

SMPTE STANDARD

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



Page 1 of 25

Table of Contents	Page
Foreword	2
Intellectual Property	2
Introduction	2
1 Scope	3
2 Conformance Notation	3
3 Normative References.....	3
4 Definition of Terms	4
5 System Overview	5
6 UHDTV1 Mapping into Single-link or Dual-link 10G-SDI	6
6.1 Video Payload Mapping	6
6.2 Single-link 10G-SDI for System U1.1 to U1.5	8
6.3 Dual-link 10G-SDI for System U1.6 to U1.9.....	8
6.4 Optical Interface Characteristics	10
6.5 ANC/Audio Data Mapping	10
6.6 Blanking Data (Informative).....	13
7 UHDTV2 Mapping into Quad-link or Octa-link 10G-SDI	14
7.1 Video Payload Mapping	14
7.2 Quad-link 10G-SDI for System U2.1 to U2.5	16
7.3 Octa-link 10G-SDI for System U2.6 to U2.9	17
7.4 Optical Interface Characteristics	17
7.5 ANC/Audio Data Mapping	18
7.6 Blanking Data (Informative).....	22
Annex A Bibliography (Informative)	24
Annex B Further Guidance on Luminance and Color Difference Signal Identification (Informative).....	25

Foreword

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

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

SMPTE ST 2036-3 was prepared by Technology Committee 32NF.

Intellectual Property

The user's attention is called to the possibility that compliance with this standard may require use of an invention covered by patent rights.

By publication of this standard, no position is taken with respect to the validity of this claim or of any patent rights in connection therewith.

The patent holder has, however, filed a statement of willingness to grant a license under these rights on reasonable and nondiscriminatory terms and conditions to applicants desiring to obtain such a license. Details may be obtained from the publisher.

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Introduction

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

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

This document is Part 3 of SMPTE ST 2036 and describes UHD TV1, 2 image mapping and High Dynamic Range (HDR) UHD TV1, 2 image mapping of signals into a Single-link or a Multi-link 10 Gb/s Serial Signal/Data Interface (10G-SDI) Mode D defined in SMPTE ST 435-2.

1 Scope

This document defines UHDTV and HDR UHDTV video payload mapping into Single-link, Dual-link, Quad-link or Octa-link 10G-SDI Mode D defined in SMPTE ST 435-2. This document also defines mapping of ANC, Audio Data, payload ID and other ancillary data formatted as defined in SMPTE ST 291-1. The "Basic Stream" complies with the interleaved data stream defined in SMPTE ST 292-1 and is utilized as the input source stream for the 10G-SDI.

When transporting UHDTV1,2 signals through a single single-mode fiber, WDM (Wavelength Division Multiplexing) or DWDM (Dense Wavelength Division Multiplexing) as defined in Section 6.4 and Section 7.4 can be used.

2 Conformance Notation

Normative text is text that describes elements of the design that are indispensable or text that contains the conformance language keywords: "shall," "should," or "may." Informative text is text that is potentially helpful to the user, but not indispensable, and that can be removed, changed, or added editorially without affecting interoperability. Informative text does not contain any conformance keywords.

All text in this document is, by default, normative, except: the Introduction, any section explicitly labeled as "Informative" or individual paragraphs that start with "Note:".

The keywords "shall" and "shall not" indicate requirements strictly to be followed in order to conform to the document and from which no deviation is permitted.

The keywords, "should" and "should not" indicate that, among several possibilities, one is recommended as particularly suitable, without mentioning or excluding others; or that a certain course of action is preferred but not necessarily required; or that (in the negative form) a certain possibility or course of action is deprecated but not prohibited.

The keywords "may" and "need not" indicate courses of action permissible within the limits of the document.

The keyword "reserved" indicates a provision that is not defined at this time, shall not be used, and may be defined in the future. The keyword "forbidden" indicates "reserved" and, in addition, indicates that the provision will never be defined in the future.

A conformant implementation according to this document is one that includes all mandatory provisions ("shall") and, if implemented, all recommended provisions ("should") as described. A conformant implementation need not implement optional provisions ("may") and need not implement them as described.

Unless otherwise specified, the order of precedence of the types of normative information in this document shall be as follows: Normative prose shall be the authoritative definition; Tables shall be next; followed by formal languages; then figures; and then any other language forms

3 Normative References

The following standards contain provisions which, through reference in this text, constitute provisions of this 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 ST 291-1:2011, Ancillary Data Packet and Space Formatting

SMPTE ST 292-1:2012, 1.5 Gb/s Signal/Data Serial Interface

SMPTE ST 299-1:2009, 24-Bit Digital Audio Format for SMPTE 292 Bit-Serial Interface

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

SMPTE ST 372:2011, Dual Link 1.5 Gb/s Digital Interface for 1920 × 1080 and 2048 × 1080 Picture Formats

SMPTE ST 435-1:2012, 10 Gb/s Serial Signal/Data Interface — Part 1: Basic Stream Derivation

SMPTE ST 435-2:2012, 10 Gb/s Serial Signal/Data Interface — Part 2: 10.692 Gb/s Stream — Basic Stream Data Mapping

SMPTE ST 435-3:2012, 10 Gb/s Serial Signal/Data Interface — Part 3: 10.692 Gb/s Optical Fiber Interface

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

SMPTE RP 291-2:2013, Ancillary Data Space Use — 4:2:2 SDTV and HDTV Component Systems and 4:2:2 2048 × 1080 Production Image Formats

SMPTE RP 2077:2013, Full Range Image Mapping

Recommendation ITU-R BT.2100-1 (06/2017), Image parameter values for high dynamic range television for use in production and international programme exchange

4 Definition of Terms

4.1 UHDTV

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

4.2 UHDTV1

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

4.3 UHDTV2

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

4.4 Basic Stream

10-bit parallel interleaved data stream which has the same structure as the source data stream defined in SMPTE ST 292-1 and carries the image structure defined in the source format data defined in SMPTE ST 292-1

4.5 HANC

Horizontal Ancillary Data Space as defined in SMPTE RP 291-2

4.6 VANC

Vertical Ancillary Data Space as defined in SMPTE RP 291-2

5 System Overview

The source UHDTV (Ultra High Definition Television) image sample structures for the interface are listed in Table 1. UHDTV has an image format (sample structure) of 3840 × 2160 (UHDTV1) or 7680 × 4320 (UHDTV2). The source image formats listed in Table 1 shall be as defined in SMPTE ST 2036-1 or Recommendation ITU-R BT.2100.

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

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 ST 435-2 through Basic Streams that comply with 1.5 Gb/s Serial Digital Interface defined in SMPTE ST 292-1 as shown in Figure 1.

When embedding optional ancillary data, the ancillary data packet format shall be in conformance with SMPTE ST 291-1. Ancillary audio data shall be as defined in SMPTE ST 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

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.

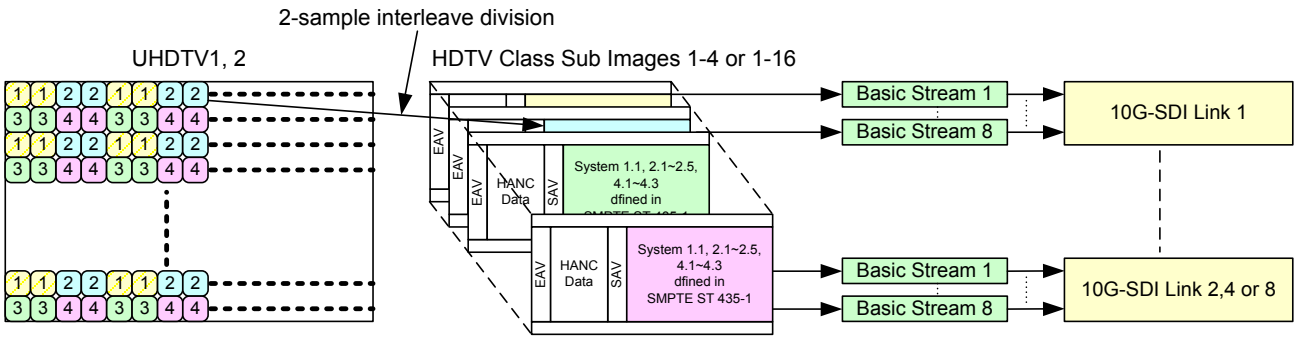


Figure 1 – UHDTV1, 2 mapping overview

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

6.1 Video Payload Mapping

Table 2 shows the UHDTV1 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 ST 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 ST 435-1.

The mappings for Y'C_BC_R signal formats defined in SMTE ST 435-1 and SMPTE ST 435-2 may be applied to the mappings for IC_TC_P signal formats as defined in Recommendation ITU-R BT.2100. For IC_TC_P signal formats the mappings for Y'C_BC_R signal formats shall be used with Y' replaced by I, C_B replaced by C_T and C_R replaced by C_P.

Table 2 – Source image formats of UHD TV1 Class

System Number	System nomenclature	Sampling Structure/Pixel Depth	Frame Rate/sec	Sub-image format defined in SMPTE ST 435-1
U1.1	3840 x 2160/24/P 3840 x 2160/25/P 3840 x 2160/30/P	4:2:0(Y'C'B'C'R)/10-bit 4:2:2(Y'C'B'C'R)/10-bit 4:2:0(IC _{TCP})/10-bit 4:2:2(IC _{TCP})/10-bit	24, 25 and 30 Frames Progressive	System 1.1
	3840 x 2160/23.98/P 3840 x 2160/29.97/P		24/1.001, 30/1.001 Frames Progressive	
U1.2	3840 x 2160/24/P 3840 x 2160/25/P 3840 x 2160/30/P	4:4:4(R'G'B')/10-bit	24, 25 and 30 Frames Progressive	System 2.2
	3840 x 2160/23.98/P 3840 x 2160/29.97/P		24/1.001, 30/1.001 Frames Progressive	
U1.3	3840 x 2160/24/P 3840 x 2160/25/P 3840 x 2160/30/P	4:4:4(R'G'B')/12-bit	24, 25 and 30 Frames Progressive	System 2.3
	3840 x 2160/23.98/P 3840 x 2160/29.97/P		24/1.001, 30/1.001 Frames Progressive	
U1.4	3840 x 2160/24/P 3840 x 2160/25/P 3840 x 2160/30/P	4:4:4(Y'C'B'C'R)/10-bit 4:4:4(IC _{TCP})/10-bit	24, 25 and 30 Frames Progressive	System 2.4
	3840 x 2160/23.98/P 3840 x 2160/29.97/P		24/1.001, 30/1.001 Frames Progressive	
U1.5	3840 x 2160/24/P 3840 x 2160/25/P 3840 x 2160/30/P	4:2:0(Y'C'B'C'R)/12-bit 4:2:2(Y'C'B'C'R)/12-bit 4:4:4(Y'C'B'C'R)/12-bit 4:2:0(IC _{TCP})/12-bit 4:2:2(IC _{TCP})/12-bit 4:4:4(IC _{TCP})/12-bit	24, 25 and 30 Frames Progressive	System 2.5
	3840 x 2160/23.98/P 3840 x 2160/29.97/P		24/1.001, 30/1.001 Frames Progressive	
U1.6	3840 x 2160/50/P 3840 x 2160/60/P	4:2:0(Y'C'B'C'R)/10-bit 4:2:2(Y'C'B'C'R)/10-bit 4:2:0(IC _{TCP})/10-bit 4:2:2(IC _{TCP})/10-bit	50 and 60 Frames Progressive	System 2.1
	3840 x 2160/59.94/P		60/1.001 Frames Progressive	
U1.7	3840 x 2160/50/P 3840 x 2160/60/P	4:2:0(Y'C'B'C'R)/12-bit 4:2:2(Y'C'B'C'R)/12-bit 4:2:0(IC _{TCP})/12-bit 4:2:2(IC _{TCP})/12-bit	50 and 60 Frames Progressive	System 4.1
	3840 x 2160/59.94/P		60/1.001 Frames Progressive	
U1.8	3840 x 2160/50/P 3840 x 2160/60/P	4:4:4(R'G'B')/10-bit 4:4:4(Y'C'B'C'R)/10-bit 4:4:4(IC _{TCP})/10-bit	50 and 60 Frames Progressive	System 4.2
	3840 x 2160/59.94/P		60/1.001 Frames Progressive	
U1.9	3840 x 2160/50/P 3840 x 2160/60/P	4:4:4(R'G'B')/12-bit 4:4:4(Y'C'B'C'R)/12-bit 4:4:4(IC _{TCP})/12-bit	50 and 60 Frames Progressive	System 4.3
	3840 x 2160/59.94/P		60/1.001 Frames Progressive	
NOTE: ICTCP sampling is only applied to High Dynamic Range (HDR) image formats defined in Recommendation ITU-R BT.2100				

System U1.1 through U1.9 images shall be divided and mapped into the active area of Sub images 1 through 4 by 2-sample interleave division as defined by Figure 4 in SMPTE ST 435-1:2012. Sub images of System U1.1 through U1.9 shall be System 1.1, 2.2 through 2.5, 2.1 or 4.1 through 4.3 as shown in Table 2 and shall have the digital sample structure as defined in Section 6 through Section 9 of SMPTE ST 274.

The 0 components of the 4:2:0 (even-numbered samples on odd-numbered lines of unassigned $C'_B C'_R$ or $C_T C_P$) 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 5 in SMPTE ST 435-1:2012 specifies the relation between the horizontal/vertical pixel number of the original 3840×2160 image and the sample/line number of the mapped 1920×1080 Sub images 1, 2, 3 and 4 by the 2-sample interleave division.

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 ($3840 \times 2160/23.98/P$, $24/P$, $25/P$, $29.97/P$ 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 defined in Section 6.1 and Section 6.2 of SMPTE ST 435-1:2012. Four single- or dual-link Basic Streams from four Sub images shall be mapped into the Single-link 10G-SDI as defined in Section 6.4 of SMPTE ST 435-2:2012.

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

In the case of Systems U1.6 through U1.9 images ($3840 \times 2160/50/P$, $59.94/P$ and $60/P$), each of Sub image data created by the 2-sample interleave division shall be divided into the dual-link Basic Stream or the quad-link Basic Stream with the same structure as the dual link 1.5 Gb/s class or the quad link 1.5 Gb/s class Basic Stream defined in Section 6.2 and Section 6.3 of SMPTE ST 435-1:2012.

Sub images 1 to 4 generated from System U1.6 images are equivalent to System 2.1 as defined by SMPTE ST 435-1 and shall be divided into 8 Basic Streams as shown in Figure 2.

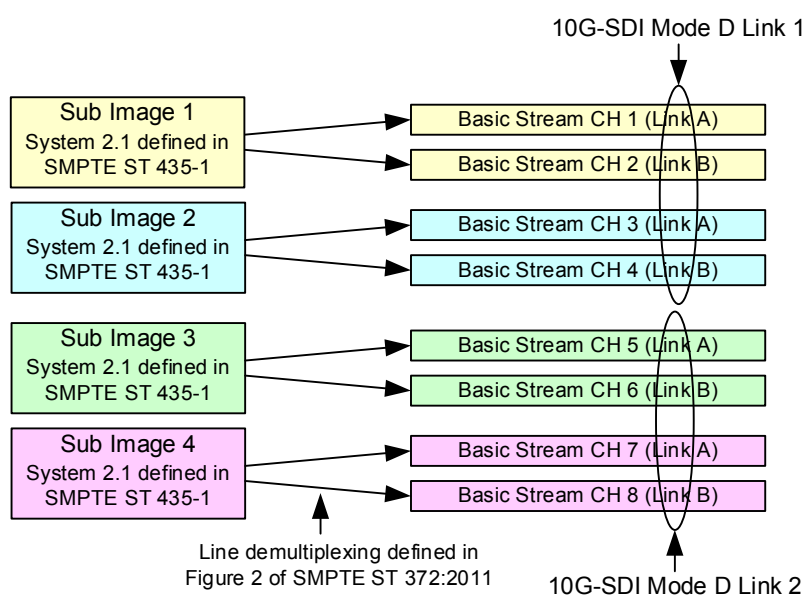


Figure 2 – 8 way division for System U1.6