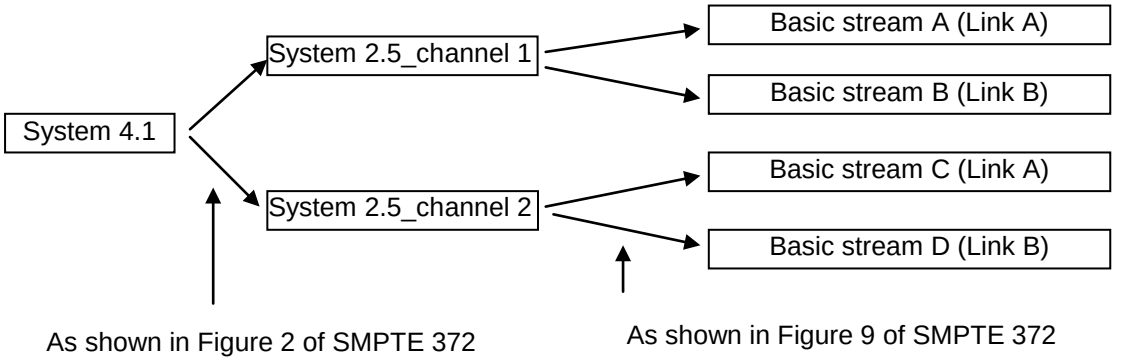
Table 3 – Source Image Formats

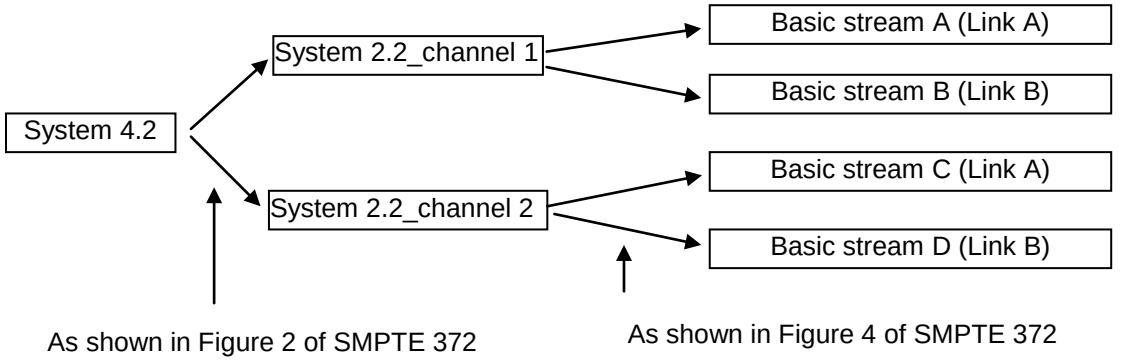
System Number	Reference SMPTE Standard	Picture Format	Signal Format sampling structure/pixel Depth	Frame/Field Rates
4.1	274M	1920 × 1080	4:2:2 ($Y'C'_BC'_R$)/12-bit	50 and 60 Frames/s Progressive
				59.94 Frames/s Progressive
4.2	274M	1920 × 1080	4:4:4 (R'G'B')/10-bit	50 and 60 Frames/s Progressive
				59.94 Frames/s Progressive
4.3	274M	1920 × 1080	4:4:4 (R'G'B')/12-bit	50 and 60 Frames/s Progressive
				59.94 Frames/s Progressive
4.4	428-1	2048 × 1080	4:4:4 (*X'Y'Z'*)/12-bit	48 Frames/s Progressive

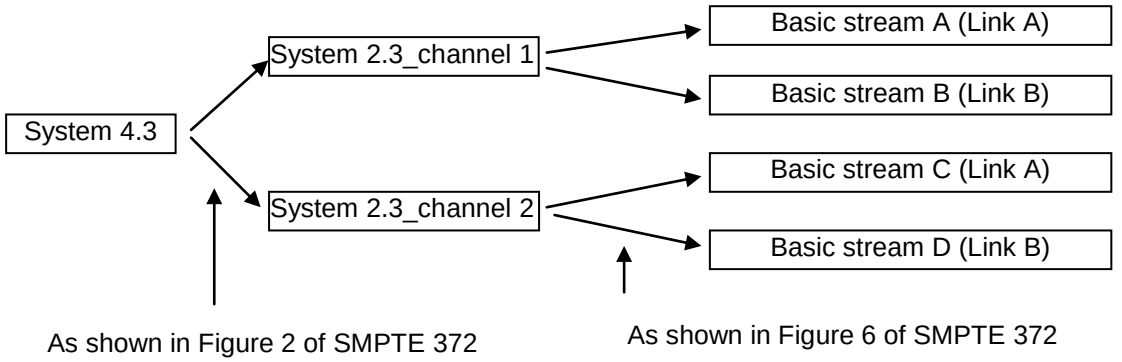
6.3.1 4 way division of source data

The image formats defined in Table 3 shall be mapped to four basic streams first by line demultiplexing to channels and second by word demultiplexing each channel to a basic stream.

Figure 2 defines 4 way division of the System 4.1, 4.2, 4.3 and 4.4 streams.







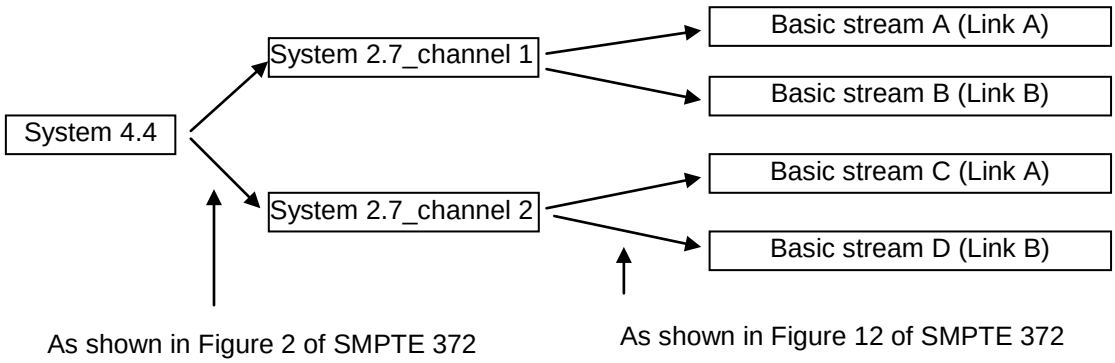


Figure 2 – 4 way division for source stream of System 4.1, 4.2, 4.3 and 4.4

6.4 Octa Link 1.5 Gb/s Class

Table 4 defines the image format that shall be mapped into eight basic streams. The image formats defined in Table 4 shall be divided to four sub images and then converted to 8 basic streams. The detail of the process is defined in § 6.4.1 and § 6.4.2.

Table 4 – Source Image Formats

System Number	Reference SMPTE/ITU Standard	Picture Format	Signal Format sampling structure/pixel Depth	Frame/Field Rates
8.1	428-1	4096 × 2160	4:4:4 (*X'Y'Z'*)/12-bit	24 Frames/s Progressive
8.2	BT.1769	3840 × 2160	4:2:0 (Y'C'$_B$C'$_R$), 4:2:2 (Y'C'$_B$C'$_R$)/10-bit,	24, 25 and 30 Frames/s Progressive
				23.98 and 29.97 Frames/s Progressive
8.3	BT.1769	3840 × 2160	4:4:4 (R'G'B')/10-bit	24, 25 and 30 Frames/s Progressive
				23.98 and 29.97 Frames/s Progressive
8.4	BT.1769	3840 × 2160	4:4:4 (Y'C'$_B$C'$_R$)/10-bit	24, 25 and 30 Frames/s Progressive
				23.98 and 29.97 Frames/s Progressive
8.5	BT.1769	3840 × 2160	4:2:0 (Y'C'$_B$C'$_R$), 4:2:2 (Y'C'$_B$C'$_R$)/12-bit	24, 25 and 30 Frames/s Progressive
				23.98 and 29.97 Frames/s Progressive
8.6	BT.1769	3840 × 2160	4:4:4 (R'G'B')/12-bit	24, 25 and 30 Frames/s Progressive
				23.98 and 29.97 Frames/s Progressive
8.7	BT.1769	3840 × 2160	4:4:4 (Y'C'$_B$C'$_R$)/12-bit	24, 25 and 30 Frames/s Progressive
				23.98 and 29.97 Frames/s Progressive

6.4.1 8 way division of source data for System 8.1 image

A frame of System 8.1 image data shall be divided into 4 images equivalent to the system 2.7 image data. Figure 3 defines the division.

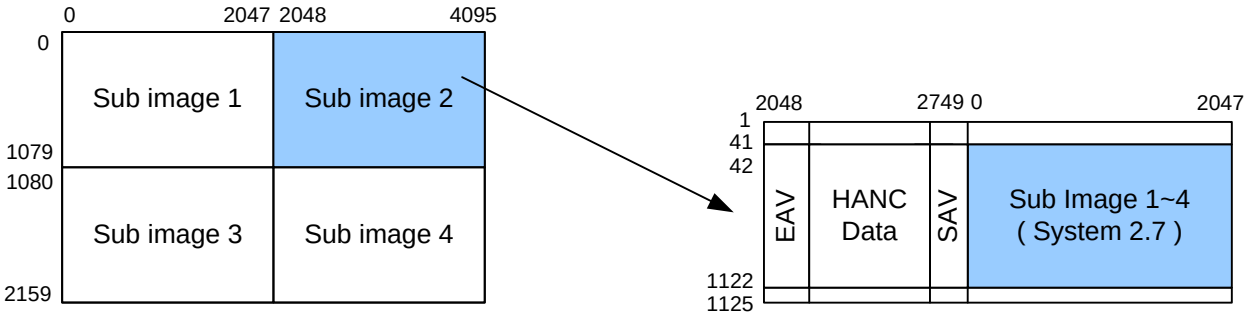


Figure 3 – 4 way division to Sub image

Each of sub image data is divided into a dual link stream with the same data structure as Dual link 1.5 Gb/s class. The digital stream derived from each link shall be assigned to a basic stream defined in this standard. Figure 4 defines the division.

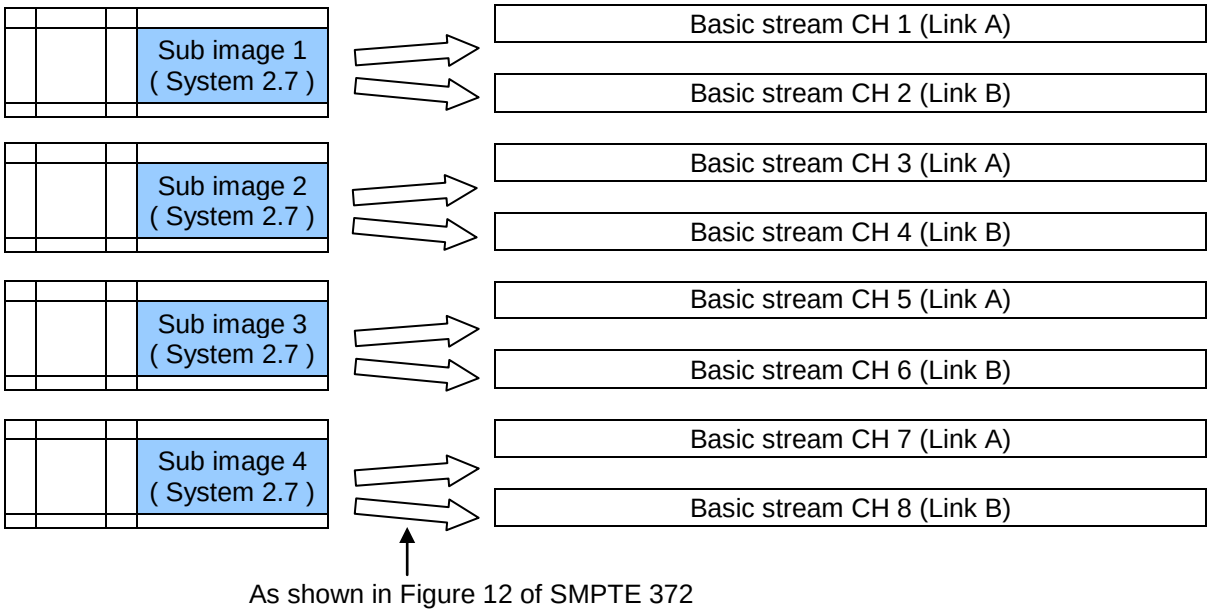


Figure 4 – 8 way division of System 8.1 image

6.4.2 8 way division of source data for System 8.2, 8.3, 8.4, 8.5, 8.6 and 8.7 images

Figure 5 defines sample structures of 4:4:4 (R'G'B') or (Y' $C'_BC'_R$), 4:2:2 (Y'$C'_BC'_R$) and 4:2:0 (Y'$C'_BC'_R$) systems for System 8.2 through 8.7 images as defined in § 7.7 of SMPTE 435-4. C'_B and C'_R signals shall be horizontally sub-sampled by a factor of two in case of a 4:2:2 system and horizontally and vertically sub-sampled by a factor of two in case of a 4:2:0 system.

When transporting 4:2:0 system image data,thru a transport which has a 4:2:2 data structure, the 0 components of the 4:2:0 (even-numbered samples and odd-numbered lines of unassigned $C'_BC'_R$) system image data shall be assigned 200h in case of a 10-bit system and 800h in case of a 12-bit system.

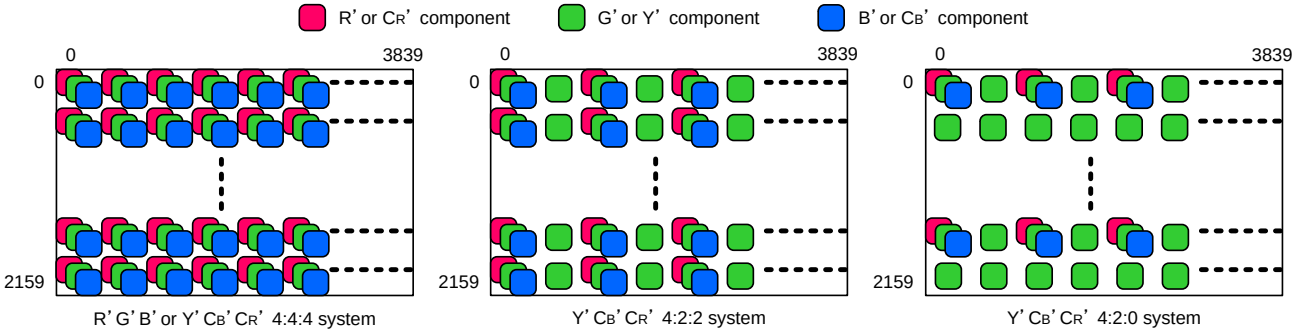


Figure 5 – Sample structures of 4:4:4 (R'G'B') or (Y' $C'_BC'_R$), 4:2:2 (Y'$C'_BC'_R$) and 4:2:0 (Y'$C'_BC'_R$) Systems

A frame of System 8.2, 8.3, 8.4, 8.5, 8.6 and 8.7 image data shall be divided into 4 images equivalent to the System 1.1 or System 2.2 to System 2.5 image data.

Figure 6 defines the 4 way division (Square division) at 30 frames/s the same as defined in § 6.4.1.

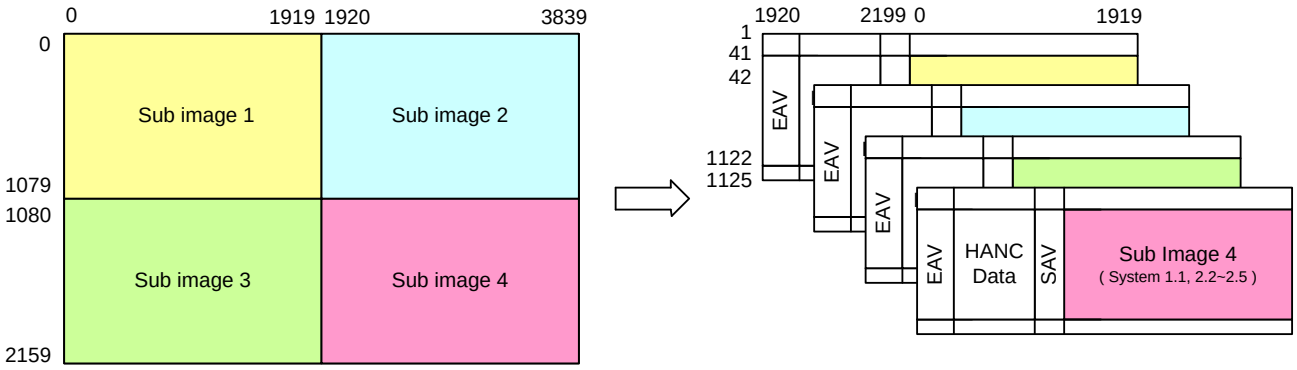


Figure 6 – 4 way division (Square division) to Sub image

Figure 7 defines 2-sample interleave division at 30 frames/s which requires less memory size and the signal processing delay is much less than that of the Square division. Even lines of System 8.2, 8.3, 8.4, 8.5, 8.6 and 8.7 shall be divided to Sub image 1 and 2 as per 2 consecutive horizontal samples and odd lines shall be divided to Sub image 3 and 4 as per 2 consecutive horizontal samples. This division has equivalent Sub image 1, 2, 3 and 4.

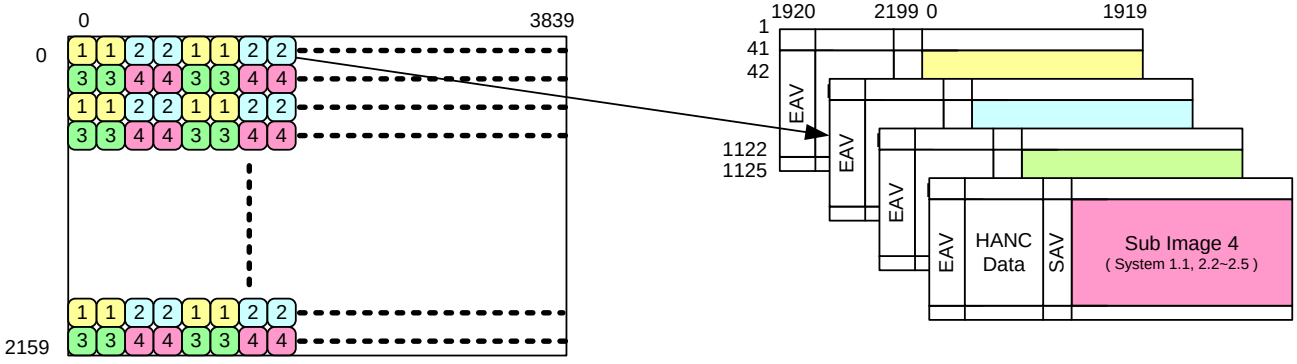


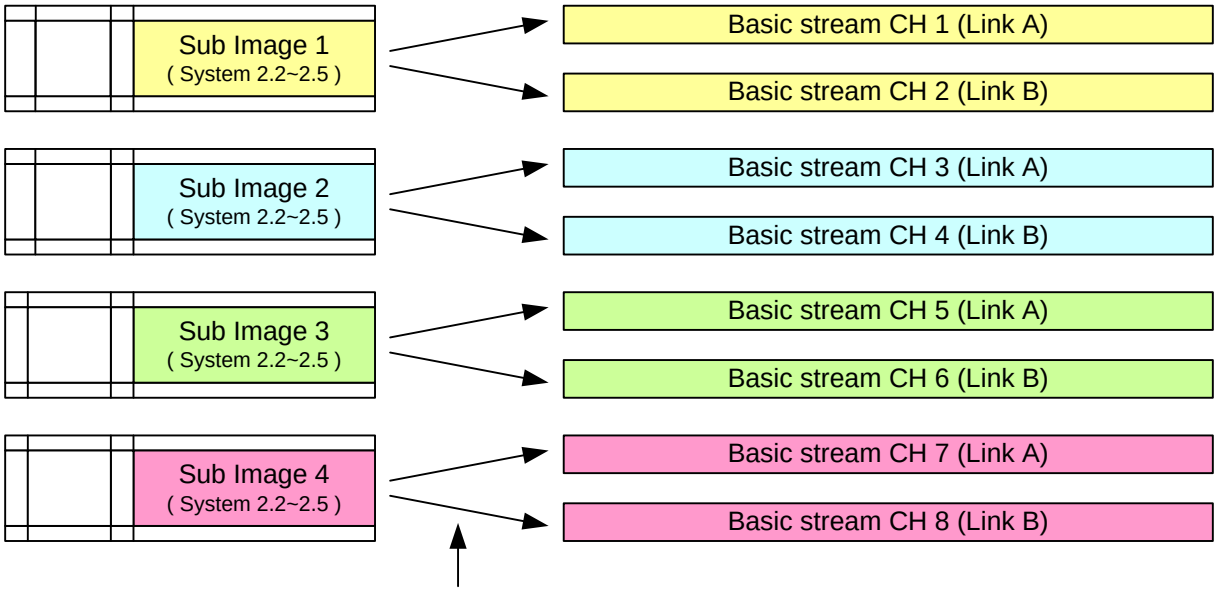
Figure 7 – 4 way division (2-sample interleave division) to Sub image

Table 5 defines the relation between sample/line numbers of the original 3840 × 2160 image and sample/line numbers of the mapped 1920 × 1080 Sub image 1, 2, 3 and 4 of the 2-sample interleave division.

Table 5 – Relation between original image sample/line and mapped Sub image sample/line of 2-sample interleave division

Sub image	Original 3840×2160 sample number Original 3840×2160 line number	Mapped 1920×1080 sample number Mapped 1920×1080 line number
1	4M, 4M+1 samples 2N line	2M, 2M+1 samples 42 + N line
2	4M+2, 4M+3 samples 2N line	
3	4M, 4M+1 samples 2N+1 line	
4	4M+2, 4M+3 samples 2N+1 line	
Note: M = 0, 1, 2, 3…959, N = 0, 1, 2, 3…1079		

Each of sub image data created by the Square division and the 2-sample interleave division is virtually divided to the dual link stream as the same structure as Dual link 1.5 Gb/s class. The digital stream derived from each link shall be assigned to a basic stream defined in this standard. Figure 8 defines the division.



As shown in Figures 4, 6, 7, 8 and 9 in SMPTE 372

Figure 8 – 8 way division of System 8.2, 8.3, 8.4, 8.5, 8.6 and 8.7 images

In case of System 8.2 image (3840×2160/4:2:2 or 4:2:0/10-bit), Sub images 1 to 4 are equivalent to System number 1.1 and Link A shall be assigned for the image transmission.

Annex A (Informative)
SMPTE 435 Document Road Map