SMPTE STANDARD

2160-line Source Image and Ancillary Data Mapping for 12G-SDI

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Foreword

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

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

SMPTE ST 2082-10 Document 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 2082-10 defines the mapping of various source images and associated ancillary data into a 12 Gb/s [nominal] SDI bit-serial interface.

The general process for creating 12G-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.

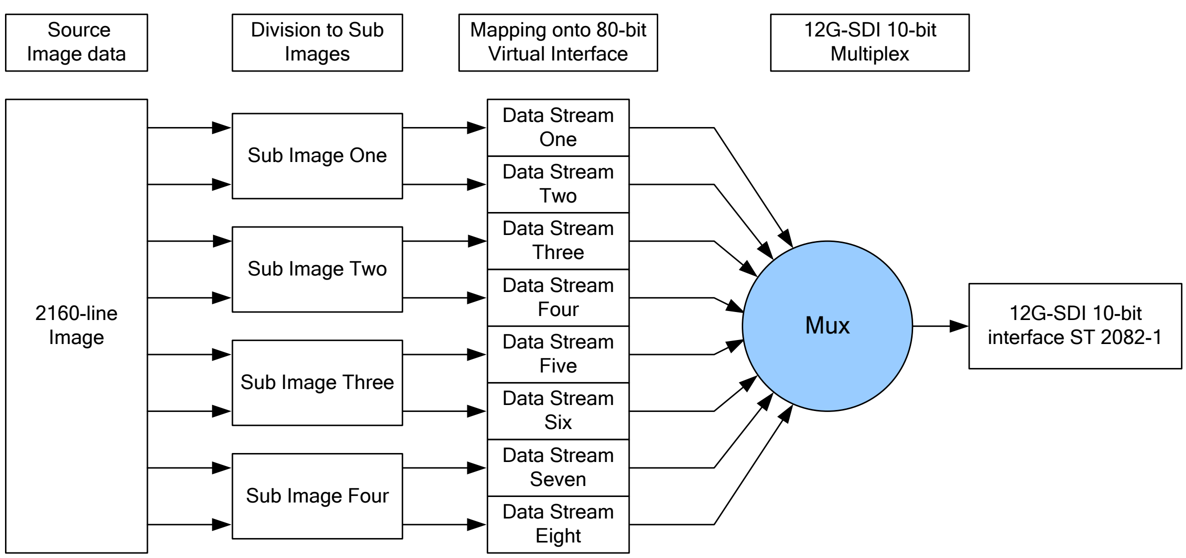

Figure 1 – Carriage of 2160-line images in a 12G-SDI interface – generalized process

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 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 a 12G-SDI 10-bit interface. The data streams are multiplexed in the order data stream eight, data stream four, data stream six, data stream two, data stream seven, data stream three, data stream five, data stream one…onto the 12G-SDI Link.

1 Scope

This Standard defines the mapping of:

- **Mode 1:** 2160-line Source image formats and ancillary data into a 12 Gb/s [nominal] SDI bit-serial interface

This Standard also defines the carriage of the SMPTE ST 352 payload ID’s for the 12 Gb/s SDI interface.

It is not necessary for implementations to include support for all formats that are included in this Standard. Implementers should 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 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 425-5:2014, Image Format and Ancillary Data Mapping for the Quad 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 Table 1 of SMPTE ST 425-5 – "2160-line Source Image Formats", repeated here for convenience.

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

<table>
<tr><th>Reference SMPTE Standard</th><th>Image Format</th><th>Signal Format Sampling Structure/pixel Depth</th><th>Frame Rate
Hz</th></tr>
<tr><td>ST 2036-1</td><td>3840 × 2160</td><td>4:2:2 ($Y'C'_BC'_R$),
4:2:0 ($Y'C'_BC'_R$)/10-bit</td><td>50, 60/1.001 and 60 Progressive</td></tr>
<tr><td>ST 2048-1</td><td>4096 × 2160[*2]</td><td>4:2:2 ($Y'C'_BC'_R$)/10-bit</td><td>48/1.001, 48, 50, 60/1.001 and 60 Progressive</td></tr>
<tr><td>ST 2036-1</td><td>3840 × 2160</td><td>4:4:4 (R′G′B′)</td><td rowspan="13">24/1.001, 24, 25, 30/1.001 and 30 Progressive</td></tr>
<tr><td>ST 2048-1</td><td>4096 × 2160[*2]</td><td>4:4:4 (R′G′B′[*1]),
4:4:4:4 (R′G′B′[*1]+A)/10-bit</td></tr>
<tr><td>ST 2036-1</td><td>3840 × 2160</td><td>4:4:4 ($Y'C'_BC'_R$)</td></tr>
<tr><td>ST 2048-1</td><td>4096 × 2160[*2]</td><td>4:4:4 ($Y'C'_BC'_R$),
4:4:4:4 ($Y'C'_BC'_R$+A)/10-bit</td></tr>
<tr><td>ST 2036-1</td><td>3840 × 2160</td><td>4:4:4 (R′G′B′)/12-bit</td></tr>
<tr><td>ST 2048-1</td><td>4096 × 2160[*2]</td><td>4:4:4 (R′G′B′[*1])/12-bit</td></tr>
<tr><td>ST 2036-1</td><td>3840 × 2160</td><td>4:4:4 ($Y'C'_BC'_R$)/12-bit</td></tr>
<tr><td>ST 2048-1</td><td>4096 × 2160[*2]</td><td>4:4:4 ($Y'C'_BC'_R$)/12-bit</td></tr>
<tr><td>ST 2036-1</td><td>3840 × 2160</td><td>4:2:2 ($Y'C'_BC'_R$)/12-bit
4:2:0 ($Y'C'_BC'_R$)/12-bit</td></tr>
<tr><td>ST 2048-1</td><td>4096 × 2160[*2]</td><td>4:2:2 ($Y'C'_BC'_R$)/12-bit</td></tr>
<tr><td>ST 2048-1</td><td>4096 × 2160[*2]</td><td>4:2:2:4 ($Y'C'_BC'_R$+A)/12-bit</td></tr>
</table>

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.

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 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 and time code – except audio – according to SMPTE ST 425-5 “Level A mapping for 2160-line source images”.

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

4.1.1 Mapping Process (Informative)

Figure 2 illustrates the process for the carriage of SMPTE ST 2036-1 and SMPTE ST 2048-1 2160-line source image formats in a 12G-SDI interface.

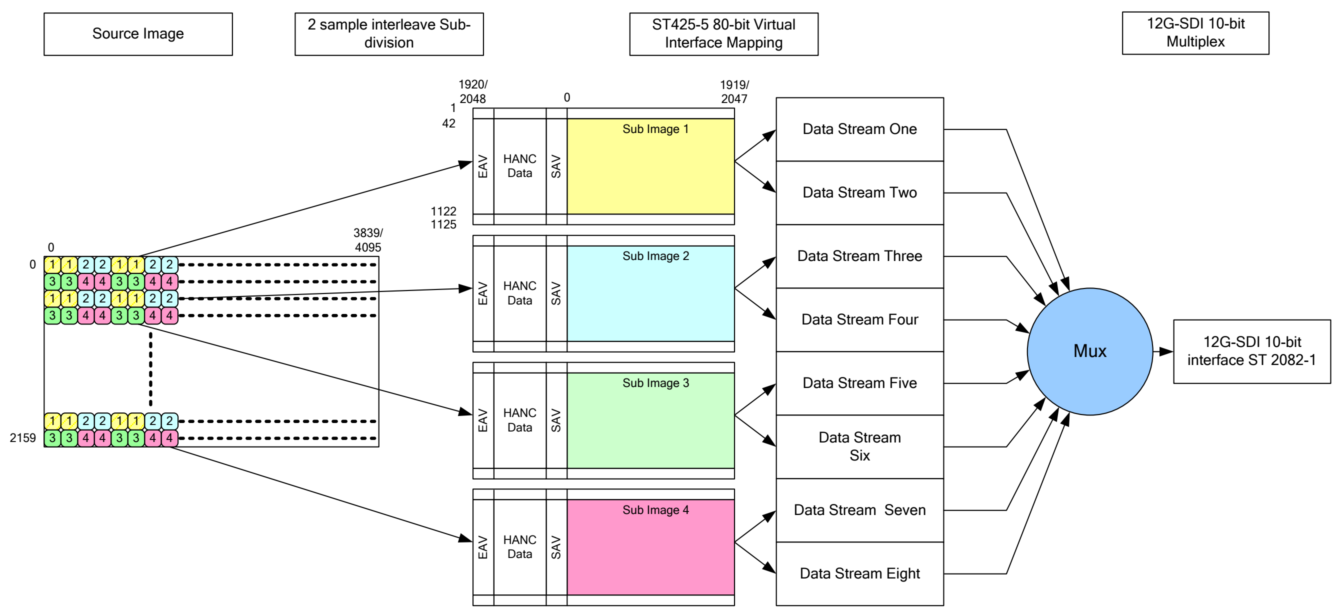

Figure 2 – Carriage of 2160-line mapping source image formats in a 12G-SDI interface

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:

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]...

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.

4.1.3 12G-SDI Link Multiplex Structure (Informative)

Following multiplexing onto a 12G-SDI 10-bit interface according to Section 5 the 12G-SDI data stream is conveyed in the following order:

{n} indicates the sub image number

Mapping Structure 1:

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

{1} C'_R0, {4} Y′1, {2} Y′1, {3} Y′1, {1} Y′1, {4} C'_B1, {2} C'_B1, {3} C'_B1, {1} C'_B1, {4} Y′2, {2} Y′2, {3} Y′2,

{1} Y′2, {4} C'_R1, {2} C'_R1, {3} C'_R1, {1} C'_R1, {4} Y′3, {2} Y′3, {3} Y′3, {1} Y′3….

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

{4} A0, {2} A0, {3} A0, {1} A0, {4} G′0, {2} G′0, {3} G′0, {1} G′0, {4} B′0, {2} B′0, {3} B′0, {1} B′0, {4} R′0,

{2} R′0, {3} R′0, {1} R′0, {4} A1, {2} A1, {3} A1, {1} A1, {4} G′1, {2} G′1, {3} G′1, {1} G′1, {4} B′1, {2} B′1,

{3} B′1, {1} B′1, {4} R′1, {2} R′1, {3} R′1, {1} R′1….

Mapping Structure 3, R′G′B′ example:

{4} R′G′B′0 [8:6], {2} R′G′B′0 [8:6], {3} R′G′B′0 [8:6], {1} R′G′B′0 [8:6], {4} R′G′B′0 [11:9],

{2} R′G′B′0 [11:9], {3} R′G′B′0 [11:9], {1} R′G′B′0 [11:9], {4} R′G′B′0 [2:0], {2} R′G′B′0 [2:0],

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

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

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

Word	Word 0	Word 1	Word 2	Word 3	Word 4
Bits b8-b6	{4}A0 [8:6]	{2}A0 [8:6]	{3}A0 [8:6]	{1}A0 [8:6]	{4}A0 [11:9]
Bits b5-b0	{4}C'_B0 [11:6]	{2}C'_B0 [11:6]	{3}C'_B0 [11:6]	{1}C'_B0 [11:6]	{4}Y′0 [11:6]

Word 5	Word 6	Word 7	Word 8	Word 9	Word 10
{2}A0 [11:9]	{3}A0 [11:9]	{1}A0 [11:9]	{4}A0 [2:0]	{2}A0 [2:0]	{3}A0 [2:0]
{2}Y′0 [11:6]	{3}Y′0 [11:6]	{1}Y′0 [11:6]	{4}C'_B0 [5:0]	{2}C'_B0 [5:0]	{3}C'_B0 [5:0]

Word 11	Word 12	Word 13	Word 14	Word 15	Word 16
{1}A0 [2:0]	{4}A0 [5:3]	{2}A0 [5:3]	{3}A0 [5:3]	{1}A0 [5:3]	{4}A1 [8:6]
{1}C'_B0 [5:0]	{4}Y′0 [5:0]	{2}Y′0 [5:0]	{3}Y′0 [5:0]	{1}Y′0 [5:0]	{4}C'_R0 [11:6]

Word 17	Word 18	Word 19	Word 20	Word 21	Word 22
{2}A1 [8:6]	{3}A1 [8:6]	{1}A1 [8:6]	{4}A1 [11:9]	{2}A1 [11:9]	{3}A1 [11:9]
{2}C'_R0 [11:6]	{3}C'_R0 [11:6]	{1}C'_R0 [11:6]	{4}Y′1 [11:6]	{2}Y′1 [11:6]	{3}Y′1 [11:6]

Word 23	Word 24	Word 25	Word 26	Word 27	Word 28
{1}A1 [11:9]	{4}A1 [2:0]	{2}A1 [2:0]	{3}A1 [2:0]	{1}A1 [2:0]	{4}A1 [5:3]
{1}Y′1 [11:6]	{4}C'_R0 [5:0]	{2}C'_R0 [5:0]	{3}C'_R0 [5:0]	{1}C'_R0 [5:0]	{4}Y′1 [5:0]

Word 29	Word 30	Word 31
{2}A1 [5:3]	{3}A1 [5:3]	{1}A1 [5:3]
{2}Y′1 [5:0]	{3}Y′1 [5:0]	{1}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 as a result of the single-link 12G-SDI signal being created by combining quad-link 3G-SDI or dual-link 6G SDI signals. It may alternatively be done in the original single-link 12G-SDI signal in order to permit simple splitting of the single-link 12G-SDI signal into a quad-link 3G-SDI or a dual-link 6G-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 or 6G-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 single-link 12G 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.

Similarly where the audio has been embedded according to SMPTE ST 2081-11 in a dual-link 6G interface that has been combined into a single 12G interface, the audio in data stream pair five/six and seven/eight may be a copy of the audio in data stream pair one/two and three/four.

Figure 3 shows a quad-link 3G interface combined into a single 12G-SDI interface, and the possible status of audio copy on each data stream.

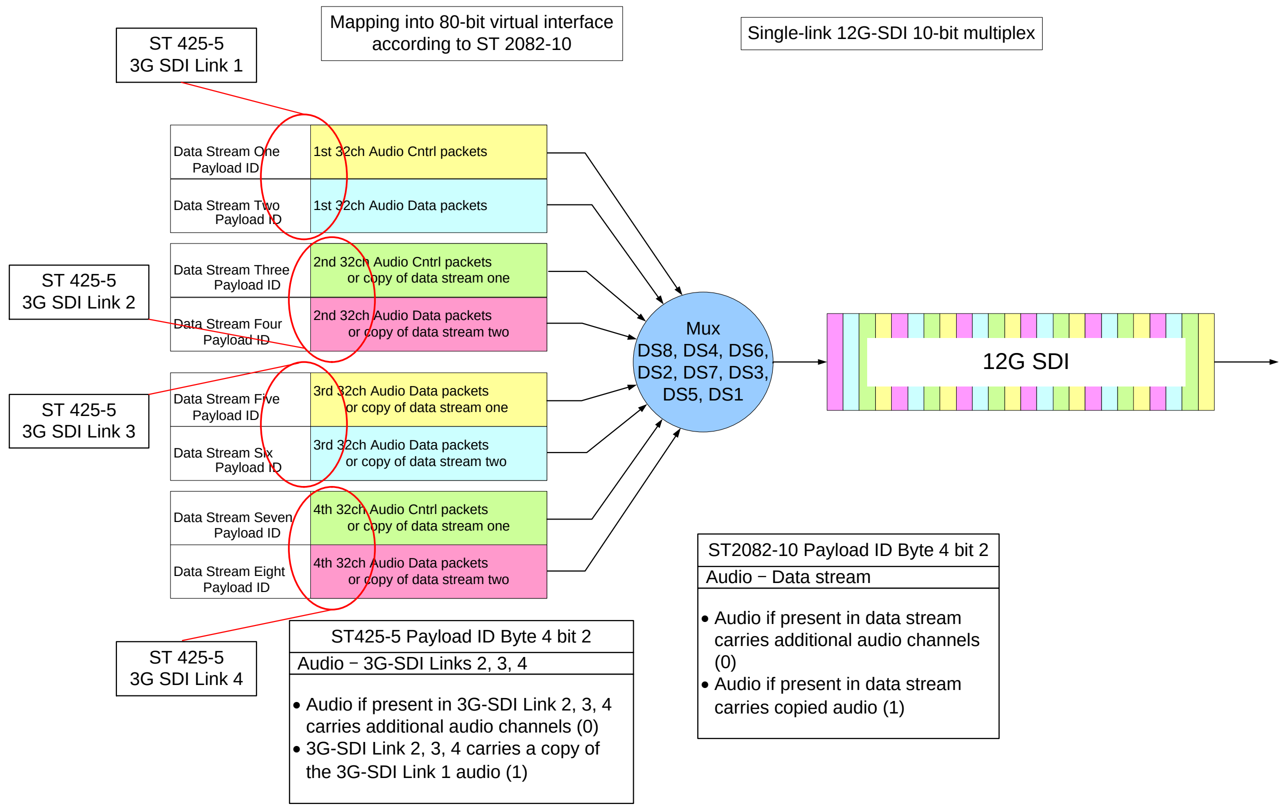

Figure 3 – Inherited audio copy as a result of combining a quad-link 3G-SDI signal

Figure 4 shows a dual-link 6G interface combined into a single 12G-SDI interface, and the possible status of audio copy on each data stream.

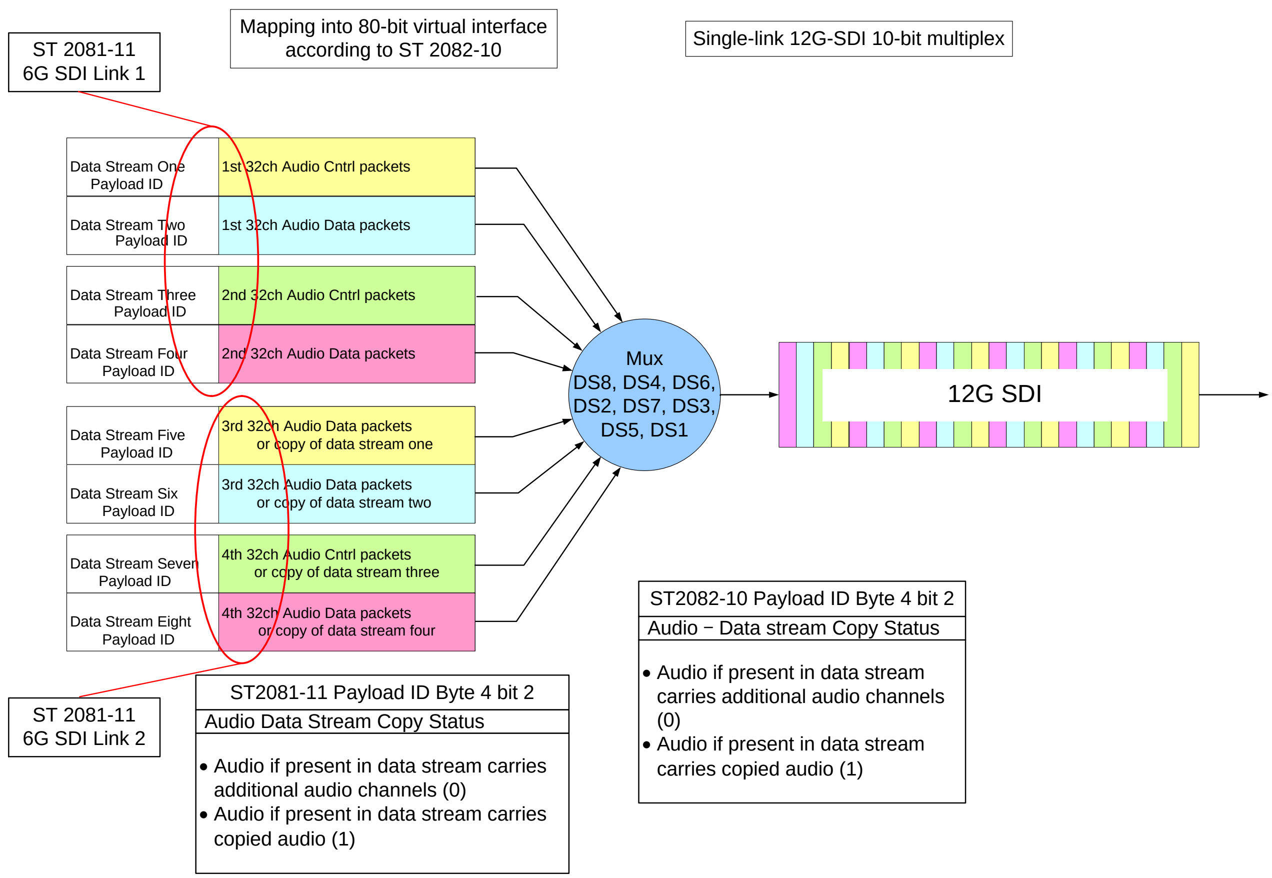

Figure 4 – Inherited audio copy as a result of combining a dual-link 6G-SDI signal

4.2.2.2 Originated Audio Copy in 12G-SDI signal

Audio may be copied within the 12G interface, in order to simplify division of a single 12G signal into dual-link 6G or 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 12 Gb/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 12G-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="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>Reserved (0)</td><td>Reserved (0)</td></tr>
<tr><td>Bit 3</td><td>1</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>1</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 (1h)
12-bit (2h)
Other values are Reserved</td></tr>
<tr><td>Bit 0</td><td>0</td></tr>
</table>

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

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 [CEh] for the Mapping for 2160-line image formats listed in Table 1 on to 12G-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 0h (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 for the image formats identified in Table 1 such that:

b5:b4 = 0h shall identify Rec 709 colorimetry

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

b5:b4 = 2h shall identify UHDTV colorimetry

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 – SMPTE ST 352 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 ($Y'C'_BC'_R$ +A)	5h	4:4:4:4 ($Y'C'_BC'_R$ +A)	6h	4:4:4:4 (R′G′B′+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 (XYZ)	Fh	Reserved

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

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

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

b7:b5 = 0h shall identify Single link 12G-SDI

Bit b4 shall be reserved and set to 0

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 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 bits per sample

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

Other values are reserved.

4.4 Multiplex

The 80-bit virtual interface with the modified PID values shall then be multiplexed onto a 12G-SDI 10-bit interface according to Section 5.

4.5 Levels of Operation (Informative)

To define the level of support for SMPTE ST 2082-10 Mode 1, manufacturers are encouraged to indicate in publications which mapping format is supported. For example:

SMPTE ST 2082-10 MODE 1 – 2160-line Source image formats and ancillary data into a Single-link 12 Gb/s [nominal] SDI bit-serial interface

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

5 12G-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 a 12G-SDI 10-bit interfaces.

The 10-bit interface shall consist of a word multiplex of data streams one through eight, in the order data stream eight, data stream four, data stream six, data stream two, data stream seven, data stream three, data stream five, data stream one…This 10-bit interface shall then be serialized according to SMPTE ST 2082-1 to create the 12G-SDI Link.

The 10-bit parallel interface so produced shall have an interface frequency of 1188 MHz or 1188/1.001 MHz as shown in the illustrative example of Figure 5.

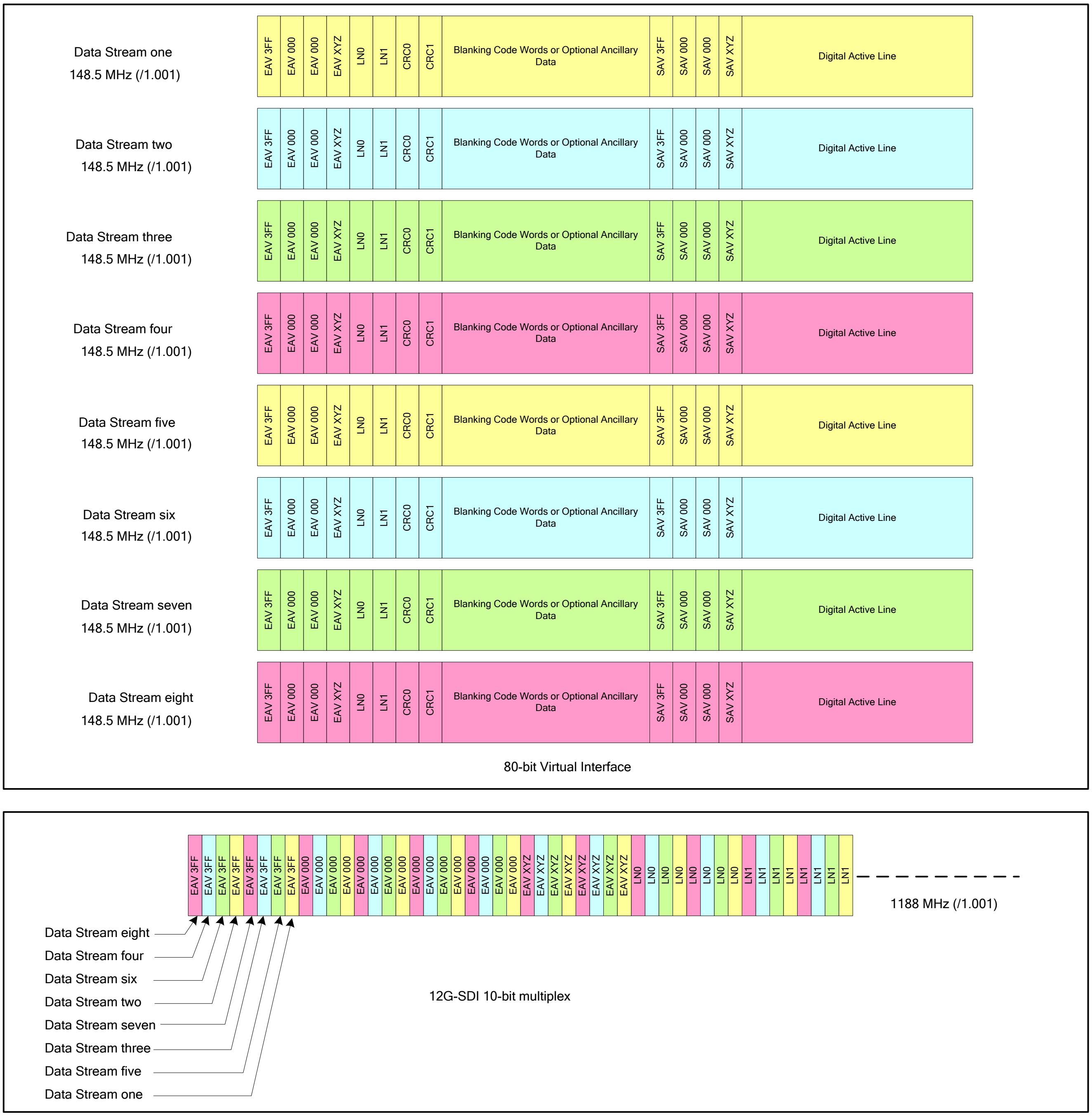

Figure 5 – 12G-SDI 10-bit Multiplex Type 1

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 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 292-1:2012, 1.5 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 425-3:2014, Image Format and Ancillary Data Mapping for the Dual 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

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

SMPTE ST 2082-1:2015, 12 Gb/s Signal/Data Serial Interface — Electrical

Annex B Ancillary Data Capacity of the 12G-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.

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.