SMPTE STANDARD

2160-Line and 1080-Line Source Image and Ancillary Data Mapping for Single-Link 6G-SDI

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Approved
February 4, 2015

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 2081-10 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

SMPTE ST 2081-10 defines the mapping of various source images and associated ancillary data into a Single-link 6 Gb/s [nominal] SDI bit-serial interface.

The general process for creating a single-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.

Parameter values included in tables or described in sections marked as (Informative), are based on reference documents of the specific version indicated in the reference section and identified in applicable normative sections of this standard.

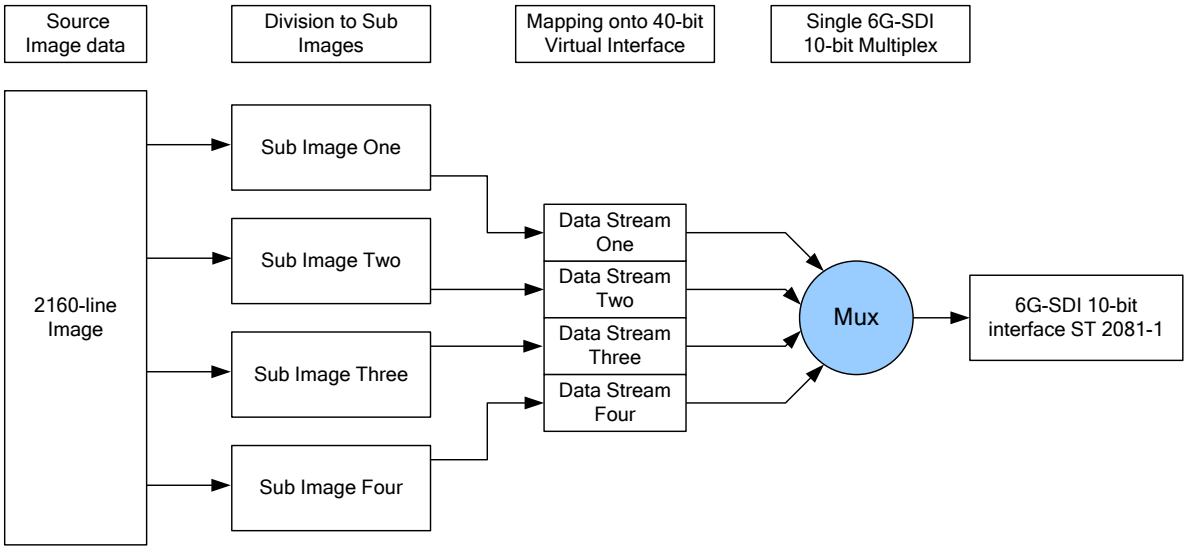

Figure 1 – Carriage of 2160-line images in a Single-link 6G-SDI interface — Generalized process

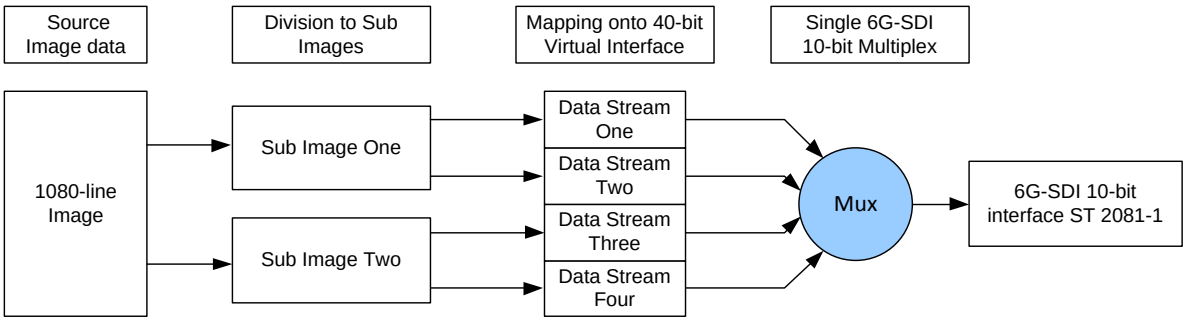

Figure 2 – Carriage of 1080-line images in a Single-link 6G-SDI interface — Generalized process

Formatting

The source images are divided into two or four 1080-line sub images, depending on the format of the source image.

The sub images are then mapped onto a 40-bit virtual interface consisting of four 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 40-bit virtual interface is multiplexed onto a single 6G-SDI 10-bit interface in the order data stream four, data stream two, data stream three, data stream one.

1 Scope

This Standard defines the mapping of:

- **Mode 1:** 2160-line Source image formats identified in Table 1 into a Single-link 6 Gb/s [nominal] SDI bit-serial interface
- **Mode 2:** 1080-line Source image formats identified in Table 6 and into a Single-link 6 Gb/s [nominal] SDI bit-serial interface

This Standard also defines the carriage of ancillary data, and the SMPTE ST 352 payload ID's for the Single-link 6 Gb/s SDI interface.

It is not necessary for implementations to include support for all operating modes or image formats that are included in this standard. Implementers should indicate supported operating modes and image 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 352:2013, Payload Identification Codes for Serial Digital Interfaces

SMPTE ST 425-3:2014, Image Format and Ancillary Data Mapping for the Dual Link 3 Gb/s Serial Interface

4 Mode 1: Carriage of 2160-Line Source Image Formats and Ancillary Data

In the case of 2160-line mapping, the image formats supported are defined in SMPTE ST 425-3, “Table 3 – 2160-line Source Image Formats”, repeated here for convenience in Table 1.

Table 1 – 2160-line Source Image Formats (Informative)

Reference SMPTE Standard	Image Format	Signal Format Sampling Structure/pixel Depth	Frame Rate (Hz)
ST 2036-1	3840 × 2160	4:2:2 ($Y'C'_BC'_R$)/10-bit 4:2:0 ($Y'C'_BC'_R$)/10-bit	24/1.001, 24, 25, 30/1.001 and 30 Progressive
ST 2048-1	4096 × 2160	4:2:2 ($Y'C'_BC'_R$)/10-bit	24/1.001, 24, 25, 30/1.001 and 30 Progressive

The image shall be mapped onto a 40-bit virtual interface in accordance with SMPTE ST 425-3 “Mapping of 2160-line Source Image”.

The 40-bit virtual interface shall include sync and timing (TRS) words, Cyclic redundancy code (CRC) words, line numbers, HANC and VANC data and time code — except audio — according to SMPTE ST 425-3 “Mapping of 2160-line Source Image”.

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

4.1 Image Mapping (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 Single-link 6G-SDI interface.

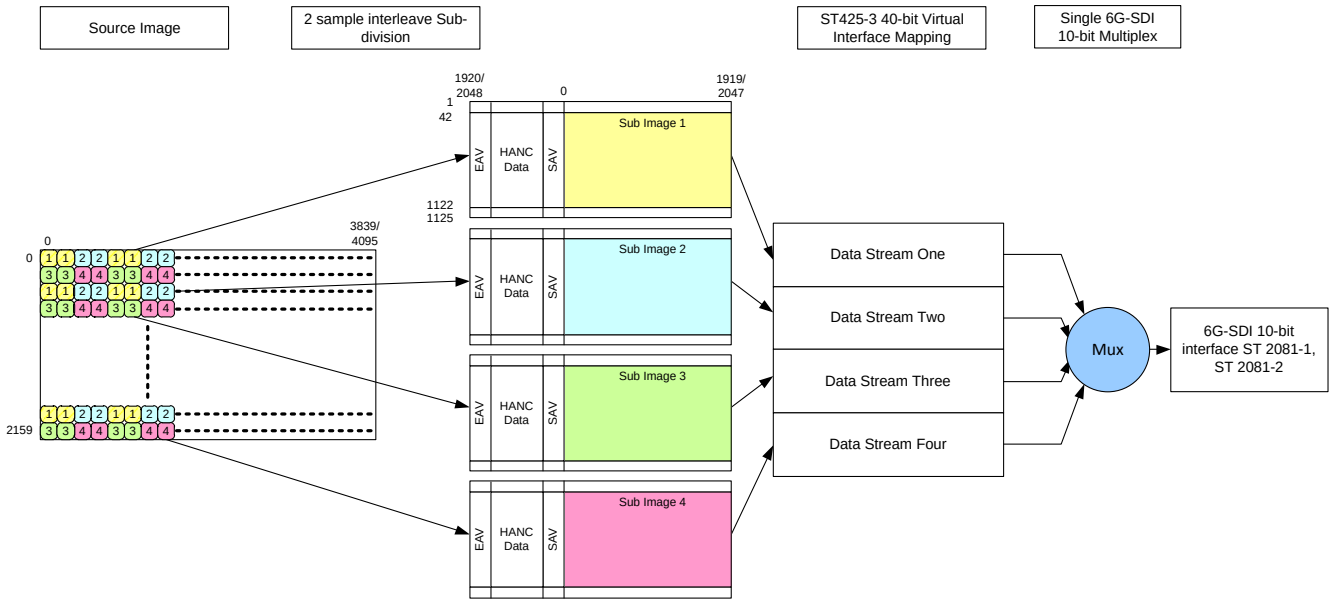

Figure 3 – Carriage of 2160-line source image formats in a single-link 6G-SDI interface

4.1.1 Image sub-division (Informative)

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 425-3 2160-line Mapping.

For 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.

Each 1080-line sub image conforms to the sub image format defined in "Table 14 – Sub Image Formats for 2160-line Source Image" of SMPTE ST 425-3 repeated here for convenience in Table 2.

Table 2 – 1080-line Sub Image Formats for 2160-line Source Images (Informative)

Reference SMPTE Standard	Image Format	Signal Format Sampling Structure/Pixel Depth	Frame Rate (Hz)
ST 274	1920 × 1080	4:2:2 ($Y'C'_BC'_R$)/10-bit	24/1.001, 24, 25, 30/1.001 and 30 Progressive
ST 2048-2	2048 × 1080	4:2:2 ($Y'C'_BC'_R$)/10-bit	24/1.001, 24, 25, 30/1.001 and 30 Progressive

Each sub image is then mapped into one of four data streams each of which complies with the 1.5 Gb/s data stream defined in SMPTE ST 292-1. Sub image 1 is mapped into data stream one. Sub image 2 is mapped into data streams two. Sub image 3 is mapped into data stream three. Sub image 4 is mapped into data stream four.

Each data stream includes sync and timing (TRS) words, Cyclic redundancy code (CRC) words, line numbers, HANC and VANC data including audio and time code as defined in SMPTE ST 425-3 2160-line Mapping.

The four 10-bit data streams are then combined onto a 40-bit virtual interface.

4.1.2 2160-line 40-bit Virtual Interface Mapping (Informative)

The video data words from each sub image are conveyed in the following order in the data streams of the 40-bit virtual interface:

Sub image 1 is mapped into data stream one:

data stream one: C'_B0, Y'0, C'_R0, Y'1, C'_B2, Y'4, C'_R2, Y'5…from even lines as per Figure 3

Sub image 2 is mapped into data stream two:

data stream two: C'_B1, Y'2, C'_R1, Y'3, C'_B3, Y'6, C'_R3, Y'7…from even lines as per Figure 3

Sub image 3 is mapped into data stream three:

data stream three: C'_B0, Y'0, C'_R0, Y'1, C'_B2, Y'4, C'_R2, Y'5…from odd lines as per Figure 3

Sub image 4 is mapped into data stream four:

data stream four: C'_B1, Y'2, C'_R1, Y'3, C'_B3, Y'6, C'_R3, Y'7…from odd lines as per Figure 3

For 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.

4.1.2.1 6G-SDI Link Multiplex Structure (Informative)

Following the 6G-SDI 10-bit multiplex according to Section 6, the 6G-SDI data stream is conveyed in the following order:

6G-SDI data stream: C'_B1_{Odd}, C'_B1, C'_B0_{Odd}, C'_B0, $Y'2_{Odd}$, $Y'2$, $Y'0_{Odd}$, $Y'0$, C'_R1_{Odd}, C'_R1, C'_R0_{Odd}, C'_R0, $Y'3_{Odd}$, $Y'3$, $Y'1_{Odd}$, $Y'1$, C'_B3_{Odd}, C'_B3, C'_B2_{Odd}, C'_B2, $Y'6_{Odd}$, $Y'6$, $Y'4_{Odd}$, $Y'4$, C'_R3_{Odd}, C'_R3, C'_R2_{Odd}, C'_R2, $Y'7_{Odd}$, $Y'7$, $Y'5_{Odd}$, $Y'5$ …

Note: The term “Odd” in subscript above indicates that the samples are derived from the odd numbered lines of the original source image.

4.2 Audio Data

When present, audio data shall be mapped into the HANC space of data streams one, two, three and four as defined in SMPTE ST 425-3 “Mapping of 2160-line Source Image — Audio Data”.

4.2.1 Number of Audio Channels

The number of audio channels shall be as defined in SMPTE ST 425-3 “Mapping of 2160-line Source Image — 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 as a result of the single-link 6G-SDI signal being created by combining dual-link 3G-SDI signals. It may alternatively be done in the original single-link 6G-SDI signal in order to permit simple splitting of the single-link 6G-SDI signal into a dual-link 3G-SDI signal.

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

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

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

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

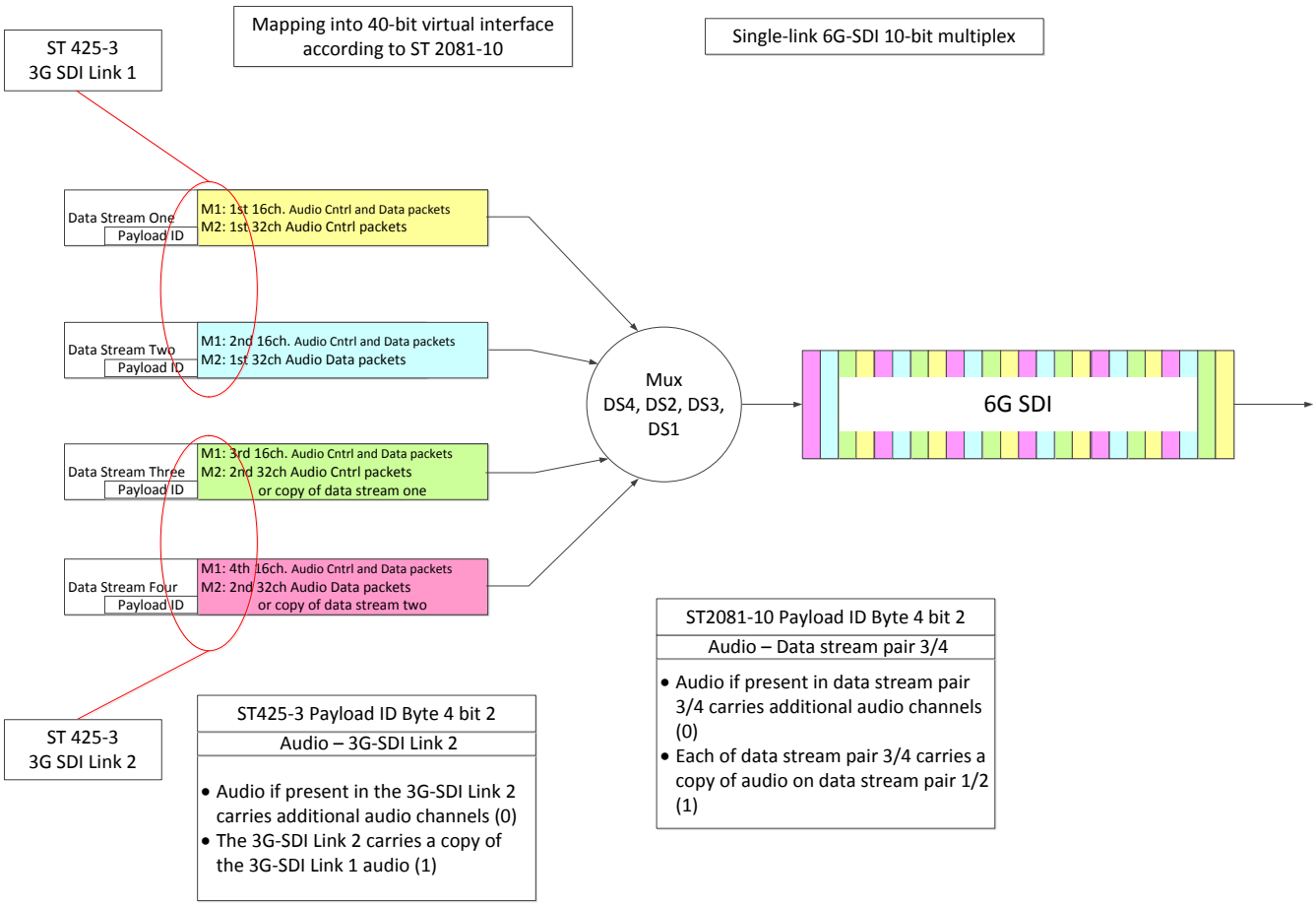

Figure 4 – Inherited audio copy as a result of combining a dual-link 3G-SDI signal

4.2.2.1 Originated Audio Copy in 6G-SDI signal

Audio may also be copied within the 6G interface in order to simplify division of a single 6G signal into dual-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 shall carry a copy of the audio data and control packets from data stream pair one/two.

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

4.3 Payload Identifier Structure

Table 3 shows the payload identifier definitions for 2160-line 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 recommended location for the payload identifier is defined in SMPTE ST 425-3.

Table 3 – Payload Identifier Definitions for Mode 1 - 2160-line mapping on a single-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
Single link 6G-SDI (0h)</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>Reserved (0)</td><td rowspan="3">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>Reserved (0)</td><td>Reserved (0)</td></tr>
<tr><td>Bit 3</td><td>0</td><td rowspan="4">Picture rate
(SeeTable 4)</td><td rowspan="4">Sampling structure
(seeTable 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>0</td><td rowspan="2">Bit depth
10-bit (1h)
Other values are Reserved</td></tr>
<tr><td>Bit 0</td><td>0</td></tr>
</table>

Notes:

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

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

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 set to [C0h] for 2160-line image formats listed in Table 1 on to single-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 set to 0 (Reserved).

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 additional picture (frame) rates

Value	Picture rate Hz	Value	Picture rate Hz	Value	Picture rate Hz	Value	Picture rate Hz
0h	Not defined	1h	Reserved	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 and Horizontal Size

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 shall identifies 2048 active Luma/R'G'B' samples

Bits b5 and b4 shall identify the colorimetry in accordance with the image format in Table 1 such that:

b5:b4 = 0h shall identify Rec 709 colorimetry

b5:b4 = 1h shall identify UHDTV colorimetry

b5:b4 = 2h shall identify that the colorimetry is defined in the Color VANC packet as referenced in SMPTE ST 2048-1

b5:b4 = 3h shall identify 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 – Byte 3 Sampling Structure

Value	Sampling	Value	Sampling	Value	Sampling	Value	Sampling
0h	4:2:2 ($Y'C'_BC'_R$)	1h	4:4:4 ($Y'C'_BC'_R$)	2h	4:4:4 ($R'G'B'$)	3h	4:2:0 ($Y'C'_BC'_R$)
4h	4:2:2:4 ($Y'C_B'C'_R$+A)	5h	4:4:4:4 ($Y'C'_BC'_R$+A)	6h	4:4:4:4 (GBR+A)	7h	Reserved
8h	4:2:2:4 ($Y'C'_BC'_R$+D)	9h	4:4:4:4 ($Y'C'_BC'_R$+D)	Ah	4:4:4:4 ($R'G'B'$+D)	Bh	Reserved
Ch	Reserved	Dh	Reserved	Eh	4:4:4 ($X'Y'Z'$)	Fh	Reserved

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

Byte 4 of the payload identifier shall be used to identify the sub image, and bit depth of the sample quantization.

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

b7:b5 = 0h shall identify Single link 6G-SDI

Bit b4 and bit 3 shall be Reserved and set to (0h)

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

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

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

b2 = 1 shall identify 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 = 1h identifies quantization using 10-bit per sample

Other values are reserved.

4.4 10-Bit Multiplex

The 40-bit virtual interface with the modified PID values shall then be multiplexed onto a 6G-SDI 10-bit interfaces according to Section 6.

4.5 Levels of Operation (Informative)

To define the level of support for ST 2081-10 Mode 1, manufacturers are encouraged to indicate in publications which mapping format is supported. For example:

ST 2081-10 MODE 1 – 2160-line Source image formats and ancillary data into a Single-link 6 Gb/s [nominal] SDI bit-serial interface

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

5 Mode 2: Carriage of 1080-Line Source Image Formats and Ancillary Data

In the case of 1080-line mapping, the image formats supported are defined in SMPTE ST 425-3 “Table 2 – 1080-line Source Image Formats”, repeated here for convenience in Table 6.

Table 6 – 1080-line Source Image Formats (Informative)

Mapping Structure	Reference SMPTE Standard	Image Format	Signal Format Sampling Structure/pixel Depth	Frame Rate (Hz)
II	ST 274	1920 × 1080	4:4:4 (R'G'B'), 4:4:4:4 (R'G'B' +A)/10-bit	50, 60/1.001 and 60 Progressive
	ST 2048-2	2048 × 1080*[2]	4:4:4 (R'G'B'*[1]), 4:4:4:4 (R'G'B'*[1]+A)/10-bit	48/1.001, 48, 50, 60/1.001 and 60 Progressive
	ST 274	1920 × 1080	4:4:4 ($Y'C'_BC'_R$), 4:4:4:4 ($Y'C'_BC'_R$+A)/10-bit	50, 60/1.001 and 60 Progressive
	ST 2048-2	2048 × 1080*[2]	4:4:4 ($Y'C'_BC'_R$), 4:4:4:4 ($Y'C'_BC'_R$+A)/10-bit	48/1.001, 48, 50, 60/1.001 and 60 Progressive
III	ST 274	1920 × 1080	4:4:4 (R'G'B')/12-bit	50, 60/1.001 and 60 Progressive
	ST 2048-2	2048 × 1080*[2]	4:4:4 (R'G'B'*[1])/12-bit	48/1.001, 48, 50, 60/1.001 and 60 Progressive
	ST 274	1920 × 1080	4:4:4 ($Y'C'_BC'_R$)/12-bit	50, 60/1.001 and 60 Progressive
	ST 2048-2	2048 × 1080*[2]	4:4:4 ($Y'C'_BC'_R$)/12-bit	48/1.001, 48, 50, 60/1.001 and 60 Progressive
IV	ST 274	1920 × 1080	4:2:2 ($Y'C'_BC'_R$)/12-bit	50, 60/1.001 and 60 Progressive
	ST 2048-2	2048 × 1080*[2]	4:2:2 ($Y'C'_BC'_R$)/12-bit	48/1.001, 48, 50, 60/1.001 and 60 Progressive
	ST 2048-2	2048 × 1080*[2]	4:2:2:4 ($Y'C'_BC'_R$+A)/12-bit	48/1.001, 48, 50, 60/1.001 and 60 Progressive

Notes:

*[1] In this image format R'G'B' indicates either R'G'B' or $R'_{FS}G'_{FS}B'_{FS}$. An additional Color VANC packet to describe the FS characteristics is defined by SMPTE ST 2048-1.

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

The source images shall be divided into two sub images in accordance with Mapping Structures II, III or IV of SMPTE ST 425-3. Each sub image shall then be mapped into two 10-bit data streams in accordance with Mapping Structure 1, as defined in SMPTE ST 425-3.

The 10-bit data streams shall then be combined into a 40-bit virtual interface.

The 40-bit virtual interface shall include sync and timing (TRS) words, Cyclic redundancy code (CRC) words, line numbers, HANC and VANC data and time code – except audio - according to SMPTE ST 425-3 “1080-line Level A Mapping”.

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

5.1 Image Mapping (Informative)

Figure 5 illustrates the process for the carriage of SMPTE ST 274 and SMPTE ST 2048-2 1080-line source image formats in a Single-link 6G-SDI interface.

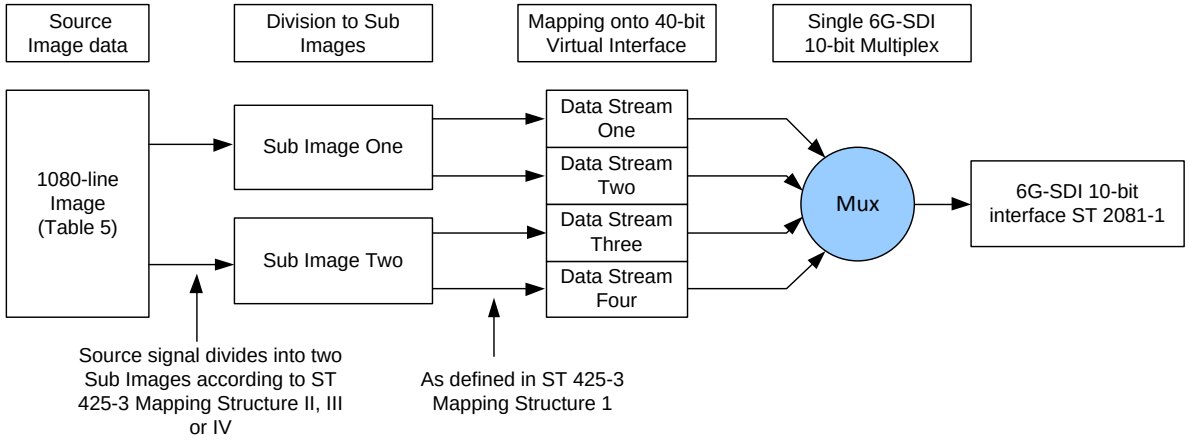

Figure 5 – Carriage of 1080-line images in a Single-link 6G-SDI interface — Generalized process

5.1.1 Image sub-division (Informative)

The 1080-line source image is divided into two 1080-line sub images in accordance with SMPTE ST 425-3 mapping structure rules II, III or IV.

Each sub image is then mapped into two 10-bit data streams such that sub image 1 is mapped into data stream one and two and sub image 2 is mapped into data stream three and four.

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

The four 10-bit data streams are combined onto a 40-bit virtual interface.

The video data words from each sub image are conveyed in the following order in the data streams of the 40-bit virtual interface in accordance with SMPTE ST 425-3 Mapping Structure II, III or IV:

5.1.1.1 1080-line 40-bit virtual interface mapping — Mapping Structure II (Informative)

The - 4:4:4 (R'G'B')/ (Y'C'$_B$C'$_R$) and 4:4:4:4 (R'G'B'+A)/ (Y'C'$_B$C'$_R$+A)/10-bit Signals are conveyed in the data streams as follows:

data stream one: G'0, G'1, G'2, G'3…

data stream two: B'0, R'0, B'2, R'2…

data stream three: A0, A1, A2, A3 …

data stream four: B'1, R'1, B'3, R'3…

For the 4:4:4 (Y'C'$_B$C'$_R$) and the 4:4:4:4 (Y'C'$_B$C'$_R$+A)/10-bit images, the image data is conveyed 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.

If Alpha samples are not present they are replaced with the value 040h.

5.1.1.1.1 6G-SDI Link Multiplex Structure (Informative)

Following the 6G SDI 10-bit multiplex according to Section 6, the 6G-SDI data stream for mapping structure II is conveyed in the following order:

6G-SDI data stream: B'1, B'0, A0, G'0, R'1, R'0, A1, G'1, B'3, B'2, A2, G'2, R'3, R'2, A3, G'3 …

5.1.1.2 1080-line 40-bit virtual interface mapping — Mapping Structure III (Informative)

The - 4:4:4 (R'G'B')/ ($Y'C'_BC'_R$)/12-bit Signals are conveyed in the data streams as follows:

data stream one: G'0:2-11, G'1:2-11, G'2:2-11, G'3:2-11 …

data stream two: B'0:2-11, R'0:2-11, B'2:2-11, R'2:2-11 …

data stream three: R'G'B'0:0-1, R'G'B'1:0-1, R'G'B'2:0-1, R'G'B'3:0-1 …

data stream four: B'1:2-11, R'1:2-11, B'3:2-11, R'3:2-11 …

For the 4:4:4 ($Y'C'_BC'_R$) and the 4:4:4:4 ($Y'C'_BC'_R$+A)/12-bit images, the image data is conveyed 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.

If Alpha samples are not present they are replaced with the value 040h.

5.1.1.2.1 6G-SDI Link Multiplex Structure (Informative)

Following the 6G SDI 10-bit multiplex according to Section 6, the 6G-SDI data stream for mapping structure III is conveyed in the following order:

6G-SDI data stream: B'1:2-11, B'0:2-11, G'B'R'0:0-1, G'0:2-11, R'1:2-11, R'0:2-11, G'B'R'1:0-1, G'1:2-11, B'3:2-11, B'2:2-11, G'B'R'2:0-1, G'2:2-11, R'3:2-11, R'2:2-11, G'B'R'3:0-1, G'3:2-11 …

5.1.1.3 1080-line 40-bit virtual interface mapping - Mapping Structure IV (Informative)

The 4:2:2 ($Y'C'_BC'_R$) and 4:2:2:4 ($Y'C'_BC'_R$ +A)/12-bit signals are conveyed in the data streams as follows:

data stream one: Y'0:2-11, Y'1:2-11, Y'2:2-11, Y'3:2-11 …

data stream two: C'_B0:2-11, C'_R0:2-11, C'_B 2:2-11, C'_R2:2-11 …

data stream three: $Y'C'_BC'_R$0:0-1, Y'1:0-1, $Y'C'_BC'_R$2:0-1, Y'3:0-1 …

data stream four: A0, A1, A2, A3 …

If Alpha samples are not present they are replaced with the value 040h.

5.1.1.3.1 6G-SDI Link Multiplex Structure (Informative)

Following the 6G SDI 10-bit multiplex according to Section 6, the 6G-SDI data stream for mapping structure IV is conveyed in the following order:

6G-SDI data stream: A0, C'_B0:2-11, $Y'C'_BC'_R$0:0-1, Y'0:2-11, A1, C'_R0:2-11, Y'1:0-1, Y'1:2-11, A2, C'_B 2:2-11, $Y'C'_BC'_R$2:0-1, Y'2:2-11, A3, C'_R2:2-11, Y'3:0-1, Y'3:2-11 …

5.2 Audio Data

When present, audio data shall be mapped into the HANC space of data streams one, two, three and four as defined in SMPTE ST 425-3 “1080-Line Level A Mapping – Audio Data”.

5.2.1 Number of Audio Channels

The number of audio channels shall be as defined in SMPTE ST 425-3 “1080-Line Level A Mapping – Number of Audio Channels”.

5.2.2 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 as a result of the single-link 6G-SDI signal being created by combining dual-link 3G-SDI signals. It may alternatively be done in the original single-link 6G-SDI signal in order to permit simple splitting of the single-link 6G-SDI signal into a dual-link 3G-SDI signal.

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

5.2.2.1 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 425-3, for example when the audio was embedded in a dual-link 3G interface that has been combined into a single-link 6G interface, the audio in data stream pair three/four may be a copy of the audio in data stream pair one/two.

The audio copy status of each data stream shall be signaled in the PID as described in Section 5.3.

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

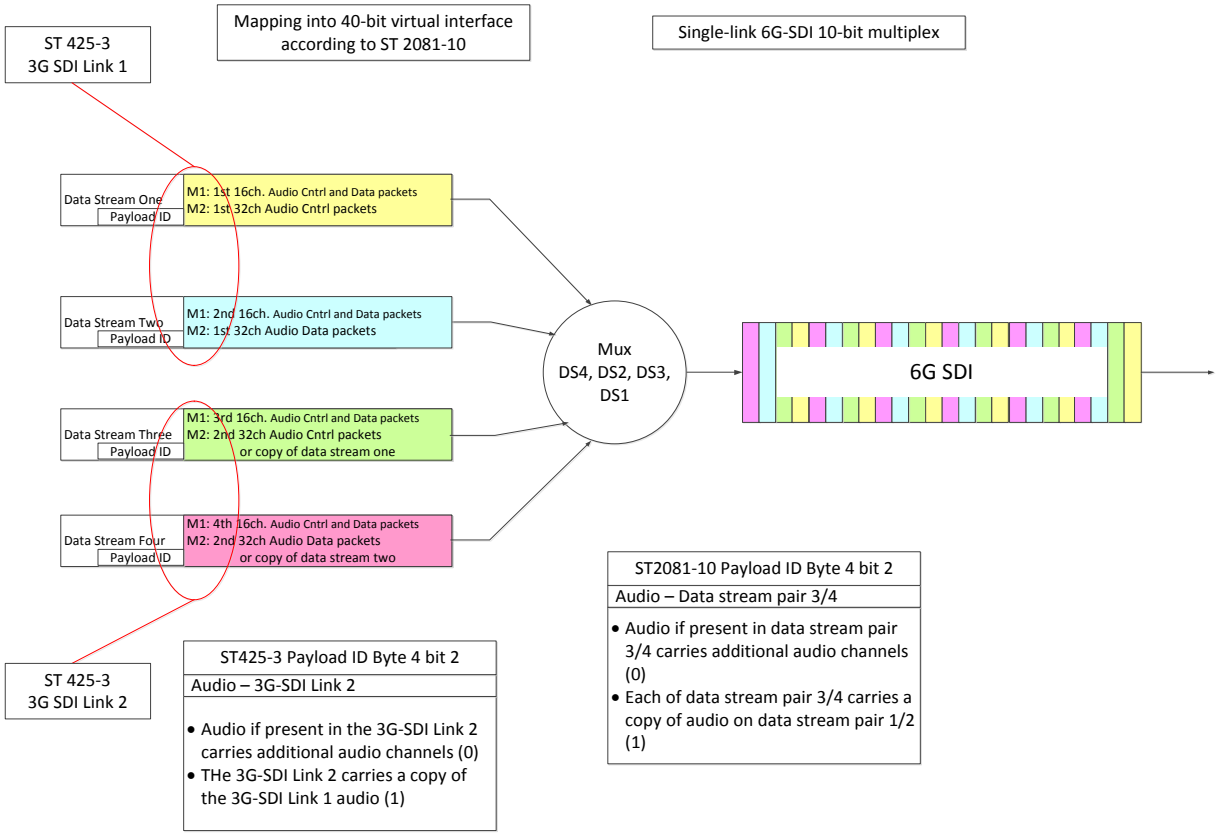

Figure 6 – Inherited audio copy as a result of combining a dual-link 3G-SDI signal

5.2.2.2 Originated Audio Copy in 6G-SDI signal

Audio may also be copied within the 6G interface in order to simplify division of a single 6G signal into dual-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 shall carry a copy of the audio data and control packets from data stream pair one/two.

The audio copy status of each data stream shall be signaled in the PID as described in Section 5.3.

5.3 Payload Identifier Structure

Table 7 shows the payload identifier definitions for 1080-line Video Payloads.

The recommended location for the payload identifier is defined in SMPTE ST 425-3.

Table 7 – Payload Identifier Definitions for Mode 2 — 1080-line Mapping on a single-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
Single link 6G-SDI (0h)</td></tr>
<tr><td>Bit 6</td><td>1</td><td>Progressive picture (1)</td><td>Horizontal sampling
1920 (0) or 2048 (1)</td></tr>
<tr><td>Bit 5</td><td>0</td><td>Reserved (0)</td><td rowspan="2">Colorimetry
Rec 709[*1] (0h)
Color VANC Packet (1h)</td></tr>
<tr><td>Bit 4</td><td>0</td><td>Reserved (0)</td><td>Reserved (0)</td></tr>
<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>0</td><td rowspan="2">Bit depth
10-bit (1h)
12-bit (2h)
Other values are Reserved</td></tr>
<tr><td>Bit 0</td><td>1</td></tr>
</table>

Note:

[*1] Rec 709 indicates Recommendation ITU-R BT.709 colorimetry is employed.

5.3.1 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 [C1h] for 1080-line image formats listed in Table 6.

5.3.2 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 set to 0 (Reserved)

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.

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

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 7 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 6 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 shall identifies 2048 active Luma/R'G'B' samples

Bits b5 and b4 indicate the colorimetry in accordance with the image format in Table 6 such that:

b5:b4 = 0h shall identify Rec 709 colorimetry

b5:b4 = 1h shall identify that the colorimetry shall be in accordance with the Color VANC packet defined in SMPTE ST 2048-1

Other values are reserved.

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.

5.3.4 Byte 4 – Sub Image Identification, Audio copy status and Quantization Bit Depth

Byte 4 of the payload identifier shall be used to identify the sub image, and bit depth of the sample quantization.

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

0h shall identify Single link 6G-SDI

Bits b4 and b3 shall be set to 0 (Reserved)

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

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

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

b2 = 1 shall identify 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 = 1h identifies quantization using 10-bit per sample

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

Other values are reserved.

5.4 10-Bit Multiplex

The 40-bit virtual interface with the modified PID values shall then be multiplexed onto a 6G-SDI 10-bit interfaces according to Section 6.

5.5 Levels of Operation (Informative)

To define the level of support for SMPTE ST 2081-10 Mode 2, manufacturers are encouraged to indicate in publications which mapping format is supported. For example:

ST 2081-10 MODE 2 – 1080-line Source image formats and ancillary data into a Single-link 6 Gb/s [nominal] SDI bit-serial interface.

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

6 Single-Link 6G-SDI 10-Bit Multiplex

Prior to serialization data streams one through four of the 40-bit virtual interface shall be multiplexed word-by-word into a 6G-SDI 10-bit interface.

The 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, etc.

The 10-bit parallel interface so produced shall have an interface frequency of 594 MHz or 594/1.001MHz as shown in the illustrative examples of Figure 7 and Figure 8.

This 10-bit interface is then serialized according to SMPTE ST 2081-1 to create the 6G-SDI serial interface.

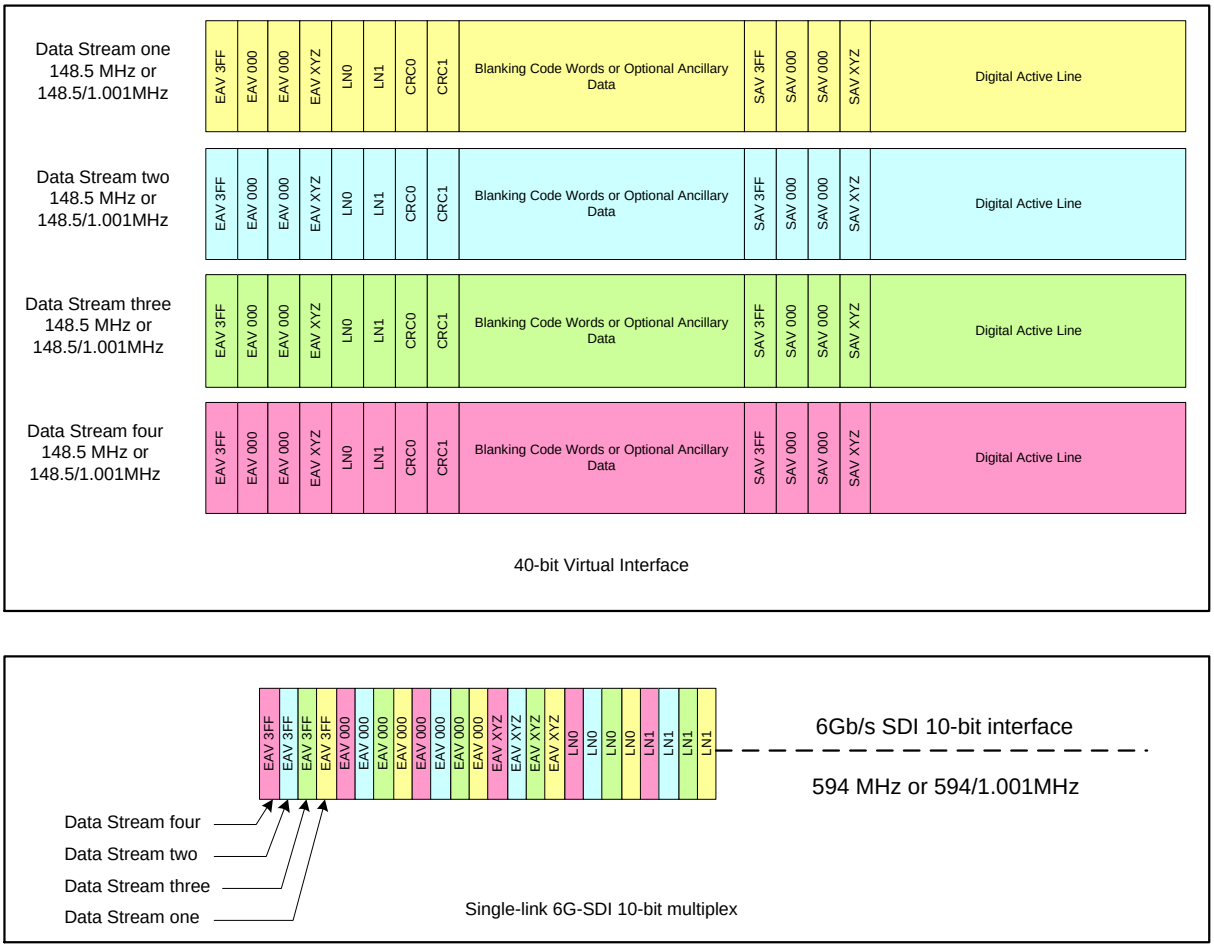

Figure 7 – Single-link 6G-SDI 10-bit Multiplex Type 1 for Mode 2

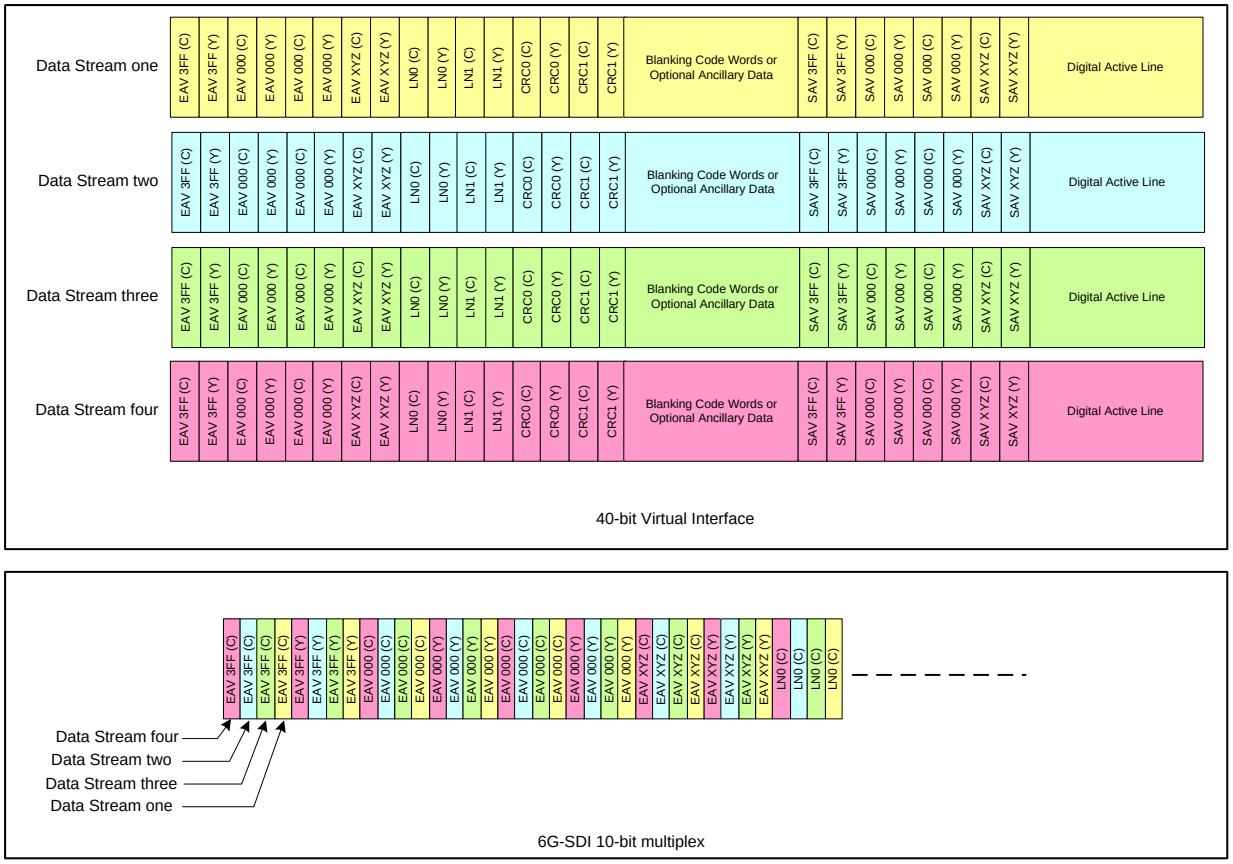

Figure 8 – Single-link 6G-SDI 10-bit Multiplex Type 2 for Mode 1

Annex A Bibliography (Informative)

Note: All references in this document to other SMPTE documents use the current numbering style (e.g. SMPTE ST 274:2008) although, during a transitional phase, the document as published (printed or PDF) may bear an older designation (such as SMPTE 274M-2008). Documents with the same root number (e.g. 274) and publication year (e.g. 2008) are functionally identical.

SMPTE ST 12-1:2014, Time and Control Code

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

SMPTE RP 157:2012, Key and Alpha Signals

SMPTE ST 274:2008, 1920 x 1080 Image Sample Structure, Digital Representation and Digital Timing Reference Sequences for Multiple Picture Rates

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

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

SMPTE ST 424:2012, Television 3 Gb/s Signal/Data Serial Interface

SMPTE ST 425-1:2014, Source Image Format and Ancillary Data Mapping for the 3 Gb/s Serial Interface

SMPTE ST 428-11:2013, Additional Frame Rates for D-Cinema

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

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

Annex B Ancillary Data Capacity of the 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 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 292-1 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 the interface is 2 times the HANC and VANC data space available (as shown in the tables of SMPTE RP 291-2) on a SMPTE ST 425-1 3G SDI link interface carrying the corresponding sub-image.

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.