SMPTE ST 2081-11:2019

Revision of ST 2081-11:2016

SMPTE STANDARD

2160-line and 1080-line Source Image and Ancillary Data Mapping for Dual-link 6G-SDI

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Approved June 24, 2019

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 2081-11 was prepared by Technology Committee 32NF.

Intellectual Property

At the time of publication no notice had been received by SMPTE claiming patent rights essential to the implementation of this Standard. However, attention is drawn to the possibility that some of the elements of this document may be the subject of patent rights. SMPTE shall not be held responsible for identifying any or all such patent rights.

Introduction

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

SMPTE ST 2081-11 defines the mapping of various source images and associated ancillary data into a Dual-link 6 Gb/s [nominal] SDI bit-serial interface.

The general process for creating a dual-link 6G-SDI is illustrated below in Figure 1. Detailed definitions of how this process applies to each of the modes defined in the scope follow in other sections of this document.

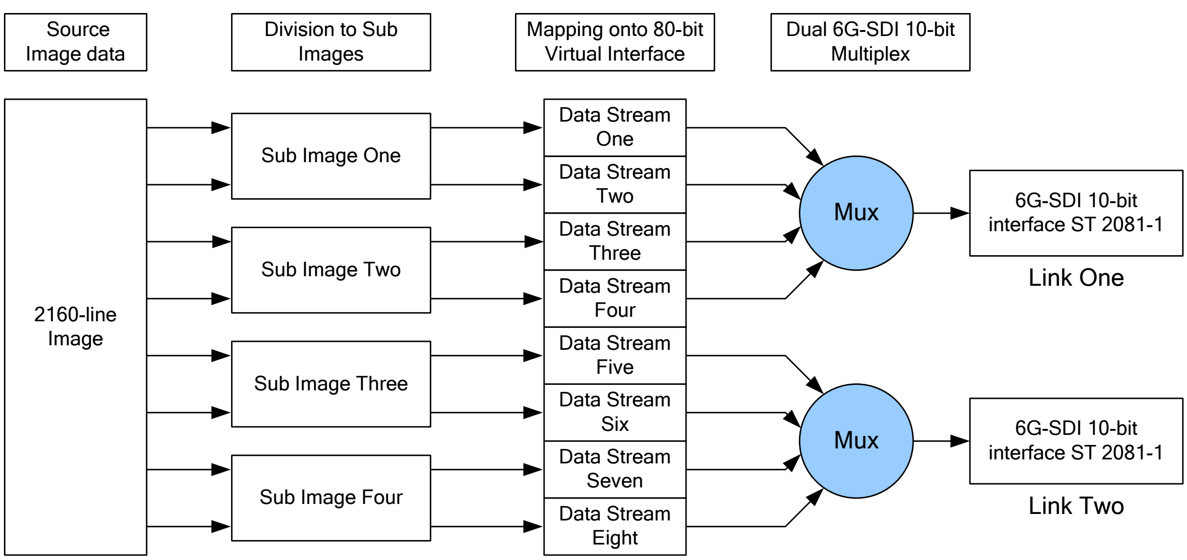


Figure 1 – Carriage of 2160-line images in a Dual-link 6G-SDI interface – generalized process

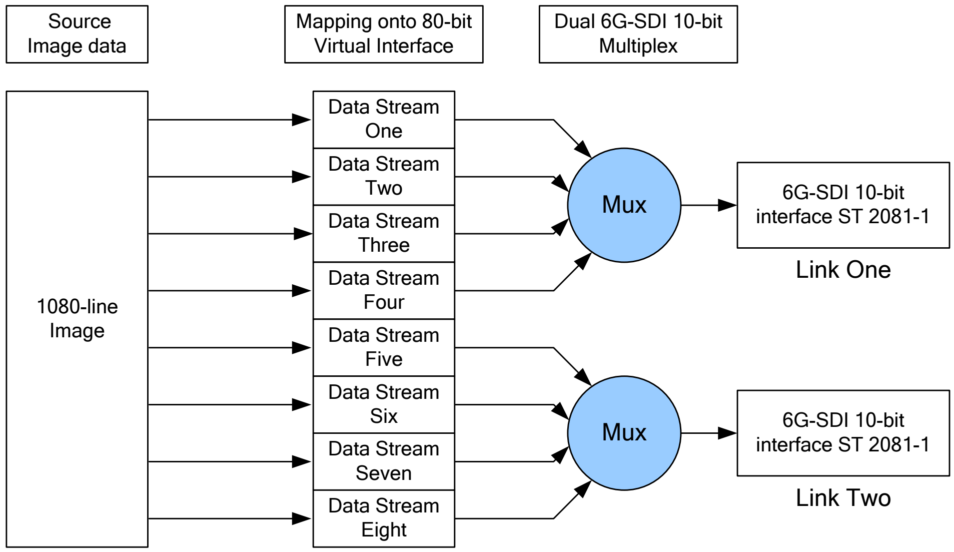


Figure 2 – Carriage of 1080-line HFR images in a Dual-link 6G-SDI interface – generalized process

Formatting

2160-line source images are divided into four 1080-line sub images.

The 1080-line source image, or the four 1080-line sub images divided from the 2160-line source image, are then mapped onto an 80-bit virtual interface consisting of eight 10-bit data streams.

Each 10-bit data stream includes timing and sync words, line numbers, cyclic redundancy codes, ancillary data, including audio, and payload identification packets.

Multiplex

The 80-bit virtual interface is multiplexed onto two 6G-SDI 10-bit interfaces. The first four data streams are multiplexed in the order data stream four, data stream two, data stream three, data stream one…onto 6G-SDI Link 1. The second four data streams are multiplexed in the order data stream eight, data stream six, data stream seven, data stream five…onto 6G-SDI Link 2.

1 Scope

This standard defines the mapping of:

- **Mode 1:** 2160-line Standard Dynamic Range (SDR) and High Dynamic Range (HDR) Source image formats and ancillary data into a Dual-link 6G-SDI 10-bit interface as defined in section 6 Dual-link 6G-SDI 10-bit Multiplex
- **Mode 2:** 1080-line High Frame Rate (HFR) Standard Dynamic Range (SDR) and High Dynamic Range (HDR) Source formats and ancillary data into a Dual-link 6G-SDI 10-bit interface as defined in section 6 Dual-link 6G-SDI 10-bit Multiplex

This standard also defines the carriage of the SMPTE ST 352 payload ID's for the Dual-link 6 Gb/s SDI interface.

It is not necessary for implementations to include support for all formats that are included in this standard. Implementers are encouraged to indicate supported formats in commercial publications.

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.

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 that, 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 12-3:2016, Time Code for High Frame Rate Signals and Formatting in the Ancillary Data Space

SMPTE ST 291-1:2011, Ancillary Data Packet and Space Formatting

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

SMPTE ST 299-2:2010, Extension of the 24-Bit Digital Audio Format to 32 Channels for 3 Gb/s Bit-Serial Interfaces

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

SMPTE ST 425-5:2019, Image Format and Ancillary Data Mapping for the Quad Link 3 Gb/s Serial Interface

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

SMPTE ST 2048-1:2011, 2048 × 1080 and 4096 × 2160 Digital Cinematography Production Image Formats FS/709

Amendment 1:2016 to SMPTE ST 2048-1:2011

SMPTE RP 2077:2013, Full Range Image Mapping

Recommendation ITU-R BT.2100-2 (07/2018), Image parameter values for high dynamic range television for use in production and international programme exchange

4 Mode 1: Carriage of 2160-line Source image formats and ancillary data

In the case of 2160-line mapping, the image formats supported shall be as defined in Table 1.

Table 1 – 2160-line Source Image Formats Supported

Reference Standard	Image Format	Signal Format Sampling Structure/pixel Depth	Frame Rate Hz
SMPTE ST 2036-1 Rec. ITU-R BT.2100	3840 × 2160	4:2:2 ($Y'C'_BC'_R$)/10-bit 4:2:2 (IC_TC_P[*4])/10-bit, 4:2:0 ($Y'C'_BC'_R$)/10-bit 4:2:0 (IC_TC_P[*4])/10-bit	50, 60/1.001 and 60 Progressive
SMPTE ST 2048-1	4096 × 2160[*2]	4:2:2 ($Y'C'_BC'_R$)/10-bit	48/1.001, 48, 50, 60/1.001 and 60 Progressive
SMPTE ST 2036-1 Rec. ITU-R BT.2100	3840 × 2160	4:4:4 (R′G′B′)/10-bit 4:4:4:4 (R′G′B′+A[*3])/10-bit	24/1.001, 24, 25, 30/1.001 and 30 Progressive
SMPTE ST 2048-1	4096 × 2160[*2]	4:4:4 (R′G′B′)[*1], 4:4:4:4 (R′G′B′[*1]+A[*3])/10-bit	
SMPTE ST 2036-1 Rec. ITU-R BT.2100	3840 × 2160	4:4:4 ($Y'C'_BC'_R$)/10-bit 4:4:4:4 ($Y'C'_BC'_R$+A[*3])/10-bit 4:4:4 (IC_TC_P[*4])/10-bit 4:4:4:4 (IC_TC_P[*4]+A[*3])/10-bit	
SMPTE ST 2048-1	4096 × 2160[*2]	4:4:4 ($Y'C'_BC'_R$) 4:4:4:4 ($Y'C'_BC'_R$+A[*3])/10-bit	
SMPTE ST 2036-1 Rec. ITU-R BT.2100	3840 × 2160	4:4:4 (R′G′B′)/12-bit	
SMPTE ST 2048-1	4096 × 2160[*2]	4:4:4 (R′G′B′)[*1]/12-bit	
SMPTE ST 2036-1 Rec. ITU-R BT.2100	3840 × 2160	4:4:4 ($Y'C'_BC'_R$)/12-bit 4:4:4 (IC_TC_P)[*4]/12-bit	
SMPTE ST 2048-1	4096 × 2160[*2]	4:4:4 ($Y'C'_BC'_R$)/12-bit	
SMPTE ST 2036-1 Rec. ITU-R BT.2100	3840 × 2160	4:2:2 ($Y'C'_BC'_R$)/12-bit 4:2:2 ($Y'C'_BC'_R$+A[*3])/12-bit 4:2:2 (IC_TC_P[*4])/12-bit 4:2:2 (IC_TC_P[*4]+A[*3])/12-bit 4:2:0 ($Y'C'_BC'_R$)/12-bit 4:2:0 ($Y'C'_BC'_R$+A[*3])/12-bit 4:2:0 (IC_TC_P[*4])/12-bit 4:2:0 (IC_TC_P[*4]+A[*3])/12-bit	
SMPTE ST 2048-1	4096 × 2160[*2]	4:2:2 ($Y'C'_BC'_R$)/12-bit	
SMPTE ST 2048-1	4096 × 2160[*2]	4:2:2:4 ($Y'C'_BC'_R$+A[*3])/12-bit	

Notes:

*1 In this image format R′G′B′ indicates either R′G′B′ or $R'_{FS}G'_{FS}B'_{FS}$. The suffix FS and an additional Color VANC packet to describe the FS characteristics are defined by SMPTE ST 2048-1.

*2 This is the maximum pixel array, the active image might not fill the maximum array.

*3 Definition of the A channel is application-dependent. An auxiliary component signal designated A or Alpha may optionally accompany the R′G′B′, $R'_{FS}G'_{FS}B'_{FS}$, $Y'C'_BC'_R$ or IC_TC_P video signal. Interfaces containing the auxiliary component are denoted as R′G′B′+A, $Y'C'_BC'_R$+A and IC_TC_P+A. In the cases when the A channel is used for non-picture data, the payload is constrained to 8-bit words maximum

*4 In accordance with Recommendation ITU-R BT.2100, IC_TC_P sampling is only applied to High Dynamic Range (HDR) progressive image formats.

4.1 Mapping

The source image shall be divided into four sub images in accordance with the 2-sample interleave division method defined in SMPTE ST 425-5 “2160-line image division into four sub images”.

The four resulting sub images shall then be mapped into an 80-bit virtual interface in accordance with the sub image mapping structure numeral 1, 2, 3 or 4 defined in Table 1 - “2160-line Source Image Formats” of SMPTE ST 425-5 and the corresponding mapping rules defined in SMPTE ST 425-1 such that:

Sub image 1 is mapped into data stream one and data stream two.

Sub image 2 is mapped into data stream three and data stream four.

Sub image 3 is mapped into data stream five and data stream six.

Sub image 4 is mapped into data stream seven and data stream eight

This process is illustrated in the Figure “Mapping Overview for 2160-line Source Images” in SMPTE ST 425-5.

The 80-bit virtual interface shall include sync and timing (TRS) words, Cyclic redundancy code (CRC) words, line numbers, HANC and VANC data– except audio – according to SMPTE ST 425-5 “Level A mapping for 2160-line source images”.

Time code, when present, shall be included in the 80-bit virtual interface according to SMPTE ST 425-5 “Level A mapping for 2160-line source images”.

For IC_TC_P formats the mappings for $Y'C'_BC'_R$ formats shall be used with Y′ replaced by I, C'_B replaced by C_T and C'_R replaced by C_P.

Informative Annex A provides information about the amount of HANC and VANC data space available in this operating mode.

4.1.1 Mapping Process (Informative)

Figure 3 illustrates the process for the carriage of SMPTE ST 2036-1 and SMPTE ST 2048-1 2160-line source image formats in a Dual-link 6G-SDI interface.

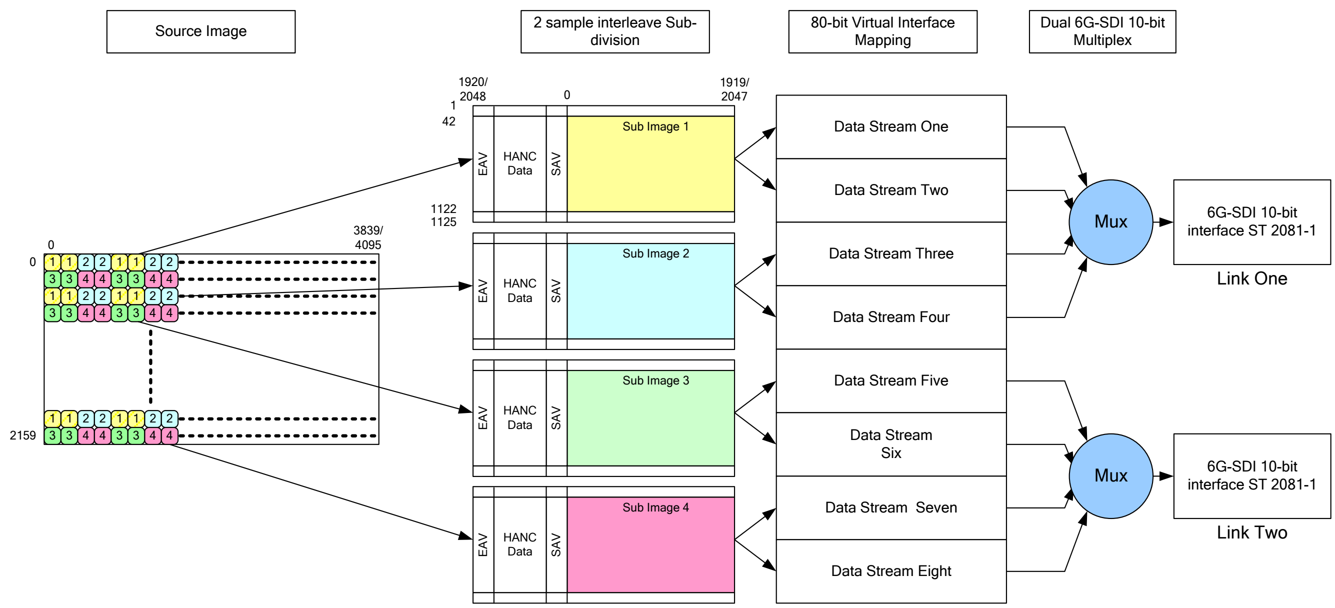


Figure 3 – Carriage of 2160-line mapping source image formats in a dual-link 6G-SDI interface

The 2160-line source image is divided into four 1080-line sub images in accordance with the 2 sample interleave sub-division method referenced in SMPTE ST 425-5 2160-line Mapping.

For a 4:2:0 source image, the C'_B and C'_R samples in sub images 3 and 4 are set to the value 200h for 10-bit systems and 800h for 12-bit systems.

Each 1080-line sub image has the structure as shown in Table 2 – "Sub Image Formats", of SMPTE ST 425-5 repeated here for convenience in Table 2.

Table 2 – Sub Image Formats (Informative)

Source Image		Sub Image	
Reference SMPTE Standard	**Image Format**	**Reference SMPTE Standard**	**Image Format**
ST 2036-1	3840 × 2160	ST 274	1920 × 1080
ST 2048-1	4096 × 2160	ST 2048-2	2048 × 1080

Each sub image is mapped into two 10-bit data streams.

Sub image 1 is mapped into data streams one and two.

Sub image 2 is mapped into data streams three and four.

Sub image 3 is mapped into data streams five and six.

Sub image 4 is mapped into data streams seven and eight.

Each data stream includes sync and timing (TRS) words, Cyclic redundancy code (CRC) words, line numbers, HANC and VANC data and time code.

The eight 10-bit data streams are combined onto an 80-bit virtual interface:

4.1.2 2160-line 80-bit Virtual Interface Multiplex Structure (Informative)

The video data words from each sub image are conveyed in the following order in the data streams of the 80-bit virtual interface. The mapping rules for each Mapping Structure are defined in SMPTE ST 425-1:

Mapping Structure 1:

Sub image 1 is mapped into data streams one and two:

data stream one: Y′0, Y′1, Y′2, Y′3...

data stream two: C'_B0, C'_R0, C'_B1, C'_R1...

Sub image 2 is mapped into data streams three and four:

data stream three: Y′0, Y′1, Y′2, Y′3...

data stream four: C'_B0, C'_R0, C'_B1, C'_R1...

Sub image 3 is mapped into data streams five and six:

data stream five: Y′0, Y′1, Y′2, Y′3...

data stream six: C'_B0, C'_R0, C'_B1, C'_R1...

Sub image 4 is mapped into data streams seven and eight:

data stream seven: Y′0, Y′1, Y′2, Y′3...

data stream eight: C'_B0, C'_R0, C'_B1, C'_R1...

For a 4:2:0 source images, the 10-bit C'_B and C'_R samples in sub images 3 and 4 are set to the value 200h.

Mapping Structure 2:

Sub image 1 is mapped into data streams one and two:

data stream one: G′0, R′0, G′1, R′1...

data stream two: A0, B′0, A1, B′1...

Sub image 2 is mapped into data streams three and four:

data stream three: G′0, R′0, G′1, R′1...

data stream four: A0, B′0, A1, B′1...

Sub image 3 is mapped into data streams five and six:

data stream five: G′0, R′0, G′1, R′1...

data stream six: A0, B′0, A1, B′1...

Sub image 4 is mapped into data streams seven and eight:

data stream seven: G′0, R′0, G′1, R′1...

data stream eight: A0, B′0, A1, B′1...

Mapping Structure 3:

Bit b9 in every word is the complement of b8. The lists and tables below describe Bits b8 – b0

Sub image 1 is mapped into data streams one and two:

data stream one: R′G′B′ 0 [11:9], R′G′B′ 0 [5:3], R′G′B′ 1 [11:9], R′G′B′ 1 [5:3]...

data stream two: R′G′B′ 0 [8:6], R′G′B′ 0 [2:0], R′G′B′ 1 [8:6], R′G′B′ 1 [2:0]...

Sub image 2 is mapped into data streams three and four:

data stream three: R′G′B′ 0 [11:9], R′G′B′ 0 [5:3], R′G′B′ 1 [11:9], R′G′B′ 1 [5:3]...

data stream four: R′G′B′ 0 [8:6], R′G′B′ 0 [2:0], R′G′B′ 1 [8:6], R′G′B′ 1 [2:0]...

Sub image 3 is mapped into data streams five and six:

data stream five: R′G′B′ 0 [11:9], R′G′B′ 0 [5:3], R′G′B′ 1 [11:9], R′G′B′ 1 [5:3]...

data stream six: R′G′B′ 0 [8:6], R′G′B′ 0 [2:0], R′G′B′ 1 [8:6], R′G′B′ 1 [2:0]...

Sub image 4 is mapped into data streams seven and eight:

data stream seven: R′G′B′ 0 [11:9], R′G′B′ 0 [5:3], R′G′B′ 1 [11:9], R′G′B′ 1 [5:3]...

data stream eight: R′G′B′ 0 [8:6], R′G′B′ 0 [2:0], R′G′B′ 1 [8:6], R′G′B′ 1 [2:0]...

For $Y'C'_BC'_R$ formats, G′ is replaced with Y′, B′ with C'_B and R′ with C'_R.

For IC_TC_P formats, G′ is replaced with I, B′ with C_T and R′ with C_P.

Mapping Structure 4:

Bit b9 in every word is the complement of b8. The lists and tables below describe Bits b8 – b0

Sub image 1 is mapped into data streams one and two:

data stream one:	Bits b8 – b6:	A0 [11:9],	A0 [5:3],	A1 [11:9],	A1 [5:3]...
	Bits b5 – b0:	Y′0 [11:6],	Y′0 [5:0],	Y′1 [11:6],	Y′1 [5:0]...
data stream two:	Bits b8 – b6:	A0 [8:6],	A0 [2:0],	A1 [8:6],	A1 [2:0]...
	Bits b5 – b0:	C'_B 0 [11:6],	C'_B 0 [5:0],	C'_R 0 [11:6],	C'_R 0 [5:0]...

Sub image 2 is mapped into data streams three and four:

data stream three:	Bits b8 – b6:	A0 [11:9],	A0 [5:3],	A1 [11:9],	A1 [5:3]...
	Bits b5 – b0:	Y′0 [11:6],	Y′0 [5:0],	Y′1 [11:6],	Y′1 [5:0]...
data stream four:	Bits b8 – b6:	A0 [8:6],	A0 [2:0],	A1 [8:6],	A1 [2:0]...
	Bits b5 – b0:	C'_B 0 [11:6],	C'_B 0 [5:0],	C'_R 0 [11:6],	C'_R 0 [5:0]...

Sub image 3 is mapped into data streams five and six:

data stream five:	Bits b8 – b6:	A0 [11:9],	A0 [5:3],	A1 [11:9],	A1 [5:3]...
	Bits b5 – b0:	Y′0 [11:6],	Y′0 [5:0],	Y′1 [11:6],	Y′1 [5:0]...
data stream six:	Bits b8 – b6:	A0 [8:6],	A0 [2:0],	A1 [8:6],	A1 [2:0]...
	Bits b5 – b0:	C'_B 0 [11:6],	C'_B 0 [5:0],	C'_R 0 [11:6],	C'_R 0 [5:0]...

Sub image 4 is mapped into data streams seven and eight:

data stream seven:	Bits b8 – b6:	A0 [11:9],	A0 [5:3],	A1 [11:9],	A1 [5:3]...
	Bits b5 – b0:	Y′0 [11:6],	Y′0 [5:0],	Y′1 [11:6],	Y′1 [5:0]...

data stream eight: Bits b8 – b6: A0 [8:6], A0 [2:0], A1 [8:6], A1 [2:0]...

Bits b5 – b0: C'_B 0 [11:6], C'_B 0 [5:0], C'_R 0 [11:6], C'_R 0 [5:0]...

For a 4:2:0 source image, the 12-bit C'_B and C'_R samples in sub images 3 and 4 are set to the value 800h.

For IC_TC_P formats, Y′ is replaced with I, C'_B with C_T and C'_R with C_P.

4.1.3 6G-SDI Link Multiplex Structure (Informative)

Following multiplexing onto a Dual-link 6G-SDI 10-bit interface according to Section 6 the 6G-SDI data streams are conveyed in the following order:

{n} indicates the sub image number

Mapping Structure 1:

6G-SDI Link 1:

{2} C'_B0, {1} C'_B0, {2} Y′0, {1} Y′0, {2} C'_R0, {1} C'_R0, {2} Y′1, {1} Y′1, {2} C'_B1, {1} C'_B1, {2} Y′2, {1} Y′2, {2} C'_R1, {1} C'_R1, {2} Y′3, {1} Y′3…

6G-SDI Link 2:

{4} C'_B0, {3} C'_B0, {4} Y′0, {3} Y′0, {4} C'_R0, {3} C'_R0, {4} Y′1, {3} Y′1, {4} C'_B1, {3} C'_B1, {4} Y′2, {3} Y′2, {4} C'_R1, {3} C'_R1, {4} Y′3, {3} Y′3...

Mapping Structure 2, R′G′B′+A example:

6G-SDI Link 1

{2} A0, {1} A0, {2} G′0, {1} G′0, {2} B′0, {1} B′0, {2} R′0, {1} R′0, {2} A1, {1} A1, {2} G′1, {1} G′1, {2} B′1, {1} B′1, {2} R′1, {1} R′1….

6G-SDI Link 2

{4} A0, {3} A0, {4} G′0, {3} G′0, {4} B′0, {3} B′0, {4} R′0, {3} R′0, {4} A1, {3} A1, {4} G′1, {3} G′1, {4} B′1, {3} B′1, {4} R′1, {3} R′1….

Mapping Structure 3, R′G′B′ example:

6G-SDI Link 1

{2} R′G′B′0 [8:6], {1} R′G′B′0 [8:6], {2} R′G′B′0 [11:9], {1} R′G′B′0 [11:9], {2} R′G′B′0 [2:0],...

{1} R′G′B′0 [2:0], {2} R′G′B′0 [5:3], {1} R′G′B′0 [5:3], {2} R′G′B′1 [8:6], {1} R′G′B′1 [8:6],…

6G-SDI Link 2

{4} R′G′B′0 [8:6], {3} R′G′B′0 [8:6], {4} R′G′B′0 [11:9], {3} R′G′B′0 [11:9], {4} R′G′B′0 [2:0],...

{3} R′G′B′0 [2:0], {4} R′G′B′0 [5:3], {3} R′G′B′0 [5:3], {4} R′G′B′1 [8:6], {3} R′G′B′1 [8:6],…

Mapping Structure 4, 4:2:2:4 $Y'C'_BC'_R$+A example

6G-SDI Link 1

Word	Word 0	Word 1	Word 2	Word 3	Word 4
Bits b8-b6	{2}A0 [8:6]	{1}A0 [8:6]	{2}A0 [11:9]	{1}A0 [11:9]	{2}A0 [2:0]
Bits b5-b0	{2}C′B0 [11:6]	{1}C′B0 [11:6]	{2}Y′0 [11:6]	{1}Y′0 [11:6]	{2}C′B0 [5:0]

Word 5	Word 6	Word 7	Word 8	Word 9	Word 10
{1}A0 [2:0]	{2}A0 [5:3]	{1}A0 [5:3]	{2}A1 [8:6]	{1}A1 [8:6]	{2}A1 [11:9]
{1}C′B0 [5:0]	{2}Y′0 [5:0]	{1}Y′0 [5:0]	{2}C′R0 [11:6]	{1}C′R 0 [11:6]	{2}Y′1 [11:6]

Word 11	Word 12	Word 13	Word 14	Word 15
{1}A1 [11:9]	{2}A1 [2:0]	{1}A1 [2:0]	{2}A1 [5:3]	{1}A1 [5:3]
{1}Y′1 [11:6]	{2}C′R0 [5:0]	{1}C′R0 [5:0]	{2}Y′1 [5:0]	{1}Y′1 [5:0]

6G-SDI Link 2

Word	Word 0	Word 1	Word 2	Word 3	Word 4
Bits b8-b6	{4}A0 [8:6]	{3}A0 [8:6]	{4}A0 [11:9]	{3}A0 [11:9]	{4}A0 [2:0]
Bits b5-b0	{4}C′B0 [11:6]	{3}C′B0 [11:6]	{4}Y′0 [11:6]	{3}Y′0 [11:6]	{4}C′B0 [5:0]

Word 5	Word 6	Word 7	Word 8	Word 9	Word 10
{3}A0 [2:0]	{4}A0 [5:3]	{3}A0 [5:3]	{4}A1 [8:6]	{3}A1 [8:6]	{4}A1 [11:9]
{3}C′B0 [5:0]	{4}Y′0 [5:0]	{3}Y′0 [5:0]	{4}C′R0 [11:6]	{3}C′R0 [11:6]	{4}Y′1 [11:6]

Word 11	Word 12	Word 13	Word 14	Word 15
{3}A1 [11:9]	{4}A1 [2:0]	{3}A1 [2:0]	{4}A1 [5:3]	{3}A1 [5:3]
{3}Y′1 [11:6]	{4}C′R0 [5:0]	{3}C′R0 [5:0]	{4}Y′1 [5:0]	{3}Y′1 [5:0]

4.2 Audio Data

When present, audio data shall be mapped into the HANC space of data streams one through eight and shall be in conformance with SMPTE ST 299-1 and SMPTE ST 299-2.

Audio control packets shall be mapped into the odd numbered data streams.

Audio data packets shall be mapped into the even numbered data streams.

Audio control and data packets shall be mapped into the data stream pair one/two first and any remaining data shall then be mapped onto data stream pair three/four, then into data stream pair five/six and finally into data stream pair seven/eight.

The audio clock phase data as defined in the section “CLK (audio clock phase data)” of SMPTE ST 299-1 shall be calculated at the clock frequency of 148.5 (/1.001) MHz for 4:2:2 10-bit and 4:2:0 10-bit formats at 48/1.001, 48, 50, 60/1.001 and 60 Hz, which use Mapping Structure 1.

The audio clock phase data as defined in the section “CLK (audio clock phase data)” of SMPTE ST 299-1 shall be calculated at the clock frequency of 74.25 (/1.001) MHz for formats at 24/1.001, 24, 25, 30/1.001 or 30Hz, which use Mapping Structure 2, 3 or 4.

4.2.1 Number of Audio Channels

The number of audio channels is as defined in SMPTE ST 425-5 “Number of Audio Channels”

4.2.2 Audio Copy

As an alternative to the mapping of the maximum number of unique audio channels described above, blocks of audio channels may be copied within the interface. This may be done in order for Link 2 to carry a copy of Link 1. It may alternatively be as a result of the dual-link 6G-SDI signal being created by combining a quad-link 3G-SDI signal. It may alternatively be done in the original dual-link 6G-SDI signal in order to permit simple splitting of the dual-link 6G-SDI signal into a quad-link 3G-SDI signal.

Note: Audio copy reduces the number of channels that can be transported by the interface.

4.2.2.1 Inherited Audio Copy as a result of combining multi-link 3G-SDI signals

In the case where the audio data has been embedded according to SMPTE ST 425-5, for example when the audio was embedded in a quad-link 3G interface that has been combined into a dual-link 6G interface, the audio in data stream pair three/four, five/six and seven/eight may be a copy of the audio in data stream pair one/two.

Figure 4 shows a quad-link 3G interface combined into a dual-link 6G-SDI interface, and the possible status of audio copy on each data stream.

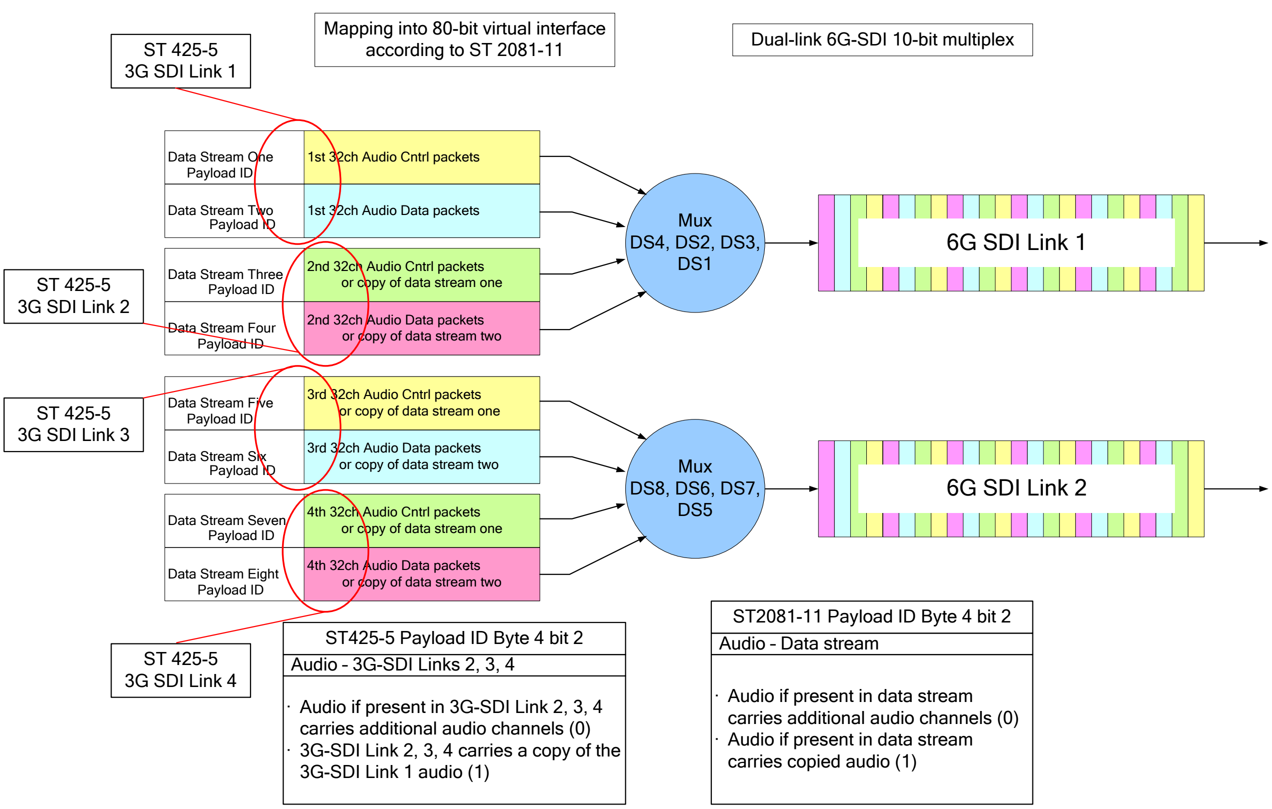


Figure 4 – Inherited audio copy as a result of combining a quad-link 3G-SDI signal

4.2.2.2 Originated Audio Copy in Dual-link 6G-SDI signal

Audio may be copied within the dual-link 6G interface,

1. In order to copy audio from Link 1 to Link 2
2. In order to simplify division of a dual-link 6G signal into a quad-link 3G with audio copy between links.

Note*:* Audio copy reduces the number of channels that can be transported by the interface.

If audio is copied:

Data stream pair one/two shall always carry original audio

Data stream pair three/four may carry additional channels of original audio

Data stream pairs five/six and seven/eight may carry additional channels of original audio, as long as data stream pair three/four is carrying original audio

Data stream pairs five/six and seven/eight may carry copied audio from data stream pairs one/two and three four

Data stream pair three/four may carry copied audio from data stream pair one/two. In this case data stream pairs five six and seven/eight shall also carry the same copied audio.

The audio copy status of each data stream shall be signaled in the PID as described in Section 4.3

4.3 Payload Identifier

Table 3 shows the payload identifier definitions for 2160-line Video Payload Mapping. As stated in SMPTE ST 352, the payload identifier consists of 4 bytes where each byte has a separate significance. The first byte of the payload identifier has the highest significance and subsequent bytes define lower order video and ancillary payload information.

The horizontal placement of the packet should be immediately following the last CRC code word (CR1) of the line(s) specified in SMPTE ST 352 for 1125-line systems.

Note: The line numbers defined in SMPTE ST 352 for the placement of the payload identifier packet in 1125-line systems avoid those lines used by SMPTE ST 299-1 and SMPTE ST 299-2 for the carriage of digital audio control packets and extended audio control packets, respectively.

Table 3 – Payload Identifier Definitions for 2160-line Video Payload for Mapping on a Dual-link 6Gb/s (nominal) Serial 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>Progressive transport (1)</td><td>Aspect Ratio
16:9 (1) or Unknown (0)</td><td rowspan="3">Link assignment
6G-SDI Link 1 (0h)
6G-SDI Link 2 (1h)</td></tr>
<tr><td>Bit 6</td><td>1</td><td>Progressive picture (1)</td><td>Sub image horizontal sampling
1920 (0) or 2048 (1)</td></tr>
<tr><td>Bit 5</td><td>0</td><td rowspan="2">Transfer characteristics
SDR-TV (0h)
HLG (1h)
PQ (2h)
Unspecified (3h)</td><td rowspan="2">Colorimetry
Rec 709*[1] (0h)
Color VANC Packet (1h)
UHDTV*[2] (2h)
Unknown (3h)</td></tr>
<tr><td>Bit 4</td><td>0</td><td>Luminance and color difference signal
$Y'C'_BC'_R$ (0)
IC_TC_P (1)</td></tr>
</table>

<table>
<tr><td>Bit 3</td><td>0</td><td rowspan="4">Picture rate
(See Table 4)</td><td rowspan="4">Sampling structure
(See Table 5)</td><td>Reserved (0)</td></tr>
<tr><td>Bit 2</td><td>0</td><td>Audio copy status:
Audio in this data stream carries additional channels (0)
Audio in this data stream is copied (1)</td></tr>
<tr><td>Bit 1</td><td>1</td><td rowspan="2">Bit depth
10-bit Full Range (0h)
10-bit (1h)
12-bit (2h)
12-bit Full Range (3h)</td></tr>
<tr><td>Bit 0</td><td>0</td></tr>
<tr><td colspan="5">Notes:
*1 Rec 709 indicates ITU-R recommendation BT.709 colorimetry and is equivalent to SMPTE ST 2036-1 Conventional System Colorimetry.
*2 UHDTV indicates SMPTE ST 2036-1 UHDTV colorimetry and is equivalent to ITU-R recommendation BT.2020 colorimetry
3 The usage of bytes 2, 3 and 4 is consistent for all modes in this document but the definitions are repeated for the convenience of the reader</td></tr>
</table>

4.3.1 Byte 1 - Digital Interface and Payload Identification

Byte 1 of the payload identifier identifies the video payload and the digital interface and shall be as defined below.

Byte 1 shall be set to [C2h] for the Mapping for 2160-line image formats listed in Table 1 on to dual-link 6G-SDI.

4.3.2 Byte 2 – Picture Rate and Scanning Method

Byte 2 of the payload identifier shall be used to identify the picture and transport scanning methods and the picture rate.

Bit b7 shall be set to 1 (progressive transport).

Bit b6 shall be set to 1 (progressive picture).

Bits b5 and b4 shall be used to indicate Transfer Characteristic such that:

> b5:b4 = 0h identifies SDR-TV in accordance with SMPTE ST 274 or SMPTE ST 2036-1
>
> b5:b4 = 1h identifies HLG HDR-TV in accordance with Recommendation ITU-R BT.2100
>
> b5:b4 = 2h identifies PQ HDR-TV in accordance with Recommendation ITU-R BT.2100
>
> b5:b4 = 3h identifies Unspecified Transfer Characteristics
>
> In the case where bits b5:b4 of Byte 3 indicate “Color VANC packet as defined in SMPTE ST 2048-1”, if the Transfer Characteristic signaled in the Color VANC packet is active, then it takes precedence over the Transfer Characteristic signaled in b5:b4.

Note: The Reference EOTF as defined in SMPTE ST 2084 is the same as the Reference PQ EOTF defined in Recommendation ITU-R BT.2100.

Bits b3 to b0 shall be used to identify the picture rate in Hz according to Table 4 and shall only use the values as permitted for image formats in Table 1.

Table 4 SMPTE ST 352 Byte 2 Picture rate extended to include high picture (frame) rates

Value	Picture rate Hz	Value	Picture rate Hz	Value	Picture rate Hz	Value	Picture rate Hz
0h	Not defined	1h	96/1.001	2h	24/1.001	3h	24
4h	48/1.001	5h	25	6h	30/1.001	7h	30
8h	48	9h	50	Ah	60/1.001	Bh	60
Ch	96	Dh	100	Eh	120/1.001	Fh	120

4.3.3 Byte 3 – Sub Image Sampling Structure, Aspect Ratio, Horizontal Size and Colorimetry

Byte 3 of the payload identifier shall be used to identify the aspect ratio, horizontal pixel array size, and sampling structure of the sub image video payload.

Bit b7 shall be used to identify the aspect ratio such that:

b7 = 0 identifies unknown aspect ratio

b7 = 1 identifies a 16:9 aspect ratio

Bit b6 shall be used to identify the number of active Luma/R′G′B′ samples for the sub image such that:

b6 = 0 identifies 1920 active Luma/R′G′B′ samples

b6 = 1 identifies 2048 active Luma/R′G′B′ samples

Bits b5 and b4 shall be used to identify the colorimetry for the image formats identified in Table 1 such that:

b5:b4 = 0h identifies Rec 709 colorimetry in accordance with Recommendation ITU-R BT.709 as referenced by SMPTE ST 274

b5:b4 = 1h identifies that the colorimetry is defined in the Color VANC packet as defined in SMPTE ST 2048-1

b5:b4 = 2h identifies UHDTV colorimetry in accordance with the Reference Primaries and reference white as defined in SMPTE ST 2036-1. See Note 2 to Table 3.

b5:b4 = 3h identifies unknown colorimetry

Bits b3 to b0 shall be used to identify the sampling structure in accordance with Table 5 and shall only use the values as permitted for image formats in Table 1.

Table 5 SMPTE ST 352 Byte 3 Sampling Structure

Value	Sampling	Value	Sampling	Value	Sampling	Value	Sampling
0h	4:2:2 ($Y'C'_BC'_R$) or (IC_TC_P)	1h	4:4:4 ($Y'C'_BC'_R$) or (IC_TC_P)	2h	4:4:4 (R′G′B′)	3h	4:2:0 ($Y'C'_BC'_R$) or (IC_TC_P)
4h	4:2:2:4	5h	4:4:4:4	6h	4:4:4:4	7h	Reserved

	(Y′C′BC′R+A) or (ICTCP+A)		(Y′C′BC′R+A) or (ICTCP+A)		(R′G′B′+A)		
8h	4:2:2:4 (Y′C′BC′R+D) or (ICTCP+D)	9h	4:4:4:4 (Y′C′BC′R+D) or (ICTCP+D)	Ah	4:4:4:4 (R′G′B′+D)	Bh	Reserved
Ch	Reserved	Dh	Reserved	Eh	4:4:4 (XYZ)	Fh	Reserved

4.3.4 Byte 4 – Link Identification, Audio copy status and Quantization Bit Depth

Byte 4 of the payload identifier shall be used to identify the link assignment, audio copy status and bit depth of the sample quantization.

Bits b7 to b5 shall be used to identify link assignment such that:

b7:b5 = 0h identifies 6G-SDI Link 1

b7:b5 = 1h identifies 6G-SDI Link 2

other values are reserved

Bit b4 shall be used to indicate the interpretation of the Luminance and color difference signal such that:

b4 = 0 indicates $Y'C'_BC'_R$ in accordance with SMPTE ST 2036-1

b4 = 1 indicates IC_TC_P in accordance with Recommendation ITU-R BT.2100

Note: In the case where Byte 3 bits b3:b0 indicate R′G′B′, bit b4 can be ignored.

See informative Annex B – Further Guidance on luminance and color difference signal Identification.

Bit b3 shall be reserved and set to 0

For data streams one and two, bit b2 shall be set to 0 (reserved)

For data streams three through eight, bit b2 shall be used to identify whether audio data in this data stream is copied:

b2 = 0 identifies that all audio if present in this data stream carries additional channels

b2 = 1 identifies that audio if present in this data stream is copied

Bits b1 to b0 shall be used to identify the bit depth of the sample quantization such that:

b1:b0 = 0h identifies quantization using Full Range 10-bit per sample as defined in Recommendation ITU-R BT.2100.

The prohibited code values shall be protected in accordance with SMPTE RP 2077 “Mapping to Interfaces and Formats that Rely upon Protected Code Values” with CV_{LOW} = 4 and CV_{HIGH} = 1019

b1:b0 = 1h identifies quantization using 10 bits per sample

b1:b0 = 2h identifies quantization using 12 bits per sample

b1:b0 = 3h identifies quantization using Full Range 12-bit per sample as defined in Recommendation ITU-R BT.2100

Note: due to the nature of the bit-mapping structures applied to these 12-bits per sample image formats, there is no requirement to clip or scale 12-bit full range images to avoid protected code words.

4.4 Blanking (Informative)

As defined in the sub image source format documents SMPTE ST 274 and SMPTE ST 2048-2, HANC and VANC space with no ancillary data packets or audio data packets contain data words that represent video black level for the video structure being carried.

In the case of Mapping Structure 1, 4:2:2 $Y'C'_BC'_R$ or IC_TC_P 10-bit video structure, all words of all odd numbered data streams take the value 040h, and all words of all even numbered data streams take the value 200h

In the case of Mapping Structure 1, 4:2:2 $Y'C'_BC'_R$ or IC_TC_P 10-bit Full Range video structure, all words of all odd numbered data streams take the value 004h, and all words of all even numbered data streams take the value 200h

In the case of Mapping Structure 2, 4:4:4(:4) R′G′B′(+A) 10-bit video structure, all words of all data streams take the value 040h

In the case of Mapping Structure 2, 4:4:4(:4) R′G′B′ (+A) 10-bit Full Range video structure, all words in all odd numbered data streams take the value 004h. Even numbered words in even numbered data streams take the value 040h and odd numbered words in even numbered data streams take the value 004h.

In the case of Mapping Structure 2, 4:4:4(:4) $Y'C'_BC'_R$ (+A) or IC_TC_P(+A) 10-bit video structure, even numbered words in each data stream take the value 040h, and odd numbered words in each data stream take the value 200h

In the case of Mapping Structure 2, 4:4:4(:4) $Y'C'_BC'_R$ (+A) or IC_TC_P(+A) 10-bit Full Range video structure, even numbered words in odd numbered data streams take the value 004h, even numbered words in even numbered data streams take the value 040h and odd numbered words in each data stream take the value 200h

In the case of Mapping Structure 3, 4:4:4 R′G′B′ 12-bit video structure, all words in odd numbered data streams take the value 200h, even numbered words in even numbered data streams take the value 124h, and odd numbered words in even numbered data streams take the value 200h.

In the case of Mapping Structure 3, 4:4:4 R′G′B′ 12-bit Full Range video structure, all words in all data streams take the value 200h.

In the case of Mapping Structure 3, 4:4:4 $Y'C'_BC'_R$ or IC_TC_P 12-bit video structure, even numbered words in odd numbered data streams take the value 104h, odd numbered words in odd numbered data streams take the value 200h, even numbered words in even numbered data streams take the value 220h, and odd numbered words in even numbered data streams take the value 200h.

In the case of Mapping Structure 3, 4:4:4 $Y'C'_BC'_R$ or IC_TC_P 12-bit Full Range video structure, even numbered words in odd numbered data streams take the value 104h, odd numbered words in odd numbered data streams take the value 200h, and all words in even numbered data streams take the value 200h.

In the case of Mapping Structure 4, 4:2:2(:4) $Y'C'_BC'_R$ (+A) or IC_TC_P(+A) 12-bit video structure, even numbered words in odd numbered data streams take the value 204h, odd numbered words in odd numbered data streams take the value 200h, even numbered words in even numbered data streams take the value 120h, and odd numbered words in even numbered data streams take the value 200h.

In the case of Mapping Structure 4, 4:2:2(:4) $Y'C'_BC'_R$ (+A) or IC_TC_P(+A) 12-bit Full Range video structure, all words in odd numbered data streams take the value 200h, even numbered words in even numbered data streams take the value 120h, and odd numbered words in even numbered data streams take the value 200h.

Note: Word numbering starts at the first word of active video which is numbered zero and is an even numbered word. Word numbering refers to the 10-bit words which make up each data stream and is not the same as sample numbering.

4.5 Multiplex

The 80-bit virtual interface with the modified PID values shall then be multiplexed onto two 6G-SDI 10-bit interfaces according to Section 6.

4.6 Levels of Operation (Informative)

To define the level of support for SMPTE ST 2081-11 Mode 1, manufacturers are encouraged to indicate in publications which mapping format is supported. For example:

SMPTE ST 2081-11 MODE 1 – 2160-line Source image formats and ancillary data into a Dual-link 6 Gb/s [nominal] SDI bit-serial interface

Manufacturers are also encouraged to indicate in publications supported audio and video formats.

5 MODE 2: Carriage of 1080-line R′G′B′, $Y'C'_BC'_R$, IC_TC_P, XYZ, 4:4:4(:4) 10-bit and 4:4:4 12-bit High Frame Rate (HFR) Source image formats and ancillary data

For this mode, the Source Image Formats and corresponding mapping structures shall be as defined in Table 6.

Table 6 – Supported Image sample structures and frame rates

Reference Standard	Format	Signal Format Sampling Structure/pixel Depth	Frame Rates	Mapping Structure
Rec. ITU-R BT.2100	1920 x 1080	4:4:4 (R′G′B′)/10-bit 4:4:4:4 (R′G′B′+A[*3])/10-bit 4:4:4 ($Y'C'_BC'_R$)/10-bit 4:4:4:4 ($Y'C'_BC'_R$+A[*3])/10-bit 4:4:4 (IC_TC_P[*4])/10-bit 4:4:4:4 (IC_TC_P[*4]+A[*3])/10-bit	120 frames progressive	II
			120/1.001 frames progressive	
			100 frames progressive	
SMPTE ST 2048-1	2048 x 1080[*2]	4:4:4 (R′G′B′[*1])/10-bit, 4:4:4:4 (R′G′B′[*1]+A[*3])/10-bit, 4:4:4 ($Y'C'_BC'_R$)/10-bit, 4:4:4:4 ($Y'C'_BC'_R$+A[*3])/10-bit	120 frames progressive	
			120/1.001 frames progressive	
			100 frames progressive	
			96 frames progressive	
			96/1.001 frames progressive	
Rec. ITU-R BT.2100	1920 x 1080	4:4:4 (R′G′B′[*1])/12-bit, 4:4:4 ($Y'C'_BC'_R$)/12-bit 4:4:4 (IC_TC_P[*4])/12-bit	120 frames progressive	III
			120/1.001 frames progressive	
			100 frames progressive	
SMPTE ST 2048-1	2048 x 1080[*2]	4:4:4 (R′G′B′[*1])/12-bit, 4:4:4 ($Y'C'_BC'_R$)/12-bit	120 frames progressive	
			120/1.001 frames progressive	
			100 frames progressive	
			96 frames progressive	
			96/1.001 frames progressive	
Rec. ITU-R BT.2100	1920 x 1080	4:2:2 ($Y'C'_BC'_R$)/12-bit 4:2:2:4 ($Y'C'_BC'_R$+A[*3])/12-bit 4:2:2 (IC_TC_P[*4])/12-bit 4:2:2:4 (IC_TC_P[*4]+A[*3])/12-bit 4:2:0 ($Y'C'_BC'_R$)/12-bit 4:2:0 (IC_TC_P[*4])/12-bit	120 frames progressive	IV
			120/1.001 frames progressive	
			100 frames progressive	
SMPTE ST 2048-1	2048 x 1080[*2]	4:2:2 ($Y'C'_BC'_R$)/12-bit 4:2:0 ($Y'C'_BC'_R$)/12-bit 4:2:2:4 ($Y'C'_BC'_R$+A[*3])/12-bit	120 frames progressive	
			120/1.001 frames progressive	
			100 frames progressive	
			96 frames progressive	
			96/1.001 frames progressive	

Notes:

*1 In this image format R′G′B′ indicates either R′G′B′ or $R'_{FS}G'_{FS}B'_{FS}$.

*2 This is the maximum pixel array, the active image may not fill the maximum array.

*3 Definition of the A channel is application-dependent. An auxiliary component signal designated A or Alpha may optionally accompany the R′G′B′, $R'_{FS}G'_{FS}B'_{FS}$, $Y'C'_BC'_R$ or IC_TC_P video signal. Interfaces containing the auxiliary component are denoted as R′G′B′+A, $Y'C'_BC'_R$+A and IC_TC_P+A. In the cases when the A channel is used for non-picture data, the payload is constrained to 8-bit words maximum

*4 In accordance with Recommendation ITU-R BT.2100, IC_TC_P sampling is only applied to High Dynamic Range (HDR) progressive image formats.

Image data values shall be constrained to avoid SDI prohibited codes.

- In the case of 10-bit formats the image data values shall be constrained to values 004h through 3FBh to avoid SDI prohibited codes 000h through 003h and 3FCh through 3FFh after mapping
- In the case of 12-bit formats the image data values shall be constrained to values 010h through FEFh to avoid SDI prohibited codes 000h through 003h and 3FCh through 3FFh after mapping

5.1 Mapping

Figure 5 illustrates the process for the carriage of 1080-line HFR source image formats in a Dual-link 6G-SDI interface.

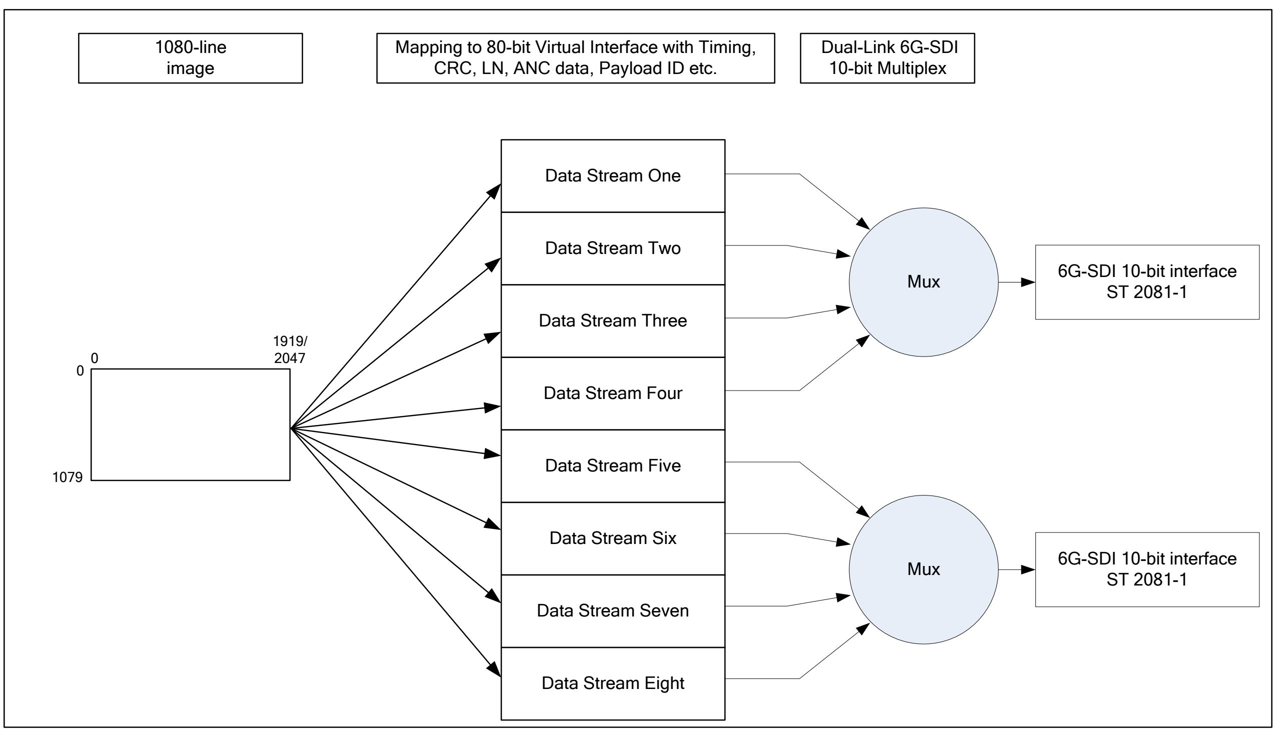
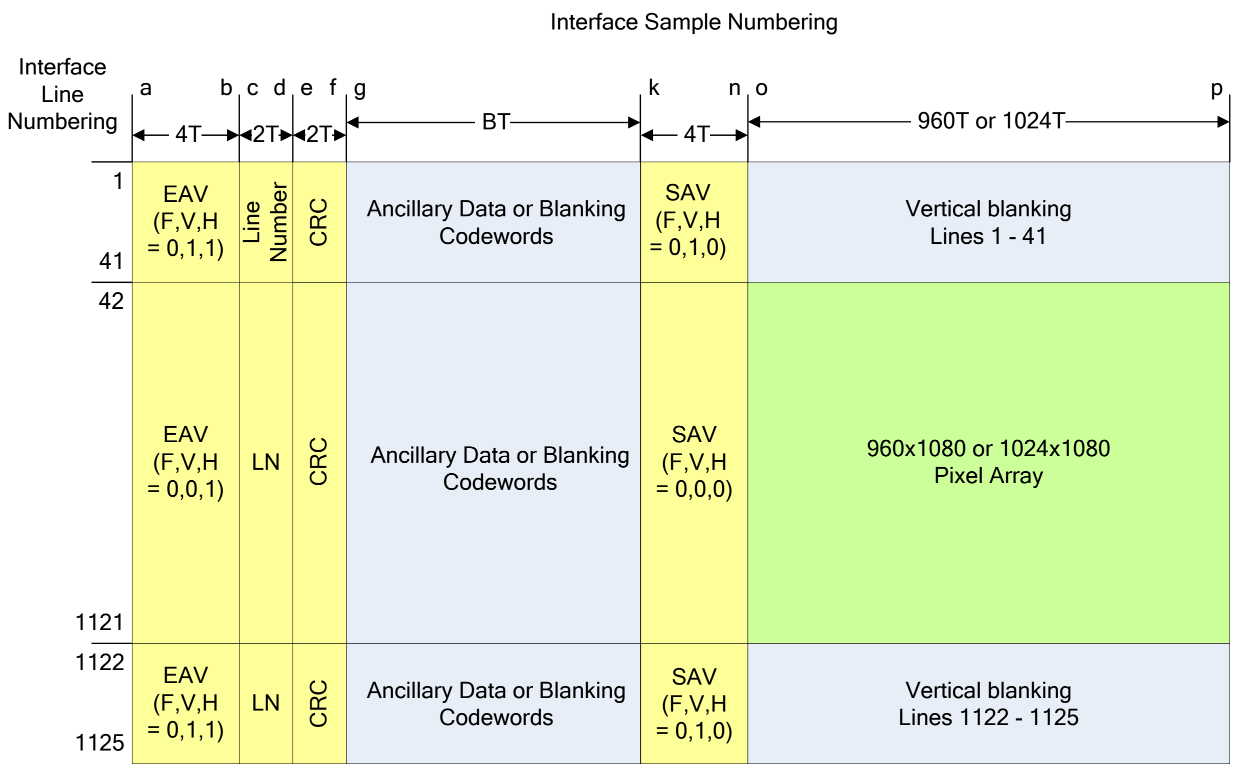


Figure 5 – Carriage of 1080-line HFR image on a Dual-link 6G-SDI interface – overall process

The 1080-line image shall be mapped to an 80-bit virtual interface consisting of eight data streams. The structure of each data stream shall be as illustrated in Figure 6.



Sub Image Format	a	b	c	d	e	f	g	BT	k	n	o	p
1920 x 1080 / 120	960	963	964	965	966	967	968	128	1096	1099	0	959
1920 x 1080 / 120/1.001	960	963	964	965	966	967	968	128	1096	1099	0	959
1920 x 1080 / 100	960	963	964	965	966	967	968	348	1316	1319	0	959
2048 x 1080 / 120	1024	1027	1028	1029	1030	1031	1032	64	1096	1099	0	1023
2048 x 1080 / 120/1.001	1024	1027	1028	1029	1030	1031	1032	64	1096	1099	0	1023
2048 x 1080 / 100	1024	1027	1028	1029	1030	1031	1032	284	1316	1319	0	1023
2048 x 1080 / 96	1024	1027	1028	1029	1030	1031	1032	339	1371	1374	0	1023
2048 x 1080 / 96/1.001	1024	1027	1028	1029	1030	1031	1032	339	1371	1374	0	1023

Figure 6 – Structure of each data stream for 120 Hz, 120/1.001 Hz, 100 Hz, 96 Hz or 96/1.001 Hz frame rates

5.1.1 Mapping Structure II:

The image shall be mapped on to data streams one through eight.

Data stream one shall carry the odd G′ samples G′1, G′3, G′5, G′7 …

Data stream two shall carry the even R′ samples R′0, R′2, R′4…

Data stream three shall carry the even G′ samples G′0, G′2, G′4, G′6 …

Data stream four shall carry the even B′ samples B′0, B′2, B′4…

Data stream five shall carry the odd A samples A1, A3, A5, A7 …

Data stream six shall carry the odd R′ samples R′1, R′3, R′5…

Data stream seven shall carry the even A samples A0, A2, A4, A6 …

Data stream eight shall carry the odd B′ samples B′1, B′3, B′5…

For the 4:4:4 ($Y'C'_BC'_R$) and the 4:4:4:4 ($Y'C'_BC'_R$+A)/10-bit images, the sub image shall be mapped as above such that:

The G′ samples are replaced with Y′ samples,
the B′ samples are replaced with C'_B samples
and the R′ samples are replaced with C'_R samples.

For the 4:4:4 (IC_TC_P) and the 4:4:4:4 (IC_TC_P+A)/10-bit images, the sub image shall be mapped as above such that:

The G′ samples are replaced with I samples,
the B′ samples are replaced with C_T samples
and the R′ samples are replaced with C_P samples.

The eight data streams, data stream one through data stream eight, shall be combined into an 80-bit virtual interface having an interface frequency of 148.5 MHz or 148.5/1.001 MHz.

5.1.2 Mapping Structure III

The image shall be mapped on to data streams one through eight.

Data stream one shall carry the 10 MSBs of odd G′ samples: G′1:2-11, G′3:2-11, G′5:2-11….

Data stream two shall carry the 10 MSBs of even R′ samples: R′0:2-11, R′2:2-11, R′4:2-11…

Data stream three shall carry the 10 MSBs of even G′ samples: G′0:2-11, G′2:2-11, G′4:2-11…

Data stream four shall carry the 10 MSBs of even B′ samples: B′0:2-11, B′2:2-11, B′4:2-11…

Data stream five shall carry the two LSBs of the odd R′, G′ and B′ samples according to section 5.1.2.1:

R′G′B′1:0-1, R′G′B′3:0-1, R′G′B′5:0-1 ….

Data stream six shall carry the 10 MSBs of odd R′ samples:

R′1:2-11, R′ 3:2-11, R′5:2-11 …

Data stream seven shall carry the two LSBs of the even R′, G′ and B′ samples according to section 5.1.2.1:

R′G′B′0:0-1, R′G′B′2:0-1, R′G′B′4:0-1 ….

Data stream eight shall carry the 10 MSBs of odd B′ samples:

B′1:2-11, B′ 3:2-11, B′5:2-11 …

For the 4:4:4 ($Y'C'_BC'_R$) 12-bit images, the sub image shall be mapped as above such that:

The G′ samples are replaced with Y′ samples,
the B′ samples are replaced with C'_B samples
and the R′ samples are replaced with C'_R samples.

For the 4:4:4 (IC_TC_P) 12-bit images, the sub image shall be mapped as above such that:

The G′ samples are replaced with I samples,
the B′ samples are replaced with C_T samples
and the R′ samples are replaced with C_P samples.

The eight data streams, data stream one through data stream eight, shall be combined into an 80-bit virtual interface having an interface frequency of 148.5 MHz or 148.5/1.001 MHz.

5.1.2.1 R′G′B′n:0-1 Data Mapping

Note: the suffix “n” indicates the sample number.

Mapping of the least significant 2 bits from R′, G′ and B′ onto data stream five and data stream seven shall be as shown in Table 7.

Table 7 – R′G′B′n:0-1 mapping onto data stream five and data stream seven

	Bit Number									
Word	9 (MSB)	8	7	6	5	4	3	2	1	0 (LSB)
	$\overline{B8}$	EP	G′n:1	G′n:0	B′n:1	B′n:0	R′n:1	R′n:0	Res	Res

Notes:

1 MSB: most significant bit.

2 LSB: least significant bit.

3 B8 is the even parity for B7 through B0.

4 B9 is the complement of B8.

5 B0 and B1 are the reserved bits (Reserved bits shall be set to 0 until defined).

For the 4:4:4 ($Y'C'_BC'_R$) 12-bit images, the data shall be mapped as above such that:

The G′ samples are replaced with Y′ samples,
the B′ samples are replaced with C'_B samples
and the R′ samples are replaced with C'_R samples.

For the 4:4:4 (IC_TC_P) 12-bit images, the data shall be mapped as above such that:

The G′ samples are replaced with I samples,
the B′ samples are replaced with C_T samples
and the R′ samples are replaced with C_P samples.

5.1.3 Mapping Structure IV:

The image shall be mapped on to data streams one through eight.

Data stream one shall carry the 10 MSBs of odd Y′ samples: Y′1:2-11, Y′3:2-11, Y′5:2-11, Y′7:2-11 …

Data stream two shall carry the 10 MSBs of even C'_R samples: C'_R0:2-11, C'_R2:2-11, C'_R4:2-11…

Data stream three shall carry the 10 MSBs of even Y′ samples: Y′0:2-11, Y′2:2-11, Y′4:2-11, Y′6:2-11 …

Data stream four shall carry the 10 MSBs of even C'_B samples: C'_B0:2-11, C'_B2:2-11, C'_B4:2-11…

Data stream five shall carry the two LSBs of the odd Y′ samples according to section 5.1.3.1:

Y′1:0-1, Y′3:0-1, Y′5:0-1 …

Data stream six shall carry the odd A samples: A1, A3, A5, A7.…

Data stream seven shall carry the two LSBs of the even Y′, C'_B and C'_R samples according to section 5.1.3.1:
$Y'C'_BC'_R0$:0-1, $Y'C'_BC'_R2$:0-1, $Y'C'_BC'_R4$:0-1…

Data stream eight shall carry the even A samples: A0, A2, A4, A6.…

For the 4:2:2 (IC_TC_P) 12-bit images, the data shall be mapped as above such that:

The Y′ samples are replaced with I samples,
the C'_B samples are replaced with C_T samples
and the C'_R samples are replaced with C_P samples.

The eight data streams, data stream one through data stream eight, shall be combined into an 80-bit virtual interface having an interface frequency of 148.5 MHz or 148.5/1.001 MHz.

5.1.3.1 $Y'C'_BC'_Rn$:0-1, Y′n;0-1 Data Mapping

Note: the suffix “n” indicates the sample number.

Mapping of the least significant 2 bits from the even-numbered samples of Y′, C'_B and C'_R, onto data stream seven shall be as shown in Table 8.

Mapping of the least significant 2 bits from the odd-numbered samples of Y′ (only), onto data stream five shall be as shown in Table 9.

Table 8 – $Y'C'_BC'_Rn$:0-1 even sample mapping onto data stream seven

	Bit Number									
Word	9 (MSB)	8	7	6	5	4	3	2	1	0 (LSB)
	$\overline{B8}$	EP	Y′n:1	Y′n:0	C'_Bn:1	C'_Bn:0	C'_Rn:1	C'_Rn:0	Res	Res

Notes:

1 MSB: most significant bit.

2 LSB: least significant bit.

3 B8 is the even parity for B7 through B0.

4 B9 is the complement of B8.

5 B1 and B0 are the reserved bits (Reserved bits shall be set to 0 until defined).

Table 9 – Y′n:0-1 odd sample mapping onto data stream five

Word	Bit Number 9 (MSB)	8	7	6	5	4	3	2	1	0 (LSB)
	$\overline{B8}$	EP	Y′n:1	Y′n:0	Res	Res	Res	Res	Res	Res

Notes:

1 MSB: most significant bit.

2 LSB: least significant bit.

3 B8 is the even parity for B7 through B0.

4 B9 is the complement of B8.

5 B5 through B0 are the reserved bits (Reserved bits shall be set to 0 until defined).

For the 4:2:2 (IC_TC_P) 12-bit images, the data shall be mapped as above such that:

The Y' samples are replaced with I samples,
the C'_B samples are replaced with C_T samples
and the C'_R samples are replaced with C_P samples.

Figure 7 illustrates how a 1920 x 1080 R′G′B′(+A) 10-bit image is mapped onto data streams one through eight using mapping structure II. Mapping structure III and mapping structure IV have identical timing and reference, line number and line CRC codes, but different active picture data. 2048 x 1080 images have maximum sample numbers of 2047 where the 1920 x 1080 image has maximum sample numbers of 1919

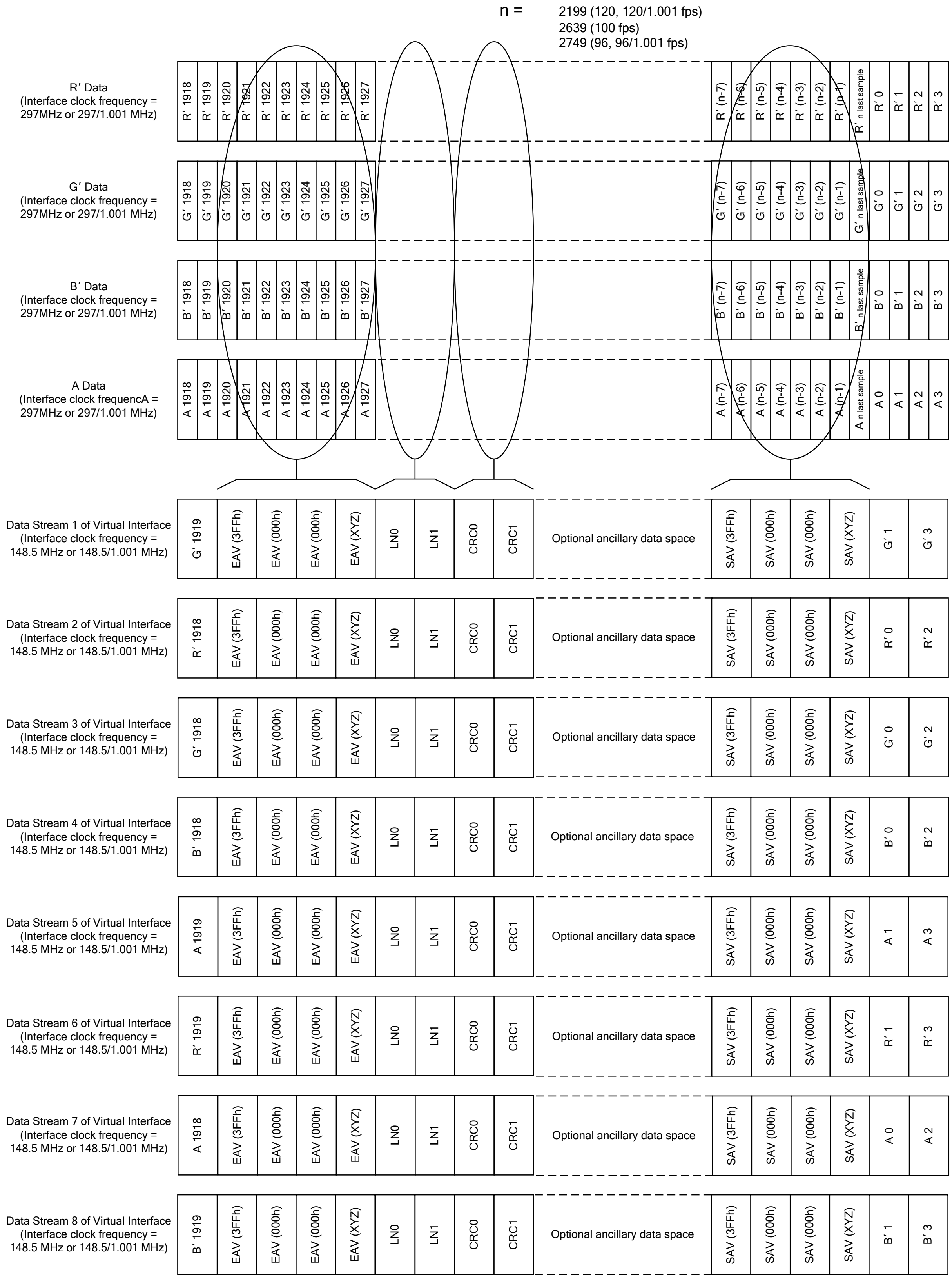


Figure 7 – Mapping Structure II 1920 x 1080 4:4:4 R′G′B′(A)/10-Bit Signals at 96/1.001, 96, 100, 120/1.001 and 120 Progressive Frames/Sec

5.2 Timing and Reference Signals

EAV (End of Active Video) and SAV (Start of Active Video) timing references shall be inserted into each data stream of the 80-bit virtual interface on a line-by-line basis as illustrated in Figure 7.

The EAV and SAV sequence, F (field/ frame), V (vertical), H (horizontal) and parity bits P3 through P1 shall be as defined in Table 10 and Table 11.

Table 10 – Bit assignment for timing reference codes

Word	Value	Bit number									
		b9 (MSB)	b8	b7	b6	b5	b4	b3	b2	b1	b0 (LSB)
1	FFFh	1	1	1	1	1	1	1	1	1	1
2	000h	0	0	0	0	0	0	0	0	0	0
3	000h	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

Table 11 – Protection Parity bits for timing reference codes

Bit number	b8	b7	b6	b5	b4	b3	b2
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

5.3 Line Numbers

Line numbers shall be inserted into each data stream of the 80-bit virtual interface starting at the first data word (of the virtual interface) following the EAV XYZ word, as illustrated in Figure 7.

Line number data are composed of two words, LN0 and LN1, and shall be as shown in Table 12.

Table 12 – Line Number Data

	B9 (msb)	B8	B7	B6	B5	B4	B3	B2	B1	B0 (lsb)
LN0	$\overline{B8}$	L6	L5	L4	L3	L2	L1	L0	Res	Res
LN1	$\overline{B8}$	Res	Res	Res	L10	L9	L8	L7	Res	Res
Notes: 1 L10 : L0 = line number in binary code. 2 Res = reserved, set to “0”										

5.4 Line CRC Codes

CRC (Cyclic Redundancy Check) codes shall be inserted into each data stream of the 80-bit virtual interface starting at the first data word (of the virtual interface) following the final word of the line number – LN1, as illustrated in Figure 7.

The CRC code words are used to detect errors in the active digital line, the EAV timing reference signal and line number words that follow it. The error detection code consists of two words determined by the polynomial generator equation:

$CRC(X) = X^{18} + X^5 + X^4 + 1$

The initial value of the CRC shall be zero. The calculation shall start at the first active line word of the interface and shall end at the final word of the line number – LN1.

Independent CRC codes shall be produced for each data stream of the 160-bit virtual interface.

The two words of the CRC code shall be as shown in Table 13.

Table 13 – CRC Data

	B9(msb)	B8	B7	B6	B5	B4	B3	B2	B1	B0(lsb)
CR0	$\overline{B8}$	CRC8	CRC7	CRC6	CRC5	CRC4	CRC3	CRC2	CRC1	CRC0
CR1	$\overline{B8}$	CRC17	CRC16	CRC15	CRC14	CRC13	CRC12	CRC11	CRC10	CRC9

5.5 HANC and VANC Space of Data Streams

When present, ancillary data packets shall be mapped into the HANC or the VANC spaces of each data stream and shall be in accordance with SMPTE ST 291-1.

The HANC and VANC spaces for each data stream are defined in Figure 6 of section 5.1.

Unless otherwise stated, the ancillary data shall be preferentially mapped into data stream one first and any remaining data shall then be mapped onto data stream three; then into data stream five, data stream seven and so on up to data stream thirty one. Data space requirements and locations for each data service are defined by their respective application documents. In some cases it is required by specific applications that ancillary data be mapped into all eight data streams (e.g. Payload ID.)

Informative Annex A provides information about the amount of HANC and VANC data space available in this operating mode.

5.6 Audio Data

When present, audio data shall be mapped into the HANC space of data streams one through eight and shall be in conformance with SMPTE ST 299-1 and SMPTE ST 299-2.

Audio control packets shall be mapped into the odd numbered data streams.

Audio data packets shall be mapped into the even numbered data streams.

Audio control and data packets shall be mapped into the data stream pair one/two first and any remaining data shall then be mapped onto data stream pair three/four; then into data stream pair five/six, then into data stream pair eight/nine.

The audio clock phase data as defined in the section “CLK (audio clock phase data)” of SMPTE ST 299-1 shall be calculated at the data stream clock frequency of 148.5 MHz.

5.6.1 Number of Audio Channels

Informative Note:

1080p images at 96, 100 and 120 fps have horizontal line rates of 108 kHz, 112.5 kHz and 135 kHz respectively.

As SMPTE ST 299-1 states that an audio sample should be placed in the next available line, and calculates the phase word from the start of the line, it is only possible to embed audio samples in one line every 20.833 us on average (i.e. at 48 kHz). This means that the majority of the lines are not available for audio embedding, and the number of audio channels that can be transported is significantly less than appears from a simple calculation of the total HANC space.

Informative Note ends

Up to 64 audio channels sampled at 32 kHz, 44.1 kHz or 48 kHz may be mapped into data streams one through eight of the 80-bit virtual interface. At 96 kHz sampling, up to 32 audio channels may be mapped into the virtual interface.

The maximum number of audio channels that can be mapped into the available ancillary data space of each data stream pair varies in accordance with the video format and the video frame rate. Table 14 shows the overall capacity of the 80-bit virtual interface.

Table 14 – Number of Audio Channels supported Source Image Format, Frame Rate and Audio Sampling Rate

Source Image Format	Frame Rate	Maximum number of audio channels at 32 kHz, 44.1 kHz or 48 kHz sampling	Maximum number of audio channels at 96 kHz sampling
1920x1080	100 and 120 Progressive	Up to 64 channels	Up to 32 channels
2048x1080	96 and 100 Progressive	Up to 64 channels	Up to 32 channels
	120 Progressive	Up to 32 channels	Up to 16 channels

5.6.1.1 Carriage of up to 64 Channels of Audio at up to 48 kHz Sampling

For audio at up to 48 kHz sampling embedded into 2048 x 1080 image formats at a frame rate of 120, the audio data and control packets for the first 8 channels shall be mapped into data stream pair one/two in conformance with SMPTE ST 299-1 (audio groups 1 to 4).

The audio data and control packets for the second 8 channels shall be mapped into data stream pair three/four in conformance with SMPTE ST 299-1 (audio groups 1 to 4).

The audio data and control packets for the third 8 channels shall be mapped into data stream pair five/ six in conformance with SMPTE ST 299-1 (audio groups 1 to 4).

The audio data and control packets for the fourth 8 channels shall be mapped into data stream pair seven/eight in conformance with SMPTE ST 299-1 (audio groups 1 to 4).

For audio at up to 48 kHz sampling embedded into all other 1080-line image formats shown in Table 14, the audio data and control packets and for the first 16 channels shall be mapped into data stream pair one/two in conformance with SMPTE ST 299-1 (audio groups 1 to 4).

The audio data and control packets and audio data and control packets for the second 16 channels shall be mapped into data stream pair three/four in conformance with SMPTE ST 299-1 (audio groups 1 to 4).

The audio data and control packets for the third 16 channels shall be mapped into data stream pair five/six in conformance with SMPTE ST 299-1 (audio groups 1 to 4).

The audio data and control packets for the fourth 16 channels shall be mapped into data stream pair seven/eight in conformance with SMPTE ST 299-1 (audio groups 1 to 4).

5.6.1.2 Carriage of up to 32 Channels of Audio at 96 kHz Sampling

For audio at 96 kHz sampling embedded into 2048 x1080 image formats at frame rates of 120, the audio data and control packets for the first 4 channels shall be mapped into data stream pair one and two in conformance with SMPTE ST 299-1 (audio groups 1 to 4).

The audio data and control packets for the second 4 channels shall be mapped into data stream pair three and four in conformance with SMPTE ST 299-1 (audio groups 1 to 4).

The audio data and control packets for the third 4 channels shall be mapped into data stream pair five and six in conformance with SMPTE ST 299-1 (audio groups 1 to 4).

The audio data and control packets for the fourth 4 channels shall be mapped into data stream pair seven and eight in conformance with SMPTE ST 299-1 (audio groups 1 to 4).

For audio at 96 kHz sampling, embedded into all other 1080-line image formats shown in Table 14, the audio data and control packets for the first 8 channels shall be mapped into data stream pair one and two in conformance with SMPTE ST 299-1 (audio groups 1 to 4).

The audio data and control packets for the second 8 channels shall be mapped into data stream pair three and four in conformance with SMPTE ST 299-1 (audio groups 1 to 4).

The audio data and control packets for the third 8 channels shall be mapped into data stream pair five and six in conformance with SMPTE ST 299-1 (audio groups 1 to 4).

The audio data and control packets for the fourth 8 channels shall be mapped into data stream pair seven and eight in conformance with SMPTE ST 299-1 (audio groups 1 to 4).

5.6.2 Audio Copy

As an alternative to the mapping of the maximum number of unique audio channels described above, blocks of audio channels may be copied within the interface. This may be as a result of the dual-link 6G-SDI signal being created by combining a quad-link 3G-SDI. It may alternatively be done in the original dual-link 6G-SDI signal in order to permit simple splitting of the dual-link 6G-SDI signal into a quad-link 3G-SDI signal.

Note: Audio copy reduces the number of channels that can be transported by the interface.

If audio is copied:

Data streams one and two shall always carry original audio

Data streams three and four may also carry original audio

Data streams five through eight may carry copied audio from data streams one through four.

Data streams three and four may carry copied audio from data streams one and two. In this case data streams five and six, and data streams seven and eight shall also carry the same copied audio.

The audio copy status of each data stream shall be signaled in that data stream's PID as described in section 5.8.

5.7 Time Code Data

When present, the data format of ATC packets shall be in conformance with SMPTE ST 12-3.

When present, the packet or packets shall be mapped into the HANC or VANC space of data stream one. The preferred location should be as indicated in Table 15.

Table 15 – Preferred locations for time code insertion into data streams

Payload Type	Location
ATC_HFRTC	HANC, Line 11
ATC_HFRTC *	HANC, Line 12
ATC_HFRTC *	HANC, Line 13
ATC_HFRTC *	HANC, Line 14
Note: * Transmissions of multiple ancillary time code packets with different instance identifications (bitstream numbers) per video frame are permissible under the provisions of SMPTE ST 12-3. The default bitstream number is zero. Lines 12, 13 and 14 are for use when necessary based on the number of bitstreams	

The ATC_HFRTC packet with bitstream number zero shall be preferentially mapped onto line 11 first and any remaining bitstreams shall then be mapped onto the same line. If there is insufficient space remaining on the same line, remaining bitstreams shall be mapped onto line 12, then onto line 13, then onto line 14.

The time code may also be mapped into data stream three, data stream five, and data stream seven, in which case the corresponding Time Address values shall be identical.

5.8 Payload Identifier

A payload identifier packet shall be placed in each data stream

Table 16 shows the payload identifier definitions for 1080-line HFR Video Payloads. As stated in SMPTE ST 352, the payload identifier consists of 4 bytes where each byte has a separate significance. The first byte of the payload identifier has the highest significance and subsequent bytes define lower order video and ancillary payload information.

The horizontal placement of the packet should be immediately following the last CRC code word (CR1) of the line(s) specified in SMPTE ST 352 for 1125-line systems.

Note: The line numbers defined in SMPTE ST 352 for the placement of the payload identifier packet in 1125-line systems avoid those lines used by SMPTE ST 299-1 and SMPTE ST 299-2 for the carriage of digital audio control packets and extended audio control packets, respectively.

Table 16 – Payload Identifier Definitions for 1080-line Video Payload for Mapping on a Dual-link 6Gb/s (nominal) Serial Interface

Bits	Byte 1	Byte 2	Byte 3	Byte 4
Bit 7	1	Progressive transport (1)	Aspect Ratio 16:9 (1) or Unknown (0)	Link assignment 6G-SDI Link 1 (0h) 6G-SDI Link 2 (1h)
Bit 6	1	Progressive picture (1)	Image horizontal sampling 1920 (0) or 2048 (1)	
Bit 5	1	Transfer characteristics SDR-TV (0h) HLG (1h) PQ (2h) Unspecified (3h)	Colorimetry Rec 709*1 (0h) Color VANC Packet (1h) UHDTV*2 (2h) Unknown (3h)	
Bit 4	1			Luminance and color difference signal $Y'C'_BC'_R$ (0) IC_TC_P (1)
Bit 3	0	Picture rate (See Table 4)	Sampling structure (See Table 5)	Reserved (0)
Bit 2	0			Audio copy status: Audio in this data stream carries additional channels (0) Audio in this data stream is copied (1)
Bit 1	1			Bit depth 10-bit Full Range (0h) 10-bit (1h) 12-bit (2h) 12-bit Full Range (3h)
Bit 0	1			

Notes:

*1 Rec 709 indicates ITU-R recommendation BT.709 colorimetry and is equivalent to SMPTE ST 2036-1 Conventional System Colorimetry.

*2 UHDTV indicates SMPTE ST 2036-1 UHDTV colorimetry and is equivalent to ITU-R recommendation BT.2020 colorimetry

3 The usage of bytes 2, 3 and 4 is consistent for all modes in this document but the definitions are repeated for the convenience of the reader

5.8.1 Byte 1 - Digital Interface and Payload Identification

Byte 1 of the payload identifier identifies the video payload and the digital interface and shall be as defined below.

Byte 1 shall be set to F3h for 1080-line image formats listed in Table 6 transported via dual-link 6G-SDI.

5.8.2 Byte 2 – Picture Rate and Scanning Method

Byte 2 of the payload identifier shall be used to identify the picture and transport scanning methods and the picture rate.

Bit b7 shall be set to 1 (progressive transport).

Bit b6 shall be set to 1 (progressive picture).

Bits b5 and b4 shall be used to indicate Transfer Characteristic such that:

b5:b4 = 0h identifies SDR-TV in accordance with SMPTE ST 274 or SMPTE ST 2036-1

b5:b4 = 1h identifies HLG HDR-TV in accordance with Recommendation ITU-R BT.2100

b5:b4 = 2h identifies PQ HDR-TV in accordance with Recommendation ITU-R BT.2100

b5:b4 = 3h identifies Unspecified Transfer Characteristics

In the case where bits b5:b4 of Byte 3 indicate “Color VANC packet as defined in SMPTE ST 2048-1”, if the Transfer Characteristic signaled in the Color VANC packet is active, then it takes precedence over the Transfer Characteristic signaled in b5:b4.

Note: The Reference EOTF as defined in SMPTE ST 2084 is the same as the Reference PQ EOTF defined in Recommendation ITU-R BT.2100.

Bits b3 to b0 shall be used to identify the picture rate in Hz according to Table 4 and shall only use the values as permitted for image formats in Table 6.

5.8.3 Byte 3 – Sampling Structure, Aspect Ratio, Horizontal Size and Colorimetry

Byte 3 of the payload identifier shall be used to identify the aspect ratio, horizontal pixel array size, and sampling structure of the video payload.

Bit b7 shall be used to identify the aspect ratio such that:

b7 = 0h identifies unknown aspect ratio

b7 = 1h identifies a 16:9 aspect ratio

Bit b6 shall be used to identify the number of active Luma/R′G′B′ samples for the image such that:

b6 = 0h identifies 1920 active Luma/R′G′B′ samples

b6 = 1h identifies 2048 active Luma/R′G′B′ samples

Bits b5 and b4 shall identify the colorimetry for the image formats identified in Table 6 such that:

b5:b4 = 0h identifies Rec 709 colorimetry in accordance with Recommendation ITU-R BT.709 as referenced by SMPTE ST 274

b5:b4 = 1h identifies that the colorimetry is defined in the Color VANC packet as defined in SMPTE ST 2048-1

b5:b4 = 2h identifies UHDTV colorimetry in accordance with the Reference Primaries and reference white as defined in SMPTE ST 2036-1. See Note 2 to Table 16.

b5:b4 = 3h identifies unknown colorimetry

Bits b3 to b0 shall be used to identify the sampling structure in accordance with Table 5 and shall only use the values as permitted for image formats in Table 6.

5.8.4 Byte 4 – Link Identification, Audio Copy Status and Quantization Bit Depth

Byte 4 of the payload identifier shall be used to identify the link assignment, the audio copy status and the bit depth of the sample quantization.

Bits b7 to b5 shall be used to identify link assignment such that:

b7:b5 = 0h identifies 6G-SDI Link 1

b7:b5 = 1h identifies 6G-SDI Link 2

other values are reserved

Bit b4 shall be used to indicate the interpretation of the Luminance and color difference signal such that:

b4 = 0 indicates $Y'C'_BC'_R$ in accordance with SMPTE ST 2036-1

b4 = 1 indicates IC_TC_P in accordance with Recommendation ITU-R BT.2100

Note: In the case where Byte 3 bits b3:b0 indicate R′G′B′, bit b4 can be ignored.

See informative Annex B – Further Guidance on luminance and color difference signal Identification.

Bit b3 shall be Reserved and set to 0

For data streams one and two, bit b2 shall be set to 0 (reserved)

For data streams three through eight, bit b2 shall be used to identify whether audio data in this data stream is copied:

b2 = 0 identifies that all audio if present in this data stream carries additional channels

b2 = 1 identifies that audio if present in this data stream is copied

Bits b1 to b0 shall be used to identify the bit depth of the sample quantization such that:

b1:b0 = 0h identifies quantization using Full Range 10-bit per sample as defined in Recommendation ITU-R BT.2100.

The prohibited code values shall be protected in accordance with SMPTE RP 2077 "Mapping to Interfaces and Formats that Rely upon Protected Code Values" with CV_{LOW} = 4 and CV_{HIGH} = 1019

b1:b0 = 1h identifies quantization using 10 bits per sample

b1:b0 = 2h identifies quantization using 12 bits per sample

b1:b0 = 3h identifies quantization using Full Range 12-bit per sample as defined in Recommendation ITU-R BT.2100.

The prohibited code values shall be protected in accordance with SMPTE RP 2077 "Mapping to Interfaces and Formats that Rely upon Protected Code Values" with CV_{LOW} = 16 and CV_{HIGH} = 4079

5.9 Blanking

HANC and VANC space with no ancillary data packets or audio data packets shall contain data words that represent video black level for the video structure being carried.

5.9.1 Blanking Values (Informative)

For Mapping Structure II R′G′B′(+A) 10-bit video structure all words of all data streams take the value 040h

For Mapping Structure II R′G′B′(+A) 10-bit Full Range video structure all words of data streams one and three take the value 004h, all words of data streams five and seven take the value 040h and all words of all even numbered data streams take the value 004h.

For Mapping Structure II $Y'C'_BC'_R$(+A) or IC_TC_P(+A) 10-bit video structure all words of all odd numbered data streams take the value 040h, and all words of all even numbered data streams take the value 200h

For Mapping Structure II $Y'C'_BC'_R$(+A) or IC_TC_P(+A) 10-bit Full Range video structure all words of data streams one and three take the value 004h, all words of data streams five and seven take the value 040h and all words of all even numbered data streams take the value 200h

For Mapping Structure III R′G′B′ 12-bit video structure all words of data streams five and seven take the value 200h. All words in all other data streams take the value 040h.

For Mapping Structure III R′G′B′ 12-bit Full Range video structure all words of data streams five and seven take the value 200h. All words in all other data streams take the value 004h.

For Mapping Structure III $Y'C'_BC'_R$ or IC_TC_P 12-bit video structure all words of data stream one and three take the value 040h. All words in all other data streams take the value 200h.

For Mapping Structure III $Y'C'_BC'_R$ or IC_TC_P 12-bit Full Range video structure all words of data stream one and three take the value 004h. All words in all other data streams take the value 200h.

For Mapping Structure IV $Y'C'_BC'_R$(+A) or IC_TC_P(+A) 4:2:2(:4) 12-bit video structure all words of data stream one, three, six and eight take the value 040h. All words in all other data streams take the value 200h.

For Mapping Structure IV $Y'C'_BC'_R$(+A) or IC_TC_P(+A) 4:2:2(:4) 12-bit Full Range video structure all words of data stream one and three take the value 004h. All words of data streams six and eight take the value 100h. All words in all other data streams take the value 200h.

5.10 Multiplex

The 80-bit virtual interface shall then be multiplexed onto two type 1 6G-SDI 10-bit interfaces according to section 6.

5.11 Levels of Operation (Informative)

To define the level of support for SMPTE ST 2081-11 Mode 2, manufacturers are encouraged to indicate in publications which mapping format is supported. For example:

SMPTE ST 2081-11 MODE 2 – 1080-line HFR Source image formats and ancillary data into a dual-link 6 Gb/s [nominal] SDI bit-serial interface

Manufacturers are also encouraged to indicate in publications supported audio and video formats.

6 Dual-Link 6G-SDI 10-bit Multiplex

Prior to serialization data streams one through eight of the 80-bit virtual interface shall be multiplexed word-by-word into two 6G-SDI 10-bit interfaces.

The first 10-bit interface shall consist of a word multiplex of data streams one through four, in the order data stream four, data stream two, data stream three, data stream one…

The second 10-bit interface shall consist of a word multiplex of data streams five through eight, in the order data stream eight, data stream six, data stream seven, data stream five…

Each of the two 10-bit parallel interfaces so produced will have an interface frequency of 594 MHz or 594/1.001MHz as shown in the illustrative example of Figure 8.

The first 10-bit interface can then be serialized according to SMPTE ST 2081-1 to create 6G-SDI Link 1.

The second 10-bit interface can then be serialized according to SMPTE ST 2081-1 to create 6G-SDI Link 2.

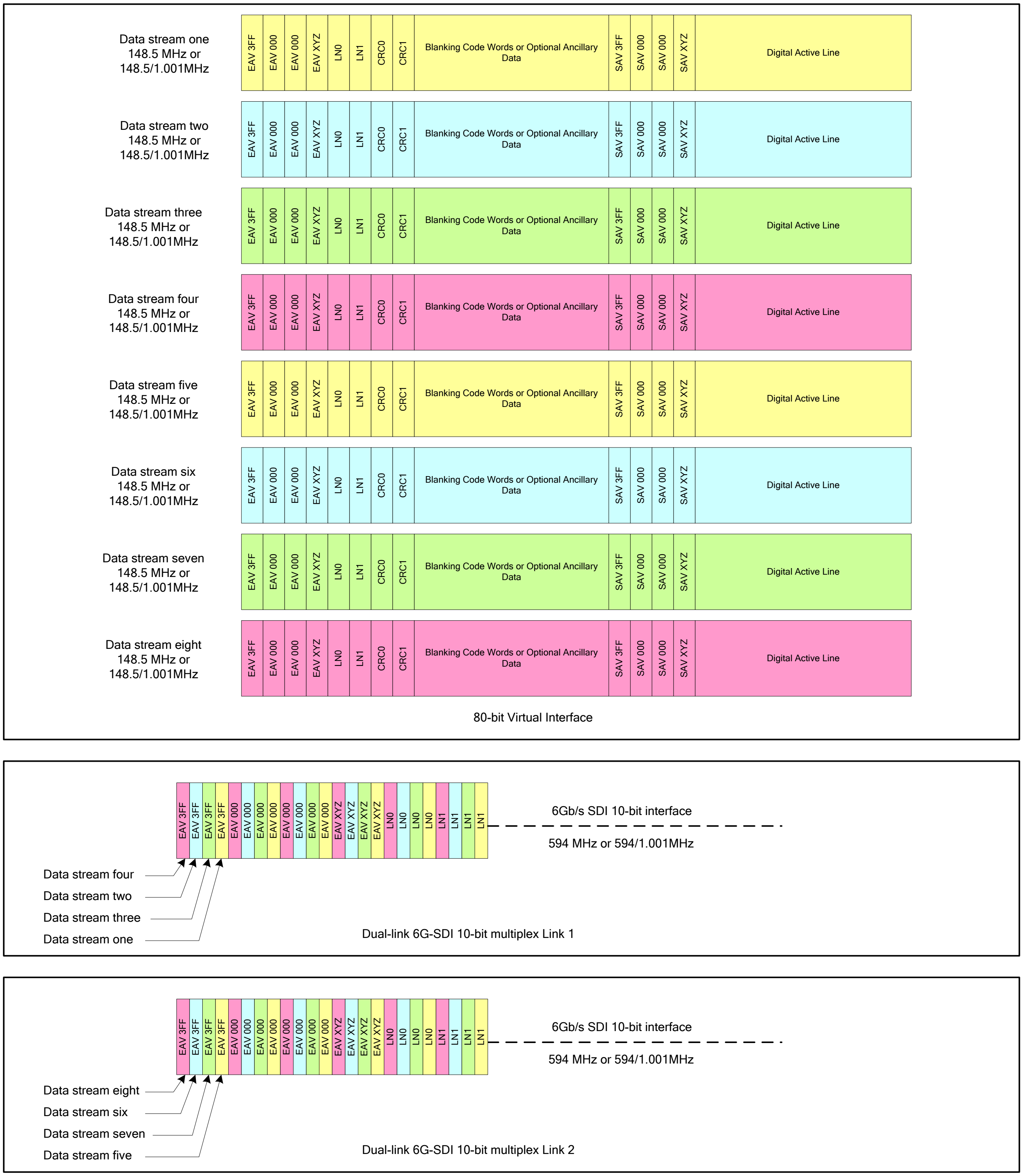


Figure 8 – Dual-link 6G-SDI 2 x 10-bit Multiplex Type 1 for Mode 1 and Mode 2

Note: Figure 8 shows the Type 1 10-bit multiplex resulting from mapping modes in which each data stream has a single instance of TRS words, Line Numbers, CRC Words, etc.

7 6G-SDI Link 1 / 6G-SDI Link 2 Interface Timing

The timing difference between the EAV / SAV of 6G-SDI Link 1 and 6G-SDI Link 2 shall not exceed 250 ns at the serial output of source equipment. This difference should be taken into consideration when designing systems and destination equipment input stages.

Annex A Ancillary Data Capacity of the Dual-link 6G-SDI Interface (Informative)

The ancillary data space available in serial digital interface transports is approximately equivalent to horizontal interval space and vertical interval space for the image format being transported. In the case of images transported on the interface specified in this standard, it is dependent on the horizontal interval space and vertical interval space for each of the data streams being carried on the interface, multiplied by the number of data streams.

SMPTE RP 291-2 provides information on the size of the ancillary data space in a SMPTE ST 425-1 and SMPTE ST 292-1 interface.

For Mode 1 2160-line source image formats specified in this standard, the available HANC and VANC data space on the interface is 4 times the HANC and VANC data space available (as shown in the tables of SMPTE RP 291-2) on a SMPTE ST 425-1 interface carrying the corresponding sub-image.

For Mode 2 1080-line source image formats specified in this standard, the available HANC and VANC data space on each of the eight data streams of the interface is defined in section 5.5 of this standard.

SMPTE RP 291-2 also provides a method of calculating the available ancillary data space on any interface. These calculations provide the reader with the underlying formulas used to calculate the numbers in the tables, as well as providing a mechanism to calculate the space for interfaces not covered explicitly by SMPTE RP 291-2.

Annex B Further Guidance on Luminance and Color Difference Signal Identification (Informative)

The following table provides additional information for the logical association and meaning of “transfer characteristics”, “sampling structure” and “luminance and color difference signal” Identification as signaled in the Payload Identifier for UHDTV1 and UHDTV2 image structures applicable to this interface.

Table B1 – Transfer Characteristics, Sampling Structure and Luminance and Color Difference Signal truth table

Transfer Characteristics	Sampling Structure	Luminance and color difference (L&CD) identifier	Meaning of L&CD Identifier
SDR-TV	$Y'C'_BC'_R$	0	Indicates $Y'C'_BC'_R$ in accordance with SMPTE ST 2036-1
	$Y'C'_BC'_R$	1	Indicates Constant luminance $Y'C'_BC'_R$ in accordance with Recommendation ITU-R BT.2020 This is not permitted in this document but it is permitted in Recommendation ITU-R BT.2077
HLG or PQ	$Y'C'_BC'_R$	0	Indicates Non-constant luminance $Y'C'_BC'_R$ in accordance with Recommendation ITU-R BT.2100
	IC_TC_P	1	Indicates IC_TC_P in accordance with Recommendation ITU-R BT.2100.
SDR-TV HLG or PQ	G′B′R′	Not valid	L&CD can be ignored

Bibliography (Informative)

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SMPTE ST 12-2:2014, Transmission of Time Code in the Ancillary Data Space

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SMPTE ST 425-1:2017, Source Image Format and Ancillary Data Mapping for the 3 Gb/s Serial Interface

SMPTE ST 2048-2:2011, 2048 × 1080 Digital Cinematography Production Image FS/709 Formatting for Serial Digital Interface

SMPTE ST 2051:2014, Two-Frame Marker for 48(/1.001)-Hz, 50-Hz and 60(/1.001)-Hz Progressive Digital Video Signals on 1.5 Gb/s and 3 Gb/s Interfaces

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