SMPTE STANDARD

Ultra High Definition Television – Mapping into Single-link or Multi-link 10 Gb/s Serial Signal/Data Interface

Table of Contents

Approved
August 1, 2010

Foreword

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Introduction

SMPTE 2036 Ultra High Definition Television suite of documents is in multiple parts.

This document is Part 3 of SMPTE 2036 and describes UHDTV1, 2 image mapping into a Single-link or a Multi-link 10 Gb/s Serial Signal/Data Interface (10G-SDI) Mode D defined in SMPTE 435-2.

The source UHDTV (Ultra High Definition Television) image sample structures for the interface are defined in SMPTE 2036-1 and are listed in Table 1. UHDTV has an image format (sample structure) of 3840 × 2160 (UHDTV1) or 7680 × 4320 (UHDTV2).

Table 1 – Image sample structures and frame rates of UHDTV systems

System category	System nomenclature	Luma or R’G’B’ samples per line	Lines per frame	Frame rate (Hz)
UHDTV 1	3840 × 2160/23.98/P	3840	2160	24/1.001
	3840 × 2160/24/P	3840	2160	24
	3840 × 2160/25/P	3840	2160	25
	3840 × 2160/29.97/P	3840	2160	30/1.001
	3840 × 2160/30/P	3840	2160	30
	3840 × 2160/50/P	3840	2160	50
	3840 × 2160/59.94/P	3840	2160	60/1.001
	3840 × 2160/60/P	3840	2160	60
UHDTV 2	7680 × 4320/23.98/P	7680	4320	24/1.001
	7680 × 4320/24/P	7680	4320	24
	7680 × 4320/25/P	7680	4320	25
	7680 × 4320/29.97/P	7680	4320	30/1.001
	7680 × 4320/30/P	7680	4320	30
	7680 × 4320/50/P	7680	4320	50
	7680 × 4320/59.94/P	7680	4320	60/1.001
	7680 × 4320/60/P	7680	4320	60

1 Scope

This document defines UHDTV video payload mapping into Single-link, Dual-link, Quad-link or Octa-link 10G-SDI Mode D defined in SMPTE 435-2. This document also defines mapping of ANC/Audio Data, payload ID and other ancillary data formatted as defined in SMPTE 291M. The “basic stream” complies with the interleaved data stream defined in SMPTE 292 and is utilized as the input source streams for the 10G-SDI.

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.

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3 Normative References

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

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

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

SMPTE 299-1:2010, 24-Bit Digital Audio Format for SMPTE 292 Bit-Serial Interface

SMPTE ST 352:2010, Video Payload Identification Codes for Digital Interfaces

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

SMPTE 435-1-2009, 10 Gb/s Serial Signal/Data Interface — Part 1: Basic Stream Distribution

SMPTE 435-2-2009, 10 Gb/s Serial Signal/Data Interface — Part 2: 10.692 Gb/s Stream — Basic Stream Data Mapping

SMPTE ST 2036-1:2009, Ultra High Definition Television — Image Parameter Values for Program Production

4 Definition of Terms

UHDTV: Ultra High Definition Television, having an image format (sample structure) of 3840 × 2160 or 7680 × 4320

UHDTV1: Class of UHDTV having an image format (sample structure) of 3840 × 2160

UHDTV2: Class of UHDTV having an image format (sample structure) of 7680 × 4320

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

5 System Overview

UHDTV1, 2 images shall be mapped into 4 or 16 Sub images through 2-sample interleave division and shall be mapped into Single-link, Dual-link, Quad-link or Octa-link 10G-SDI Mode D defined in SMPTE 435-2 through basic streams that comply with 1.5 Gb/s Serial Digital Interface defined in SMPTE 292 as shown in Figure 1.

When embedding optional ancillary data, the ancillary data packet format shall be in conformance with SMPTE 291M. Ancillary audio data shall be as defined in SMPTE 299-1 and shall be mapped in the following order:

(1^{st}) CH1 basic stream of 10G-SDI Link 1, up to a maximum of 16 channels at a sampling frequency of 48 kHz or up to a maximum of 8 channels at a sampling frequency of 96 kHz

(2^{nd}) CH1 basic stream of 10G-SDI Link 2, up to a maximum of 16 channels at a sampling frequency of 48 kHz or up to a maximum of 8 channels at a sampling frequency of 96 kHz

The multiple numbers of basic streams conveying the source data of UHDTV images shall be multiplexed and serialized into the Single-link or Multiple-link 10G-SDI as defined in the following sections. The basic stream structure is shown in Figure 2.

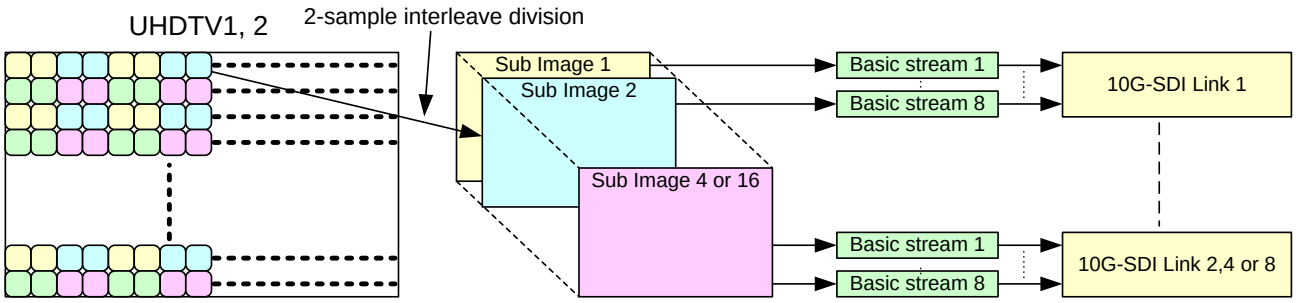


Figure 1 – UHDTV1, 2 mapping overview

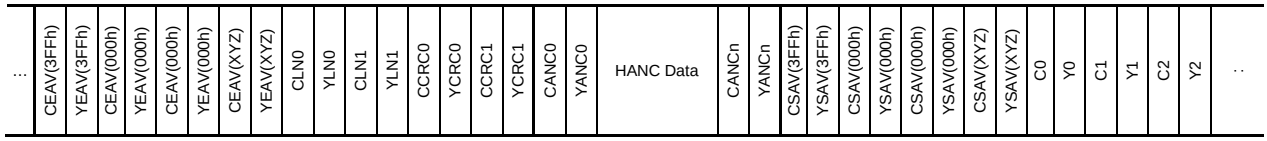


Figure 2 – Structure of 1.5 Gb/s basic stream (Informative)

6 UHDTV1 Mapping into Single-link or Dual-link 10G-SDI

6.1 Video Payload Mapping

Table 2 shows the image formats which shall be divided into four Sub images by 2-sample interleave division and shall be mapped into the Single-link or the Dual-link 10G-SDI Mode D defined by SMPTE 435-2. Each Sub image shall have the 1920 × 1080 picture format defined as System 1.1, 2.1, 2.2, 2.3, 2.4, 2.5, 4.1, 4.2 or 4.3 in SMPTE 435-1.

When transporting 4:2:0 system image data through 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 200_h ($512_{(10)}$) in case of a 10-bit system and 800_h ($2048_{(12)}$) in case of a 12-bit system.

Table 2 – Source image formats of UHDTV1 Class

System Number	System nomenclature	Sampling Structure/Pixel Depth	Frame Rate/sec	Sub-image format defined in SMPTE 435-1
U1.1	3840 × 2160/24/P 3840 × 2160/25/P 3840 × 2160/30/P	4:2:0 or 4:2:2 (Y'C'$_B$C'$_R$)/10-bit	24, 25 and 30 Frames Progressive	System 1.1
	3840 × 2160/23.98/P 3840 × 2160/29.97/P		24/1.001, 30/1.001 Frames Progressive	
U1.2	3840 × 2160/24/P 3840 × 2160/25/P 3840 × 2160/30/P	4:4:4 (R'G'B')/10-bit	24, 25 and 30 Frames Progressive	System 2.2
	3840 × 2160/23.98/P 3840 × 2160/29.97/P		24/1.001, 30/1.001 Frames Progressive	
U1.3	3840 × 2160/24/P 3840 × 2160/25/P 3840 × 2160/30/P	4:4:4 (R'G'B')/12-bit	24, 25 and 30 Frames Progressive	System 2.3
	3840 × 2160/23.98/P 3840 × 2160/29.97/P		24/1.001, 30/1.001 Frames Progressive	
U1.4	3840 × 2160/24/P 3840 × 2160/25/P 3840 × 2160/30/P	4:4:4 (Y'C'$_B$C'$_R$)/10-bit	24, 25 and 30 Frames Progressive	System 2.4
	3840 × 2160/23.98/P 3840 × 2160/29.97/P		24/1.001, 30/1.001 Frames Progressive	
U1.5	3840 × 2160/24/P 3840 × 2160/25/P 3840 × 2160/30/P	4:2:0, 4:2:2 or 4:4:4 (Y'C'$_B$C'$_R$)/12-bit	24, 25 and 30 Frames Progressive	System 2.5
	3840 × 2160/23.98/P 3840 × 2160/29.97/P		24/1.001, 30/1.001 Frames Progressive	
U1.6	3840 × 2160/50/P 3840 × 2160/60/P	4:2:0 or 4:2:2 (Y'C'$_B$C'$_R$)/10-bit	50 and 60 Frames Progressive	System 2.1
	3840 × 2160/59.94/P		60/1.001 Frames Progressive	
U1.7	3840 × 2160/50/P 3840 × 2160/60/P	4:2:0 or 4:2:2 (Y'C'$_B$C'$_R$)/12-bit	50 and 60 Frames Progressive	System 4.1
	3840 × 2160/59.94/P		60/1.001 Frames Progressive	
U1.8	3840 × 2160/50/P 3840 × 2160/60/P	4:4:4 (R'G'B' or Y'C'$_B$C'$_R$)/10-bit	50 and 60 Frames Progressive	System 4.2
	3840 × 2160/59.94/P		60/1.001 Frames Progressive	
U1.9	3840 × 2160/50/P 3840 × 2160/60/P	4:4:4 (R'G'B' or Y'C'$_B$C'$_R$)/12-bit	50 and 60 Frames Progressive	System 4.3
	3840 × 2160/59.94/P		60/1.001 Frames Progressive	

Figure 3 shows the 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 U1.1 through U1.9 images as defined in Table 2. C'_B and C'_R signals are horizontally sub-sampled by a factor of two in the case of a 4:2:2 system and horizontally and vertically sub-sampled by a factor of two in the case of a 4:2:0 system.

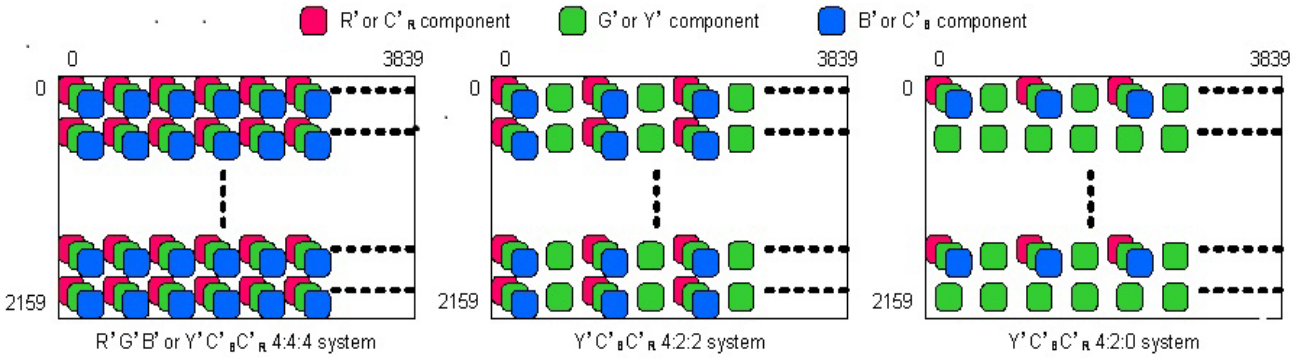


Figure 3 – Sample structures of 4:4:4 (R'G'B') or (Y' $C'_BC'_R$), 4:2:2 (Y'$C'_BC'_R$) and 4:2:0 (Y'$C'_BC'_R$) systems

Figure 4 shows 4 way division to Sub images 1 through 4 by 2-sample interleave division. Even lines of System U1.1 through U1.9 images shall be divided into Sub images 1 and 2 as per 2 consecutive horizontal samples and odd lines shall be divided into Sub images 3 and 4 as per 2 consecutive horizontal samples.

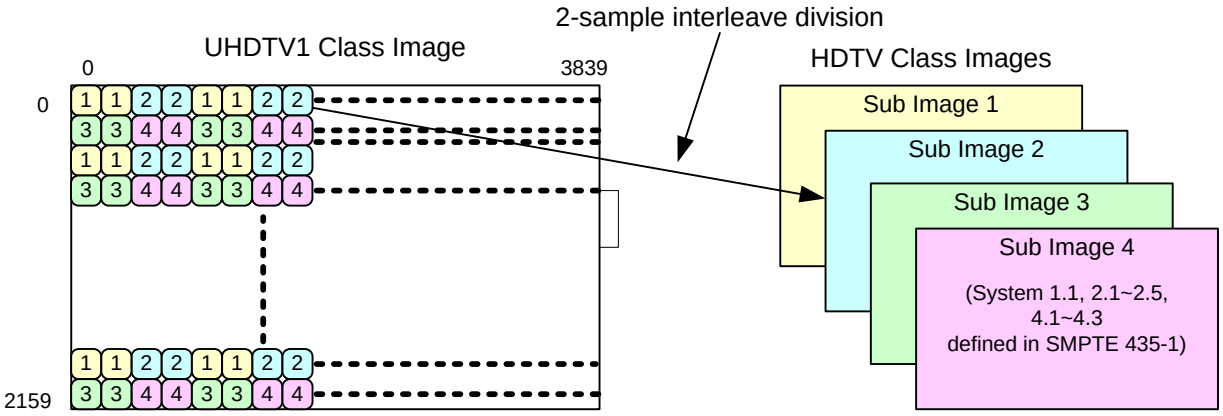


Figure 4 – 4 way division to Sub image 1 to 4

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

Table 3 – Relation between original image sample/line number and mapped Sub image sample/line number 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: Where M=0,1,2,3,…959, and N=0,1,2,3…1079.		

6.2 Single-link 10G-SDI for System U1.1 to U1.5

In the case of System from U1.1 to U1.5 images (3840 × 2160/23.98/P, 24/P, 25/P, 29.97/P and 30/P), each of Sub image 1 to 4 created by the 2-sample interleave division shall be divided into the single-link or the dual-link 1.5 Gb/s basic stream. Four single- or dual-link basic streams from four Sub images shall be mapped into the Single-link 10G-SDI as specified in § 6.4 of SMPTE 435-2.

6.3 Dual-link 10G-SDI for System U1.6 to U1.9

In the case of System from U1.6 to U1.9 images (3840 x 2160/50/P, 59.94/P and 60/P), each of Sub image data created by the 2-sample interleave division shall be divided into the dual-link stream or the quad-link stream with the same structure as the dual link 1.5 Gb/s class or the quad link 1.5 Gb/s class basic streams defined by SMPTE 435-1.

Sub images 1 to 4 generated from System U1.6 images are equivalent to System 2.1 as defined by SMPTE 435-1 and shall be divided into 8 basic streams as shown in Figure 5.

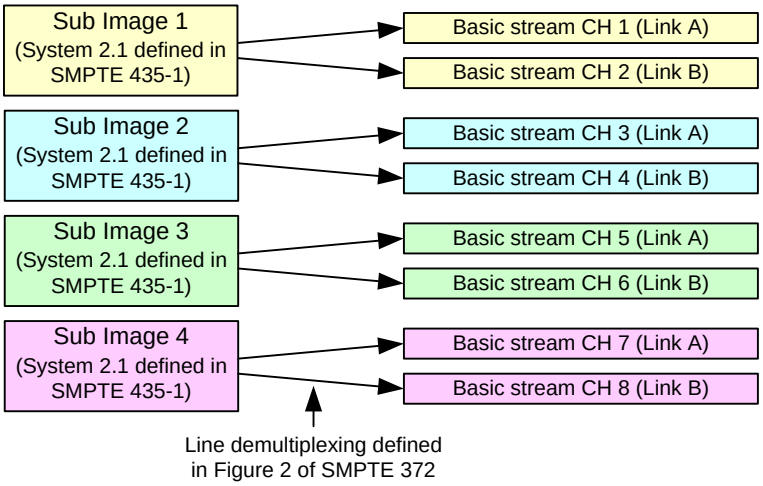


Figure 5 – 8 way division for System U1.6

In the case of System U1.7, U1.8 and U1.9 images, Sub images 1 to 4 shall be divided into 16 basic streams as shown in Figure 6.

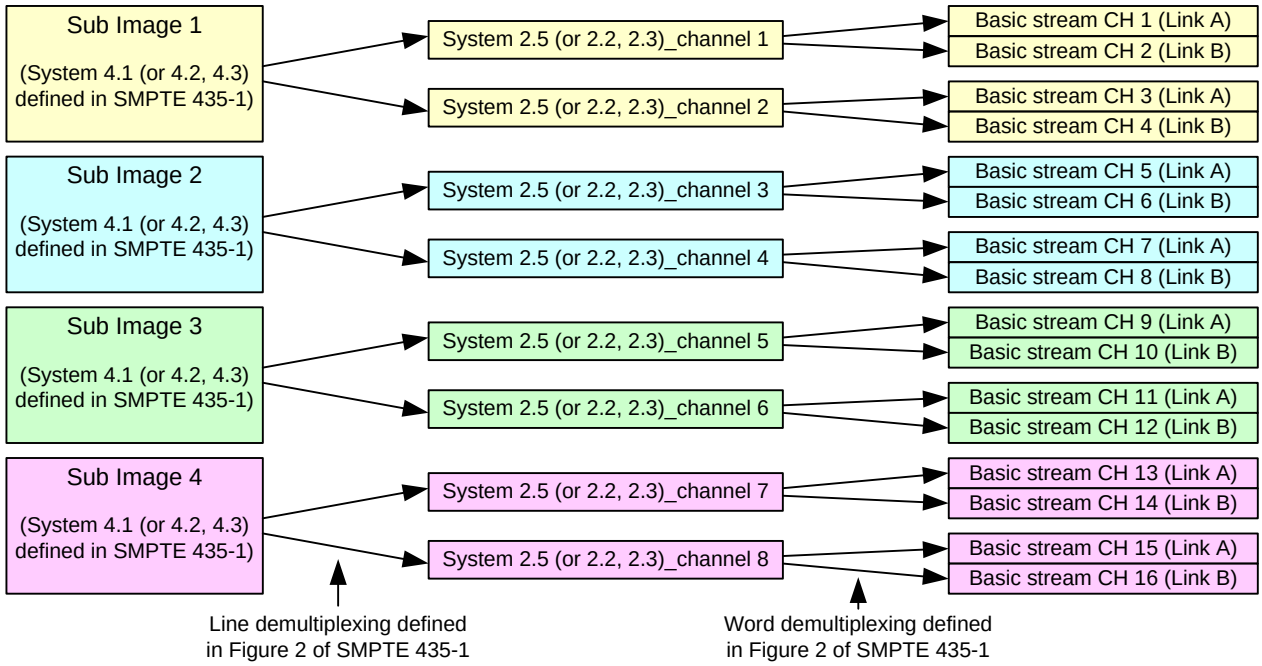


Figure 6 – 16 way division for System U1.7, U1.8 and U1.9

10G-SDI Mode D defined by SMPTE 435-2 may transmit up to four pairs of the dual link 1.5 Gb/s System 2.2, 2.3, 2.4 or 2.5 or up to two pairs of the quad link 1.5 Gb/s System 4.1, 4.2 or 4.3 as described by SMPTE 435-2. In Summary, UHDTV1 class images of System U1.6, U1.7 U1.8 and U1.9 shall be transmitted using a Dual-link 10G-SDI Mode D.

Eight basic streams of a virtual interface for U1.6 shall be mapped into Dual-link 10G-SDI. Basic streams CH1, CH2, CH 3 and CH4 shall be mapped into CH1, CH 3, CH5 and CH7 (Link As) of 10G-SDI Link 1 and basic streams CH5, CH6, CH7 and CH8 shall be mapped into CH1, CH3, CH5 and CH7 (Link As) of 10G-SDI Link 2 as shown in Figure 7; i.e.:

— basic streams CH1, CH2, CH3 and CH4 shall be mapped into CH1, CH3, CH5 and CH7 (Link As) of 10G-SDI Link 1;

— basic streams CH5, CH6, CH7 and CH8 shall be mapped into CH1, CH3, CH5 and CH7 (Link As) of 10G-SDI Link 2.

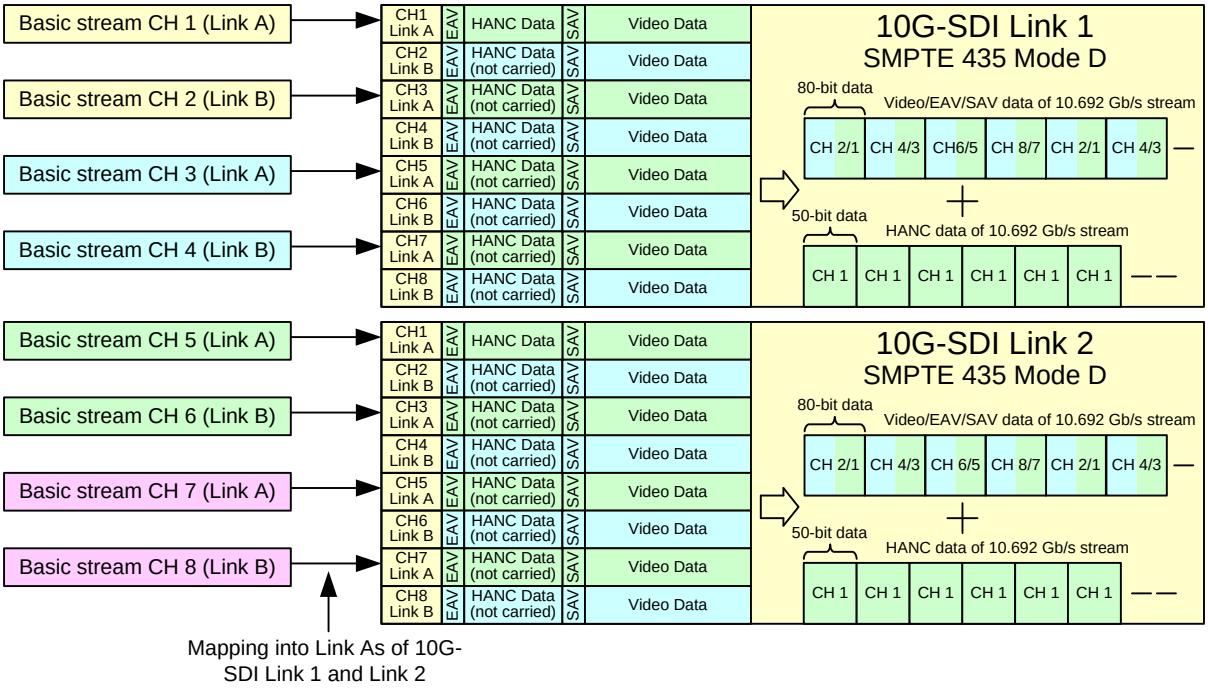


Figure 7 – Mapping into Dual-link 10G-SDI for System U1.6

Sixteen basic streams of a virtual interface for U1.7, U1.8 and U1.9 shall be mapped into Dual-link 10G-SDI. Groups of Basic streams CH(8*k*-7), CH(8*k*-6), CH(8*k*-5), CH(8*k*-4), CH(8*k*-3), CH(8*k*-2), CH(8*k*-1) and CH(8*k*), where *k* is a number from 1 to 2, shall be mapped into CH1, CH2, CH3, CH4, CH5, CH6, CH7 and CH8 of 10G-SDI Link (*k*) as shown in Figure 8; i.e.:

— basic streams CH1 through CH8 shall be mapped into CH1 through CH8 of 10G-SDI Link 1;

— basic streams CH9 through CH16 shall be mapped into CH1 through CH8 of 10G-SDI Link 2.

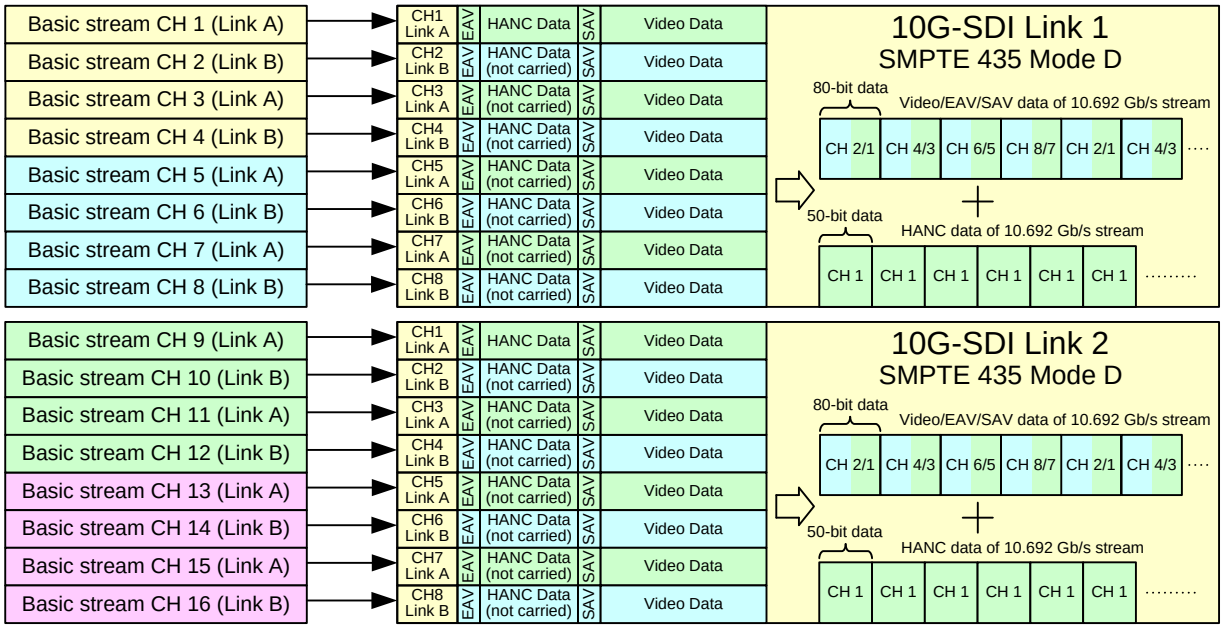


Figure 8 – Mapping into Dual-link 10G-SDI for System U1.7, U1.8 and U1.9

6.4 ANC/Audio Data Mapping

6.4.1 ANC Data Mapping

Ancillary data if present shall be mapped into the blanking area of CH1 basic stream of 10G-SDI. The data format shall be in conformance with SMPTE 291M.

In the case of the Dual-link 10G-SDI, the ancillary data shall be mapped into CH1 basic stream of 10G-SDI Link 1 first, and any remaining data shall be mapped into CH1 basic stream of 10G-SDI Link 2.

6.4.2 Audio Data Mapping

When present, audio data shall be mapped into the C_B/C_R data stream of the horizontal ancillary data space of CH1 basic stream of 10G-SDI Link in conformance with SMPTE 299-1 and shall be transmitted in groups of four up to a maximum of 16 channels at a sampling frequency of 48 kHz or up to a maximum of 8 channels at a sampling frequency of 96 kHz.

In the case of the Dual-link 10G-SDI, CH1 basic stream of 10G-SDI Link 1 shall be used first for audio data transmission in groups of four up to a maximum of 16 channels at a sampling frequency of 48 kHz or up to a maximum of 8 channels at a sampling frequency of 96 kHz in conformance with SMPTE 299-1. If more than 16 channels of audio (8 channels at a sampling frequency of 96 kHz) is required, CH1 basic stream of 10G-SDI Link 2 shall be used in conformance with SMPTE 299-1.

The maximum channel number carried by Dual-link 10G-SDI Mode D is 32 channels at a sampling frequency of 48 kHz or 16 channels at a sampling frequency of 96 kHz.

Audio control packets shall be mapped into the Y data stream of the horizontal ancillary data space of CH1 basic stream of 10G-SDI Link 1 and Link 2 (if necessary), and shall be in conformance with SMPTE 299-1.

6.4.3 Video Payload ID Mapping

The video payload identifier shall be mapped into the blanking area of each basic stream of 10G-SDIs. Table 4 defines the video payload identifier for the UHDTV 1 video payload.

This payload identifier shall be in conformance with the general video payload identifier format defined in SMPTE ST 352. The byte 1 value of $A1_h$ is mandatory and identifies the video payload format as UHDTV1. The remaining 3 bytes values specify the other features of the video payload for UHDTV1.

The specification and carriage of this video payload identifier shall also be in conformance with SMPTE ST 352.[1]

Table 4 – Video payload identifier definitions for UHDTV1 video payloads on a Single-link or a Dual-link 10 Gb/s (nominal) serial digital interface

<table>
<tr><th>Bits</th><th>Byte 1</th><th>Byte 2</th><th>Byte 3</th><th>Byte 4</th></tr>
<tr><td>Bit 7</td><td>1</td><td>Interlaced (0) or progressive (1) transport</td><td>Reserved</td><td rowspan="3">Channel assignment of octa link
Ch1 (0h), Ch2 (1h),
Ch3 (2h), Ch4 (3h),
Ch5 (4h), Ch6 (5h),
Ch7 (6h) or Ch8 (7h)</td></tr>
<tr><td>Bit 6</td><td>0</td><td>progressive (1) picture</td><td>Reserved</td></tr>
<tr><td>Bit 5</td><td>1</td><td>Reserved</td><td>Reserved</td></tr>
<tr><td>Bit 4</td><td>0</td><td>Reserved</td><td>10G link assignment of Single/Dual link
Ch1 (0) or Ch2(1)</td><td>Reserved</td></tr>
<tr><td>Bit 3</td><td>0</td><td rowspan="4">Picture rate
(see Table 2
SMPTE ST 352)</td><td rowspan="4">Sampling structure
(see Table 3
SMPTE ST 352)</td><td>Reserved</td></tr>
<tr><td>Bit 2</td><td>0</td><td>Reserved</td></tr>
<tr><td>Bit 1</td><td>0</td><td rowspan="2">Bit depth
8-bit (0h), 10-bit (1h),
12-bit (2h),
Reserved (3h)</td></tr>
<tr><td>Bit 0</td><td>1</td></tr>
</table>

When identifying UHDTV1 video payloads mapped onto a Single-link or a Dual-link 10 Gb/s serial digital interface, the following limitations shall apply:

- The interlace/progressive transport flag bit shall be set to 0 or 1 according to the digital interface transport;
- The interlaced/progressive picture flag bit shall be set to 1;
- The picture rate shall be set to the value of the UHDTV1 pay load;
- The sampling structure shall be set to the value of the payload being carried;
- The assignment order of the basic stream channels and the 10G links for the payload IDs shall correspond to the numerous order of the 10 Gb/s SDI input channel and link numbers as defined in § 6.2 and 6.3;

[1] Designers need to be aware that the first eleven samples after EAV of Line 10 and Line 572 on each basic stream channel are reserved for video payload identifier usage.

The 10G (SMPTE 435) channel number in bit b4 of byte 3 shall be set to a value of 0 in the case of a Single-link or first link and to 1 for the second link in the case of a Dual-link;

The basic stream (SMPTE 292) channel number in bit b5, b6 and b7 of byte 4 shall be set to the following values:

- 0h for the first link;
- 1h for the second link;
- 2h for the third link;
- 3h for the fourth link;
- 4h for the fifth link;
- 5h for the sixth link;
- 6h for the seventh link;
- 7h for the eighth link.

– The bit depth of the sample quantization shall be identified by bits b1 and b0 of byte 4 having the following values:

- 0h identifies quantization using 8 bits per sample;
- 1h identifies quantization using 10 bits per sample;
- 2h identifies quantization using 12 bits per sample.

7 UHDTV2 Mapping into Quad-link or Octa-link 10G-SDI

7.1 Video Payload Mapping

Table 5 shows the UHDTV2 image formats which shall be divided into four UHDTV1 class images and then shall be further divided into 16 Sub images which have been defined in SMPTE 435-1 as System 1.1, 2.1, 2.2, 2.3, 2.4, 2.5, 4.1, 4.2 or 4.3 by 2-sample interleave division. Therefore this division of a UHDTV2 image generates 16 Sub images which have the 1920 × 1080 picture formats and shall be mapped into Quad-link or Octa-link of 10G-SDI Mode D defined in SMPTE 435-2.

Figure 9 shows 4-way division of UHDTV2 class image into four UHDTV1 class images by 2-sample interleave division. Even lines of System U2.1 through U2.9 images shall be divided into Sub UHDTV1 Class images 1 and 2 as per two consecutive horizontal samples, and odd lines shall be divided into Sub UHDTV1 Class images 3 and 4 as per two consecutive horizontal samples.

Table 5– Source image formats of UHDTV2 Class

System Number	System nomenclature	Sampling Structure/Pixel Depth	Frame Rate/sec	Sub-image format defined in SMPTE 435-1
U2.1	7680 × 4320/24/P 7680 × 4320/25/P 7680 × 4320/30/P	4:2:0 or 4:2:2 (Y'C'$_B$C'$_R$)/10-bit	24, 25 and 30 Frames Progressive	System 1.1
	7680 × 4320/23.98/P 7680 × 4320/29.97/P		24/1.001, 30/1.001 Frames Progressive	
U2.2	7680 × 4320/24/P 7680 × 4320/25/P 7680 × 4320/30/P	4:4:4 (R'G'B')/10-bit	24, 25 and 30 Frames Progressive	System 2.2
	7680 × 4320/23.98/P 7680 × 4320/29.97/P		24/1.001, 30/1.001 Frames Progressive	
U2.3	7680 × 4320/24/P 7680 × 4320/25/P 7680 × 4320/30/P	4:4:4 (R'G'B')/12-bit	24, 25 and 30 Frames Progressive	System 2.3
	7680 × 4320/23.98/P 7680 × 4320/29.97/P		24/1.001, 30/1.001 Frames Progressive	
U2.4	7680 × 4320/24/P 7680 × 4320/25/P 7680 × 4320/30/P	4:4:4 (Y'C'$_B$C'$_R$)/10-bit	24, 25 and 30 Frames Progressive	System 2.4
	7680 × 4320/23.98/P 7680 × 4320/29.97/P		24/1.001, 30/1.001 Frames Progressive	
U2.5	7680 × 4320/24/P 7680 × 4320/25/P 7680 × 4320/30/P	4:2:0, 4:2:2 or 4:4:4 (Y'C'$_B$C'$_R$)/12-bit	24, 25 and 30 Frames Progressive	System 2.5
	7680 × 4320/23.98/P 7680 × 4320/29.97/P		24/1.001, 30/1.001 Frames Progressive	
U2.6	7680 × 4320/50/P 7680 × 4320/60/P	4:2:0 or 4:2:2 (Y'C'$_B$C'$_R$)/10-bit	50 and 60 Frames Progressive	System 2.1
	7680 × 4320/59.94/P		60/1.001 Frames Progressive	
U2.7	7680 × 4320/50/P 7680 × 4320/60/P	4:2:0 or 4:2:2 (Y'C'$_B$C'$_R$)/12-bit	50 and 60 Frames Progressive	System 4.1
	7680 × 4320/59.94/P		60/1.001 Frames Progressive	
U2.8	7680 × 4320/50/P 7680 × 4320/60/P	4:4:4 (R'G'B' or Y'C'$_B$C'$_R$)/10-bit	50 and 60 Frames Progressive	System 4.2
	7680 × 4320/59.94/P		60/1.001 Frames Progressive	
U2.9	7680 × 4320/50/P 7680 × 4320/60/P	4:4:4 (R'G'B' or Y'C'$_B$C'$_R$)/12-bit	50 and 60 Frames Progressive	System 4.3
	7680 × 4320/59.94/P		60/1.001 Frames Progressive	

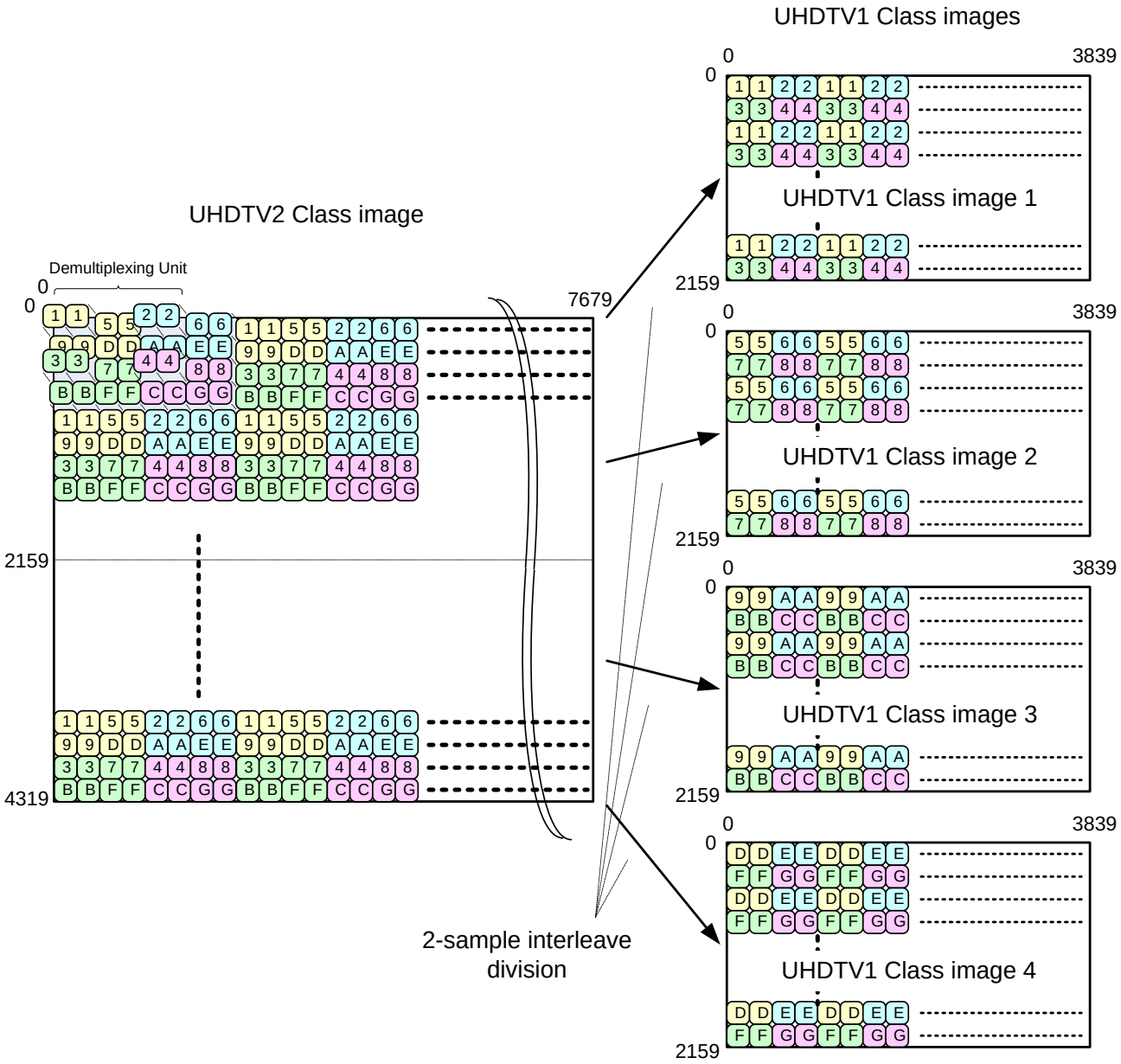


Figure 9 – 4-way division of UHDTV2 Class image into UHDTV1 Class images

7.2 Quad-link 10G-SDI for System U2.1 to U2.5

Four Sub UHDTV1 Class images generated from U2.1 to U2.5 shall be mapped into Quad-link 10G-SDI. Sub UHDTV1 Class image *k*, where *k* is a number from 1 to 4, shall be mapped into 10G-SDI Link *k* in the same way as described in § 6.4 of SMPTE 435-2, i.e.:

- UHDTV1 class image 1 shall be mapped into CH1 through CH8 of 10G-SDI Link 1;
- UHDTV1 class image 2 shall be mapped into CH1 through CH8 of 10G-SDI Link 2;
- UHDTV1 class image 3 shall be mapped into CH1 through CH8 of 10G-SDI Link 3;
- UHDTV1 class image 4 shall be mapped into CH1 through CH8 of 10G-SDI Link 4.

In the case of System U2.1 image, Sub UHDTV1 Class image *k* is equivalent to System number 8.2 defined in § 6.4 of SMPTE 435-1 and shall be mapped into CH1, CH3, CH5, CH7 (Link As) of 10G-SDI Link *k*; i.e.:

- UHDTV1 class image 1 shall be mapped into CH1, CH3, CH5 and CH7 (Link As) of 10G-SDI Link 1;
- UHDTV1 class image 2 shall be mapped into CH1, CH3, CH5 and CH7 (Link As) of 10G-SDI Link 2;
- UHDTV1 class image 3 shall be mapped into CH1, CH3, CH5 and CH7 (Link As) of 10G-SDI Link 3;
- UHDTV1 class image 4 shall be mapped into CH1, CH3, CH5 and CH7 (Link As) of 10G-SDI Link 4.

7.3 Octa-link 10G-SDI for System U2.6 to U2.9

Four Sub UHDTV1 Class images generated from U2.6 shall be mapped into Octa-link 10G-SDI. Sub UHDTV1 Class image *k*, where *k* is a number from 1 to 4, shall be mapped into CH1, CH3, CH5 and CH7 (Link As) of 10G-SDI Link (2*k*-1) and Link (2*k*) in the same way as shown in Figure 7.

- UHDTV1 class image 1 shall be mapped into CH1, CH3, CH5 and CH7 (Link As) of 10G-SDI Link 1 and Link 2;
- UHDTV1 class image 2 shall be mapped into CH1, CH3, CH5 and CH7 (Link As) of 10G-SDI Link 3 and Link 4;
- UHDTV1 class image 3 shall be mapped into CH1, CH3, CH5 and CH7 (Link As) of 10G-SDI Link 5 and Link 6;
- UHDTV1 class image 4 shall be mapped into CH1, CH3, CH5 and CH7 (Link As) of 10G-SDI Link 7 and Link 8.

Four Sub UHDTV1 Class images generated from U2.7, U2.8 and U2.9 shall be mapped into Octa-link 10G-SDI. Sub UHDTV1 Class image *k*, where *k* is a number from 1 to 4, shall be mapped into CH1, CH2, CH3, CH4, CH5, CH6, CH7 and CH8 of 10G-SDI Link (2*k*-1) and Link (2*k*) in the same way as shown in Figure 8; i.e.:

- UHDTV1 class image 1 shall be mapped into CH1 through CH8 of 10G-SDI Link 1 and Link 2;
- UHDTV1 class image 2 shall be mapped into CH1 through CH8 of 10G-SDI Link 3 and Link 4;
- UHDTV1 class image 3 shall be mapped into CH1 through CH8 of 10G-SDI Link 5 and Link 6;
- UHDTV1 class image 4 shall be mapped into CH1 through CH8 of 10G-SDI Link 7 and Link 8.

7.4 ANC/Audio Data Mapping

7.4.1 ANC Data Mapping

If present, optional ancillary data shall be mapped into the blanking area of each CH1 basic stream of four (or eight) 10G-SDI Links. The data format shall be in conformance with SMPTE 291M.

The ancillary data shall be mapped into CH1 basic stream of 10G-SDI Link 1 first, and any remaining data shall be mapped into CH1 of 10G-SDI Link 2 through Link 4 (or Link 8) in the order of Link 1, Link 2, Link 3 and so on.

7.4.2 Audio Data Mapping

When present, audio data shall be mapped into the C_B/C_R data streams of the horizontal ancillary data space in conformance with SMPTE 299-1 and shall be mapped in the following order:

(1st) CH1 basic stream of 10G-SDI Link 1, up to a maximum of 16 channels at a sampling frequency of 48 kHz or up to a maximum of 8 channels at a sampling frequency of 96 kHz.

(2nd) CH1 basic stream of 10G-SDI Link 2, up to a maximum of 16 channels at a sampling frequency of 48 kHz or up to a maximum of 8 channels at a sampling frequency of 96 kHz.

(3rd) CH1 basic stream of 10G-SDI Link 3, up to a maximum of 16 channels at a sampling frequency of 48 kHz or up to a maximum of 8 channels at a sampling frequency of 96 kHz.
…

(4th) (or 8th in the case of Octa-link) CH1 basic stream of 10G-SDI Link 4(or 8), up to a maximum of 16 channels at a sampling frequency of 48 kHz or up to a maximum of 8 channels at a sampling frequency of 96 kHz.

That is, ANC/Audio data shall be mapped into the CH1 basic stream of 10G-SDI Link 1 first, up to its maximum transmission capacity of ANC data area, then into the CH1 basic stream of 10G-SDI Link 2, up to its maximum transmission capacity of ANC data area and so on. It shall not be permitted to map ANC/Audio data into the CH1 basic streams of 10G-SDI Link (n; n = 2 ~ 4(or 8)), if the CH1 basic stream of 10G-SDI Link (n-1) is not filled up to its maximum transmission capacity.

The maximum channel number carried by Quad-link 10G-SDI Mode D is 64 channels at a sampling frequency of 48 kHz or 32 channels at a sampling frequency of 96 kHz. The maximum channel number carried by Octa-link 10G-SDI is 128 channels at a sampling frequency of 48 kHz or 64 channels at a sampling frequency of 96 kHz.

Audio control packets shall be mapped into the Y data streams of the horizontal ancillary data space of CH1 of 10G-SDI Link 1 through Link 4 (or 8) (if necessary), and shall be in conformance with SMPTE 299-1.

7.4.3 Video Payload ID Mapping

The video payload identifier if required shall be mapped into the blanking area of each basic stream of 10G-SDIs. Table 6 defines the video payload identifier for the UHDTV 2 video payload.

This payload identifier shall be in conformance with the general video payload identifier format defined in SMPTE ST 352. The byte 1 value of $A2_h$ is mandatory and identifies the video payload format as UHDTV2. The remaining 3 bytes values specify the other features of the video payload for UHDTV2.

The specification and carriage of this video payload identifier shall also be in conformance with SMPTE ST 352.[2]

[2] Designers need to be aware that the first eleven samples after EAV of Line 10 and Line 572 on each basic stream channel are reserved for video payload identifier usage.

Table 6 – Video payload identifier definitions for UHDTV2 video payloads on a Quad-link or an Octa-link 10 Gb/s (nominal) serial digital interface

<table>
<tr><th>Bits</th><th>Byte 1</th><th>Byte 2</th><th>Byte 3</th><th>Byte 4</th></tr>
<tr><td>Bit 7</td><td>1</td><td>Interlaced (0) or progressive (1) transport</td><td>Reserved</td><td rowspan="3">Channel assignment of octa link
Ch1 (0h), Ch2 (1h),
Ch3 (2h), Ch4 (3h),
Ch5 (4h), Ch6 (5h),
Ch7 (6h) or Ch8 (7h)</td></tr>
<tr><td>Bit 6</td><td>0</td><td>progressive (1) picture</td><td rowspan="3">10G channel assignment of Quad/Octa link
Ch1 (0h), Ch2(1h)
Ch3 (2h), Ch4 (3h),
Ch5 (4h), Ch6 (5h),
Ch7 (6h) or Ch8 (7h)</td></tr>
<tr><td>Bit 5</td><td>1</td><td>Reserved</td></tr>
<tr><td>Bit 4</td><td>0</td><td>Reserved</td><td>Reserved</td></tr>
<tr><td>Bit 3</td><td>0</td><td rowspan="4">Picture rate
(see Table 2
SMPTE ST 352)</td><td rowspan="4">Sampling structure
(see Table 3
SMPTE ST 352)</td><td>Reserved</td></tr>
<tr><td>Bit 2</td><td>0</td><td>Reserved</td></tr>
<tr><td>Bit 1</td><td>1</td><td rowspan="2">Bit depth
8-bit (0h), 10-bit (1h),
12-bit (2h),
Reserved (3h)</td></tr>
<tr><td>Bit 0</td><td>0</td></tr>
</table>

When identifying UHDTV2 video payloads mapped onto a Quad-link or an Octa-link 10 Gb/s serial digital interface, the following limitations shall apply:

- The interlace/progressive transport flag bit shall be set to 0 or 1 according to the digital interface transport;
- The interlaced/progressive picture flag bit shall be set to 1;
- The picture rate shall be set to the value of the UHDTV2 video payload;
- The sampling structure shall be set to the value of the payload being carried;
- The assignment order of the basic stream channels and the 10G links for the payload IDs shall correspond to the numerous order of the 10 Gb/s SDI input channel and link numbers as defined in § 7.2 and 7.3

  The 10G (SMPTE 435) channel number in bit b4, b5 and b6 of byte 3 shall be set to the following values in the case of a Quad-link:

  - 0h for the first link;
  - 1h for the second link;
  - 2h for the third link;
  - 3h for the fourth link.

  The 10G (SMPTE 435) channel number in bit b4, b5 and b6 of byte 3 shall be set to the following values in the case of an Octa-link:

  - 0h for the first link;
  - 1h for the second link;
  - 2h for the third link;
  - 3h for the fourth link;
  - 4h for the fifth link;
  - 5h for the sixth link;
  - 6h for the seventh link;
  - 7h for the eighth link.

The basic stream (SMPTE 292) channel number in bit b5, b6 and b7 of byte 4 shall be set to the following values:

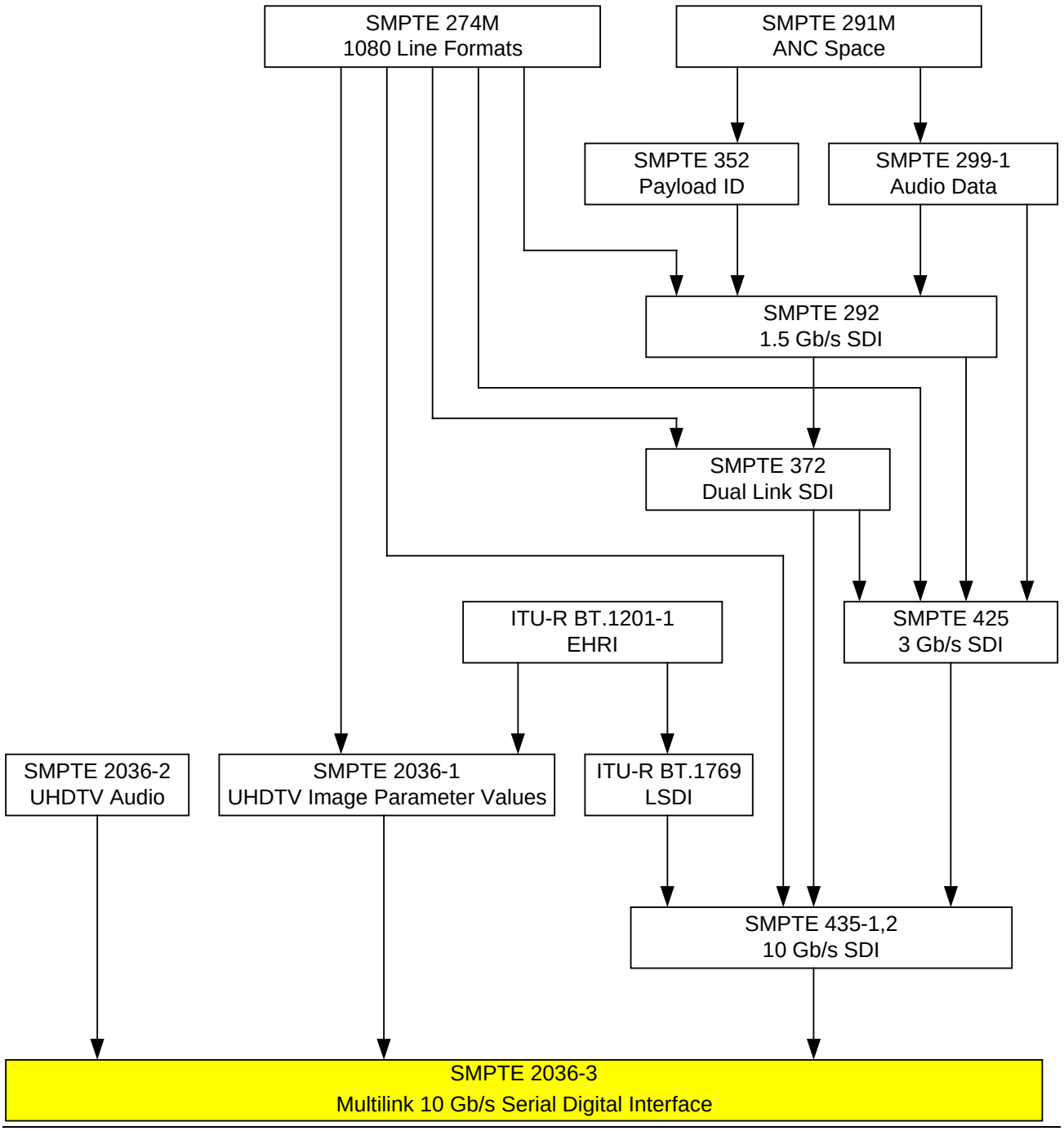
- 0h for the first link;
- 1h for the second link;
- 2h for the third link;
- 3h for the fourth link;
- 4h for the fifth link;
- 5h for the sixth link;
- 6h for the seventh link;
- 7h for the eighth link.

– The bit depth of the sample quantization shall be identified by bits b1 and b0 of byte 4 having the following values:

- 0h identifies quantization using 8 bits per sample;
- 1h identifies quantization using 10 bits per sample;
- 2h identifies quantization using 12 bits per sample.

Annex A (Informative)
SMPTE 2036-3 Document Roadmap

This roadmap shows the relation between this 10G-SDI UHDTV mapping (SMPTE ST 2036-3) and the current SMPTE/ITU image/interface standards.



Annex B (Informative)
Bibliography

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

SMPTE 2036-2-2008, Ultra High Definition Television — Audio Characteristics and Audio Channel Mapping for Program Production

ITU-R BT.1201-1 (03/04), Extremely High Resolution Imagery

ITU-R BT.1769 (07/06), Parameter Values for an Expanded Hierarchy of LSDI Image Formats for Production and International Programme Exchange