SMPTE ST 372:2011
Revision of SMPTE 372-2009

SMPTE STANDARD

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

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Approved
March 30, 2011

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 Part XIII of its Administrative Practices.

SMPTE ST 372 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.

1 Scope

This standard specifies the mapping of the source image data defined in Table 1 onto a dual-link 1.5 Gb/s HD-SDI (Link A and Link B) in conformance with SMPTE ST 292-1. The total data rate of the dual link connection is 2.970 Gb/s or 2.970/1.001 Gb/s. This dual link also specifies carriage of the embedded audio, ancillary data and the payload ID of the stream in conformance with SMPTE ST 291, SMPTE ST 299-1 and SMPTE ST 352.

The image source digital representations are defined in SMPTE ST 274, SMPTE ST 428-9, SMPTE ST 428-19 and SMPTE ST 2048-2.

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.

3 Normative References

Note: All references in this document to other SMPTE documents use the current numbering style (e.g. SMPTE ST 12-2:2008) although, during a transitional phase, the document as published (printed or PDF) may bear an older designation (such as SMPTE 12M-2-2008). Documents with the same root number (e.g. 12-2) and publication year (e.g. 2008) are functionally identical.

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

SMPTE ST 12-2:2008, Television —Transmission of Time Code in the Ancillary Data Space

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

SMPTE ST 291:2010, Ancillary Data Packet and Space Formatting

SMPTE ST 292-1:2011, 1.5 Gb/s Signal/Data Serial Interface

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

SMPTE ST 352:2011, Payload Identification Codes for Serial Digital Interfaces

SMPTE ST 428-9:2008, D-Cinema Distribution Master — Image Pixel Structure Level 3 — Serial Digital Interface Signal Formatting

SMPTE ST 428-19:2010, D-Cinema Distribution Master — Additional Frame Rates Level AFR2 and Level AFR4 — Serial Digital Interface Signal Formatting

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

4 General

This dual link standard is intended to extend SMPTE ST 292-1 applications to include R'G'B', *X'Y'Z'* and $R'_{FS}G'_{FS}B'_{FS}$ (hereafter R'G'B' indicates either R'G'B' or $R'_{FS}G'_{FS}B'_{FS}$) and 10-bit and 12-bit source signals, as well as to provide for the carriage of an optional Alpha channel. See Table 1. In addition, support for frame rates greater than 30 Frames per second are documented.

4.1 When 60P,59.94P,50P,48P,47.95P/4:2:2/10-bit signals are present, data in the 4:2:2 ($Y'C'_BC'_R$) format shall be divided line sequentially into two data streams,

4.2 When 4:4:4:4 (R'G'B'+A)/10-bit signals are present, Link A shall carry all the G' samples plus B' and R' even-numbered samples. Link B shall carry the B' and R' odd-numbered samples,and, if present, the samples of the alpha channel.

4.3 When 4:4:4 (R'G'B') or *X'Y'Z'* 12-bit signals are present, Link A shall carry the most significant 10 bits of all the G' or *Y'* samples plus the most significant 10 bits of B' or *Z'* and R' or *X'* even-numbered samples. Link B shall carry the most significant 10 bits of the B' or *Z'* and R' or *X'* odd-numbered samples, plus the least significant 2 bits of the R'G'B' or *X'Y'Z'* samples which are mapped to the alpha channel.

4.4 When 4:4:4 ($Y'C'_BC'_R$), 4:4:4:4 ($Y'C'_BC'_RA$)/10-bit or 4:4:4 ($Y'C'_BC'_R$)/12-bit signals are present, the data structure of Link A and Link B shall be identical to that used for R'G'B', R'G'B'+A/10-bit or R'G'B'/12-bit respectively.

4.5 When 4:2:2:4 ($Y'C'_BC'_R$ A) 12-bit signals are present, Link A shall carry the most significant 10 bits of all the Y' samples plus the most significant 10 bits of C'_B and C'_R even-numbered samples. Link B shall carry the least significant 2 bits of the Y', C'_B and C'_R even-numbered samples, plus the least significant 2 bits of the Y' (only) odd-numbered samples plus the alpha channel.

4.6 Link A and Link B shall carry SAV, EAV as defined in SMPTE ST 274, Line Number data (LN) and CRC as defined in SMPTE ST 292-1.

5 Source Image Formats

The source image formats used in this standard shall be as defined in Table 1.

Table 1 – Source signal formats

Reference SMPTE Standard	Image Format	Signal Format Sampling Structure/Pixel Depth	Frame Rates	Document Section Number
ST 274	1920 × 1080	4:2:2 (Y'C'$_B$C'$_R$)/10-bit	60, 60/1.001 and 50 Progressive	§ 5.1
		4:4:4 (R'G'B'), 4:4:4:4 (R'G'B' +A [see note])/10-bit	30, 30/1.001, 25, 24 and 24/1.001 Progressive, PsF 60, 60/1.001 and 50 Fields Interlaced	§ 5.2
		4:4:4 (R'G'B')/12-bit		§ 5.3
		4:4:4 (Y'C'$_B$C'$_R$), 4:4:4:4 (Y'C'$_B$C'$_R$+A [see note]) /10-bit		§ 5.4
		4:4:4 (Y'C'$_B$C'$_R$)/12-bit		§ 5.4
		4:2:2 (Y'C'$_B$C'$_R$)/12-bit, 4:2:2:4 (Y'C'$_B$C'$_R$A)/12-bit		§ 5.5
ST 2048-2[1]	2048 × 1080	4:2:2 (Y'C'$_B$C'$_R$)/10-bi t	60, 60/1.001, 50, 48 and 48/1.001 Progressive	§ 5.1
		4:4:4 (R'G'B'), 4:4:4:4 (R'G'B' +A [see note])/10-bit	30, 30/1.001, 25, 24 and 24/1.001 Progressive, PsF	§ 5.2
		4:4:4 (R'G'B')/12-bit		§ 5.3
		4:4:4 (Y'C'$_B$C'$_R$), 4:4:4:4 (Y'C'$_B$C'$_R$+A [see note]) /10-bit		§ 5.4
		4:4:4 (Y'C'$_B$C'$_R$)/12-bit		§ 5.4
		4:2:2 (Y'C'$_B$C'$_R$)/12-bit, 4:2:2:4 (Y'C'$_B$C'$_R$A)/12-bit		§ 5.5
ST 428-9	2048 × 1080	4:4:4 (*X'Y'Z'*)/12-bit	24 Progressive, PsF	§ 5.3
ST 428-19	2048 × 1080	4:4:4 (*X'Y'Z'*)/12-bit	25 and 30 Progressive, PsF	§ 5.3

Note: Definition of the A channel is application-dependent. In the cases when the A channel is used for non-picture data, the payload is constrained to 8-bit words maximum

5.1 4:2:2 (Y'C'$_B$C'$_R$)/10-bit Signals at 60, 60/1.001, 50, 48 and 48/1.001 Progressive Frame Rates

5.1.1 Data Stream Mapping

Mapping of the data created by the 4:2:2 picture sampling structure shall be as shown in Figures 1 and 2. Each line of the source picture raster shall be alternately mapped between Link A and Link B.

1 R'G'B' indicates either R'G'B' or R'$_{FS}$G'$_{FS}$B'$_{FS}$.

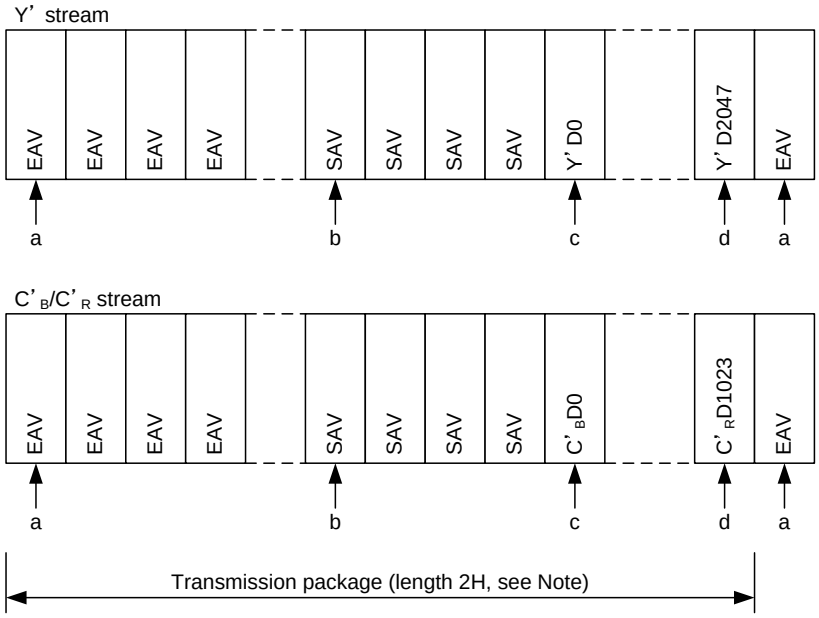
5.1.2 Timing Reference Signals and Line Numbers

The F (field/frame), V (vertical), H (horizontal), P3, P2, P1, P0 (parity) bits and the line numbers of Link A and Link B shall be as shown in Figures 1 and 2 and shall be as defined in SMPTE ST 274 and SMPTE ST 292-1.

5.1.2.1 The Line Number data carried in Link A and Link B shall be the digital interface Line Number defined in SMPTE ST 292-1 and shall not be the picture source line numbers. The relation between the digital interface line number and the picture source line number shall be as shown in Figure 2.

5.1.2.2 Buffering having a minimum duration of one horizontal line shall be required by this process at each interface, making a minimum transmission delay of two horizontal lines.

5.1.2.3 Figure 1 defines luma and color-difference signals multiplexing within a transmission package.



Note: H denotes one line period of the original 60, 60/1.001, 50 progressive signals as specified by SMPTE ST 274 or 60, 60/1.001, 50, 48, 48/1.001 progressive signals as specified by SMPTE ST 2048-2.

Reference SMPTE Standard	Frame Rate	Total words per transmission package	Total words of active image data per transmission package	Word number			
				a	b	c	d
ST 274	60 or 60/1.001	2200	1920	1920	2196	0	1919
ST 2048-2	60 or 60/1.001	2200	2048	2048	2196	0	2047
ST 274	50	2640	1920	1920	2636	0	1919
ST 2048-2	50	2640	2048	2048	2636	0	2047
ST 2048-2	48 or 48/1.001	2750	2048	2048	2746	0	2047

Figure 1 – Multiplexed horizontal data stream

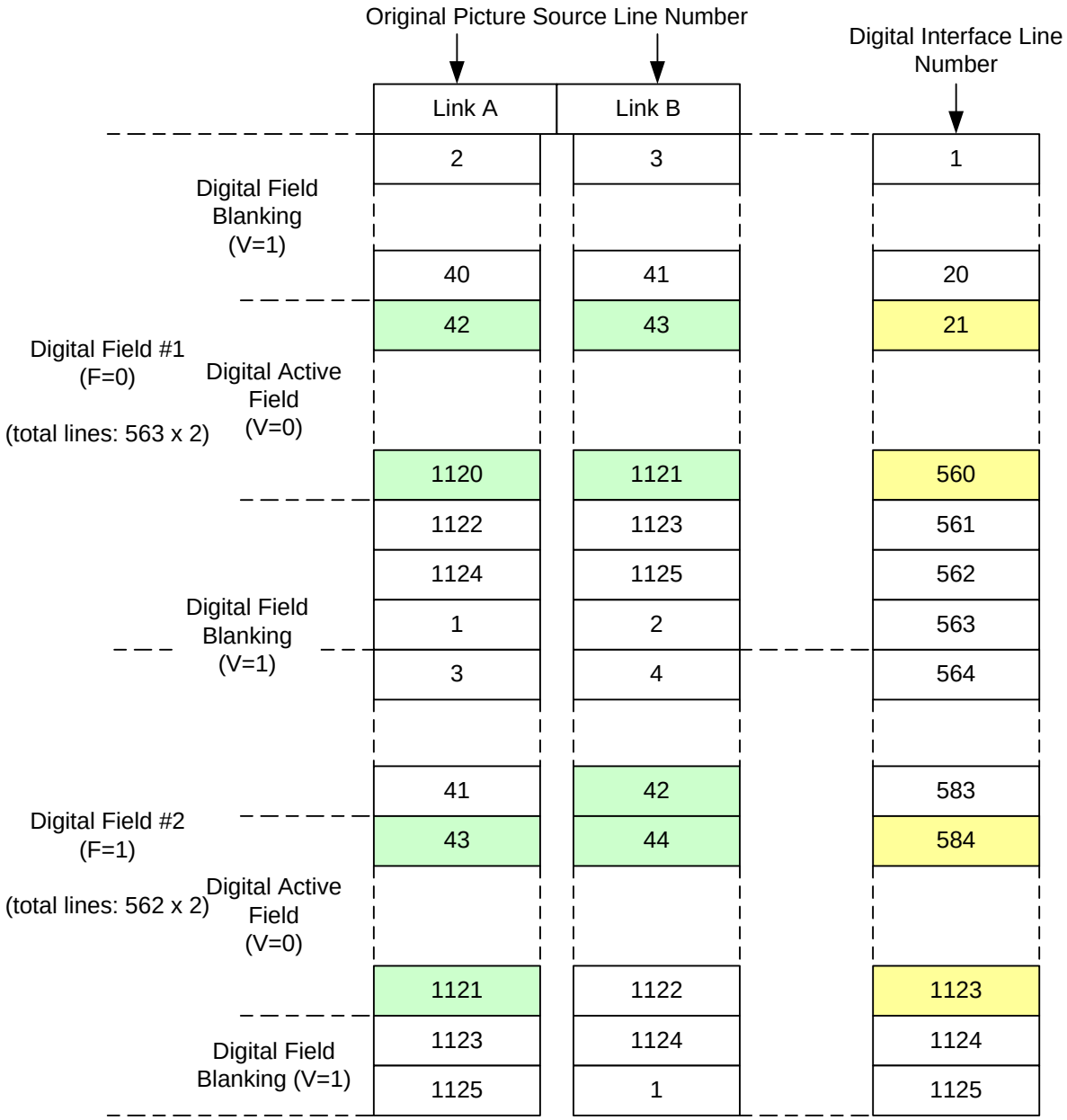


Figure 2 – 1080P— Link A/B line interleaving and line numbering

5.1.2.4 Line 42 of the source active picture and line 1122 of the source vertical blanking interval, when transported in Digital Field #2 of Link B shall be mapped on to the interface line 583 and line 1123 respectively. Interface line 583 of Link B carries active video data however V bit shall be set to 1, and interface line1123 of Link B does not carry active video data however the V bit shall be set to 0.

5.1.2.5 Link B Interface line number 583, samples number 0-1919 shall not be used to carry ancillary data packets.

Note: Some early implementations do not adhere to this requirement.

5.2 4:4:4 (R'G'B') and 4:4:4:4 (R'G'B'+A)/10-bit Signals at 30, 30/1.001, 25, 24 and 24/1.001 Frame Rates, PsF and at 60, 60/1.001 and 50 Field Rates

5.2.1 Source Sample Numbering

Each line of the R'G'B' and A channel shall consist of 2750, 2640 or 2200 total samples. The samples are designated 0-2749, 0-2639 or 0-2199 and the individual samples are designated by suffixes such as "sample G'135 or sample B'429. See Figure 4.

5.2.2 Data Stream Mapping

Link A data stream shall contain all the G' channel samples plus the even-numbered (0, 2, 4, etc.) samples from the B' and R' channels. Link B data stream shall contain the odd-numbered (1, 3, 5, etc.) samples from the B' and R' channels plus all the A-channel samples (see Figure 3). SAV, EAV, LN and CRC shall be mapped onto Link A and Link B in conformance with SMPTE ST 274 and SMPTE ST 292-1.

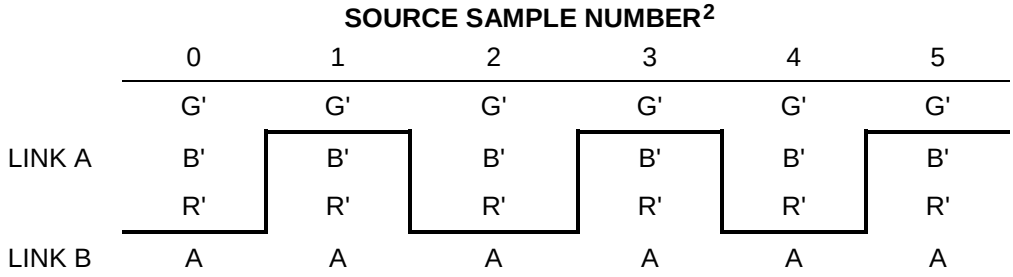


Figure 3 – 4:4:4:4 (R′G′B′+A)/10-bit — Link A/B word interleaving

5.2.3 Multiplex Structure

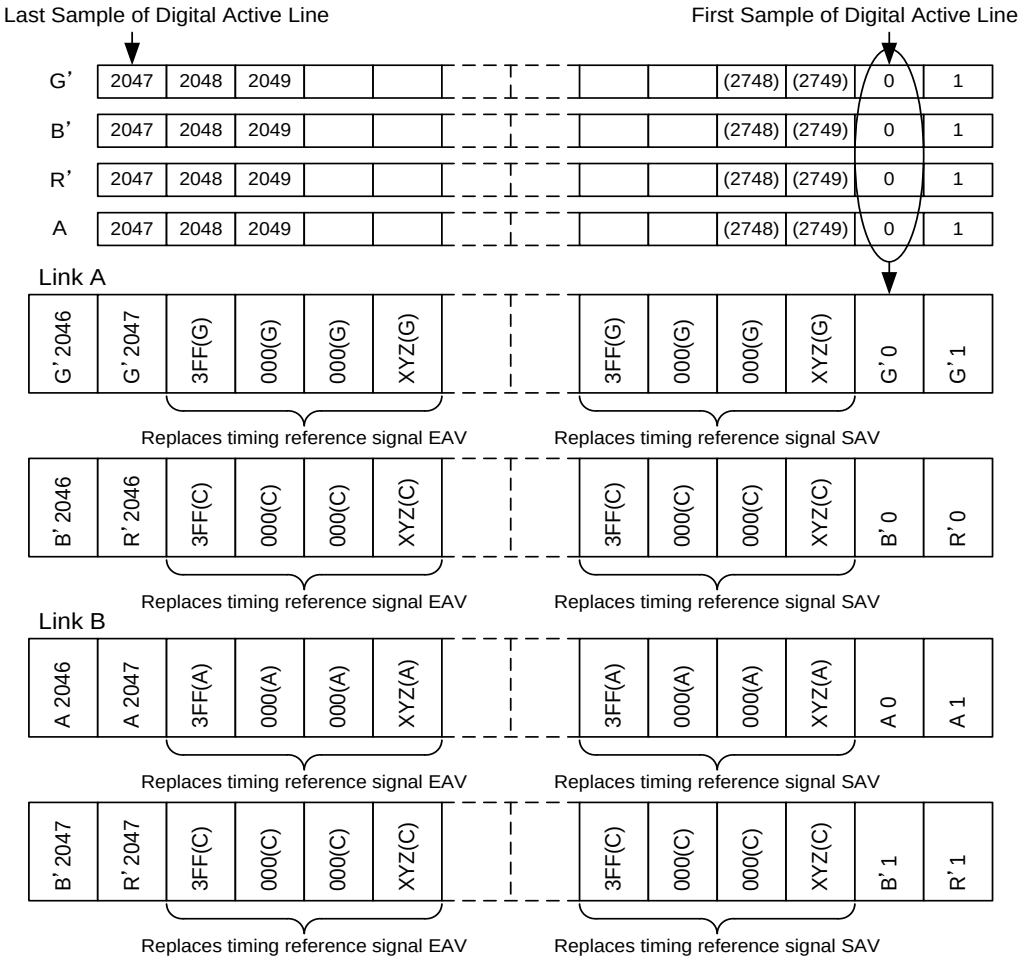
The video data words shall be conveyed in the following order:

Link A data stream: B'0, G'0, R'0, G'1, B'2, G'2, R'2, G'3 …

Link B data stream: B'1, A0, R'1, A1, B'3, A2, R'3, A3 …

See Figures 3 and 4.

[2] This figure does not convey timing information, it represents data carried by link A and Link B; timing information is conveyed in multiplex structure section and § 6.1 on interface.



Reference SMPTE Standard	Frame/ Field rate/ Pixel Depth	Total words per transmission package	Total words of active image data per transmission package	Last sample number
ST 274	60 or 60/1.001 fields, 30 or 30/1.001 frames or PsF; 10-bit	2200	1920	2199
ST 2048-2	30 or 30/1.001 frames or PsF; 10-bit	2200	2048	2199
ST 274	50 fields, 25 frames or PsF; 10-bit	2640	1920	2639
ST 2048-2	25 frames or PsF; 10-bit	2640	2048	2639
ST 274	24 or 24/1.001 frames or PsF; 10-bit	2750	1920	2749
ST 2048-2	24 or 24/1.001 frames or PsF; 10-bit	2750	2048	2749

Figure 4 – 4:4:4:4 (R′G′B′+A)/10-bit — Link A/B output data format

5.2.4 Alpha Channel

5.2.4.1 When the alpha (A) channel is not carrying a payload the samples shall be set to 40_h (64_{10}). Use of the alpha channel is application dependent.

5.2.4.2 When the alpha channel is used for conveying picture information, the raster format and frame rate shall be the same as the R'G'B' signals carried on the interface.

5.2.4.3 When the alpha channel is used to carry data, the data words shall be 8-bit maximum. As this is a 10 bit interface B8 is the even parity for B7 through B0. B9 shall be the complement of B8.

5.2.4.4 Data values 000_h to 003_h and $3FC_h$ to $3FF_h$ shall be used exclusively for interface synchronization .

5.3 4:4:4 (R'G'B' or *X'Y'Z'*)/12-bit Signals at 30, 30/1.001, 25, 24 and 24/1.001 Frame Rates, PsF and 4:4:4 (R'G'B')/12-bit Signals at 60, 60/1.001 and 50 Field Rates

5.3.1 Source Sample Numbering

R'G'B' may represent either R'G'B', $R'_{FS}G'_{FS}B'_{FS}$ or *X'Y'Z'*. Each line of G', B' and R' signals shall consist of 2750, 2640 or 2200 total samples each comprising 12 bits. The samples shall be designated 0-2749, 0-2639 or 0-2199. See Figure 6. The individual samples shall be designated by suffixes such as, sample G'135 or sample B'429. The most significant 10 bits of the 12-bit samples shall be designated by suffixes such as "sample G'135:2-11 or sample B'429:2-11, and the least significant 2 bits of 12-bit samples shall be designated by suffixes such as sample G'135:0-1 or sample B'429:0-1. The least significant 2 bits of the R'G'B' signals shall be mapped to the A (alpha) channel, and shall be designated by suffixes such as sample R'G'B'135:0-1. The nth bit of R'G'B' signals shall be designated by a suffix such as G':n. The R'G'B'n:0-1 data structure shall be as defined in § 5.3.3.

5.3.2 Data Stream Mapping

Link A data stream shall contain the most significant 10 bits of all the G' channel samples, plus the most significant 10 bits of the even-numbered (0, 2, 4, etc.) samples in the B' and R' channels. Link B data stream shall contain the most significant 10 bits of odd-numbered (1, 3, 5, etc.) samples in the B' and R' channels, plus the least significant 2 bits from all the samples in the R', G' and B' channels (see Figure 5). SAV, EAV, LN and CRC shall be mapped onto Link A and Link B in conformance with SMPTE ST 274 and SMPTE ST 292-1.

	SOURCE SAMPLE NUMBER[2]					
	0	1	2	3	4	5
	G':2-11	G':2-11	G':2-11	G':2-11	G':2-11	G':2-11
LINK A	B':2-11	B':2-11	B':2-11	B':2-11	B':2-11	B':2-11
	R':2-11	R':2-11	R':2-11	R':2-11	R':2-11	R':2-11
LINK B	R'G'B':0-1	R'G'B':0-1	R'G'B':0-1	R'G'B':0-1	R'G'B':0-1	R'G'B':0-1

Figure 5 – 4:4:4 (R′G′B′)/12-bit — Link A/B word interleaving

5.3.3 R'G'B'n:0-1 Alpha Channel Data Mapping

Mapping of the least significant 2 bits from R', G' and B' onto the alpha channel of Link B shall be as shown in Table 2.

Table 2 – R'G'B'n:0-1 Alpha channel mapping structure

Word	Bit Number 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).

5.3.4 Multiplex Structure

The video data words shall be conveyed in the following order:

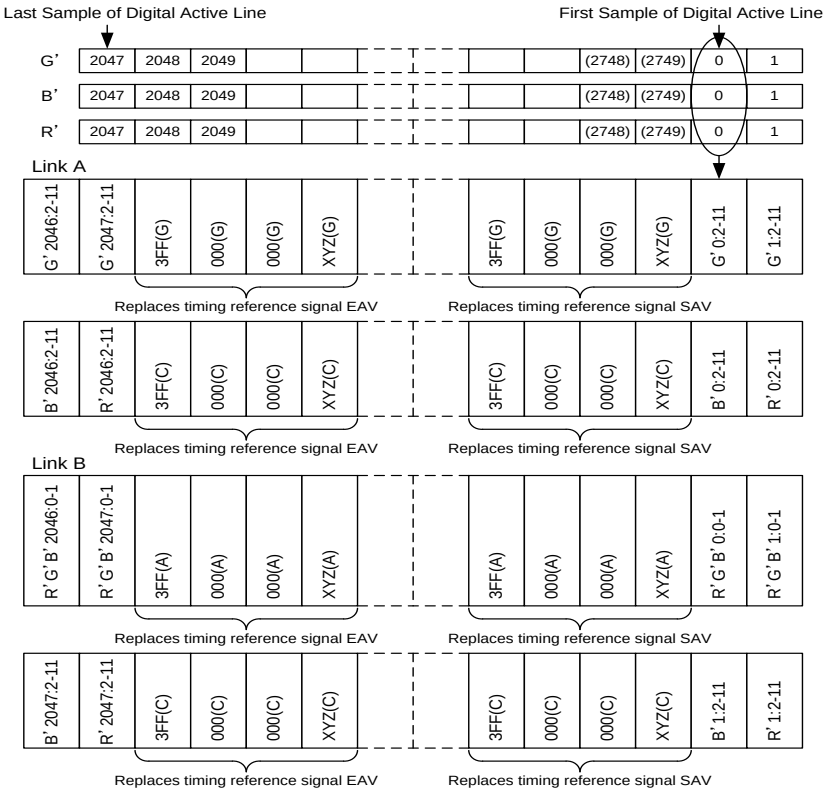
Link A data stream:

B'0:2-11, G'0:2-11, R'0:2-11, G'1:2-11, B'2:2-11, G'2:2-11, R'2:2-11, G'3:2-11 …

Link B data stream:

B'1:2-11, R'G'B'0:0-1, R'1:2-11, R'G'B'1:0-1, B'3:2-11, R'G'B'2:0-1, R'3:2-11, R'G'B'3:0-1 …

See Figures 5 and 6.



Reference SMPTE Standard	Frame/ Field rate/ Pixel Depth	Total words per transmission package	Total words of active image data per transmission package	Last sample number
ST 274	60 or 60/1.001 fields, 30 or 30/1.001 frames or PsF; 12-bit	2200	1920	2199
ST 2048-2	30 or 30/1.001 frames or PsF; 12-bit	2200	2048[3]	2199
ST 428-19	30 frames or PsF; 12-bit	2200	2048[3]	2199
ST 274	50 fields, 25 frames or PsF; 12-bit	2640	1920	2639
ST 2048-2	25 frames or PsF; 12-bit	2640	2048[3]	2639
ST 428-19	25 frames or PsF; 12-bit	2640	2048[3]	2639
ST 274	24 or 24/1.001 frames or PsF; 12-bit	2750	1920	2749
ST 428-9[4]	24 frames or PsF; 12-bit	2750	2048[3]	2749
ST 2048-2	24 or 24/1.001 frames or PsF; 12-bit	2750	2048[3]	2749

Figure 6 – 4:4:4 (R'G'B' or *X'Y'Z'*)/12-bit — Link A/B output data format

[3] For this standard there is a fixed sized container 2048x1080 pixels, the active image may or may not fill the container.

[4] Previous versions of this standard did support 24/1.001 frames/s. This frame rate is no longer supported by this standard.

5.4 4:4:4 (Y'C'$_B$C'$_R$), 4:4:4:4 (Y'C'$_B$C'$_R$ A)/10-bit and 4:4:4 (Y'C'$_B$C'$_R$)/12-bit Signals at 30, 30/1.001, 25, 24 and 24/1.001 Frame Rates, PsF and at 60, 60/1.001 and 50 Field Rates

5.4.1 General

This interface shall be used to carry Y'C'$_B$C'$_R$A (4:4:4:4)/10-bit signals, and Y'C'$_B$C'$_R$ (4:4:4)/10-bit or 12-bit signals.

5.4.2 4:4:4 (Y'C'$_B$C'$_R$) and 4:4:4:4 (Y'C'$_B$C'$_R$A)/10-bit Multiplex Structure

When transporting 4:4:4 (Y'C'$_B$C'$_R$) and 4:4:4:4 (Y'C'$_B$C'$_R$A)/10-bit signals, the samples shall be sent as follows:

Link A data stream: C'$_B$0, Y'0, C'$_R$0, Y'1, C'$_B$2, Y'2, C'$_R$2, Y'3 …

Link B data stream: C'$_B$1, A0, C'$_R$1, A1, C'$_B$3, A2, C'$_R$3, A3 …

See Figure 7.

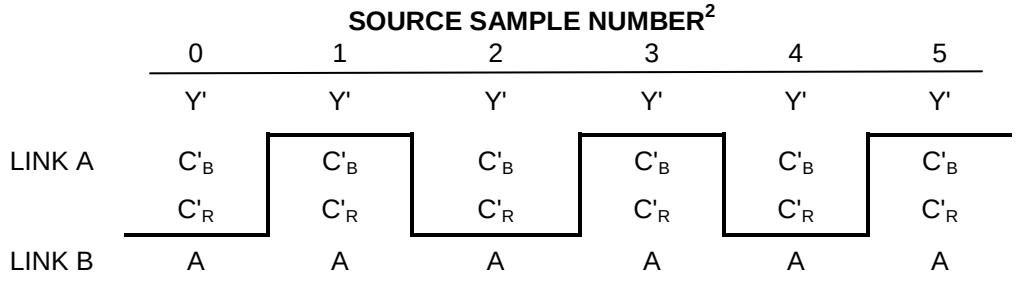


Figure 7 – 4:4:4:4 (Y′C′$_B$C′R+A)/10-bit — Link A/B word interleaving

5.4.3 4:4:4 (Y'C'$_B$C'$_R$)/12-bit Multiplex Structure

When transporting 4:4:4 (Y'C'$_B$C'$_R$)/12-bit signals the nomenclature of Y'n:2-11, C'$_B$n:2-11, C'$_R$n:2-11 and Y'C'$_B$C'$_R$n:0-1 shall be defined as per § 5.3.1.The samples shall be mapped as follows:

– The Y'n:2-11 signals shall be mapped to the sample locations G'n:2-11;
– The C'$_B$n:2-11 signals shall be mapped to the sample locations B'n:2-11;
– The C'$_R$n:2-11 signals shall be mapped to the sample locations R'n:2-11;
– The Y'C'$_B$C'$_R$n:0-1 signals shall be mapped to the sample locations R'G'B'n:0-1;

Link A data stream: C'$_B$0:2-11, Y'0:2-11, C'$_R$0:2-11, Y'1:2-11, C'$_B$2:2-11, Y'2:2-11, C'$_R$2:2-11, Y'3:2-11 …

Link B data stream: C'$_B$1:2-11, Y'C'$_B$C'$_R$0:0-1, C'$_R$1:2-11, Y'C'$_B$C'$_R$1:0-1, C'$_B$3:2-11, Y'C'$_B$C'$_R$2:0-1, C'$_R$3:2-11, Y'C'$_B$C'$_R$3:0-1 …

See Figure 8.

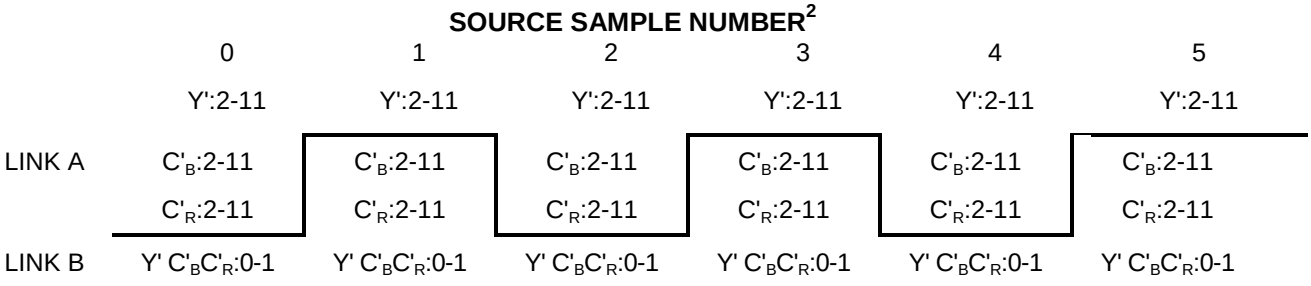


Figure 8 – 4:4:4 (Y'C'$_B$C'$_R$)/12-bit — Link A/B word interleaving

5.4.4 Alpha Channel

See § 5.2.4.

5.5 4:2:2:4 (Y'C'$_B$C'$_R$A)/12-bit Signals at 30, 30/1.001, 25, 24, 24/1.001 Frame Rates, PsF and at 60, 60/1.001 and 50 Field Rates

5.5.1 4:2:2 (Y'C'$_B$C'$_R$)/12-bit Multiplex Structure

This interface shall be used to carry 4:2:2 (Y'C'$_B$C'$_R$)/12-bit signals. The nomenclature of Y'n:2-11, C'$_B$n:2-11, C'$_R$n:2-11 and Y'C'$_B$C'$_R$n:0-1 shall be defined as in § 5.3.1.

5.5.2 Data Stream Mapping

Link A data stream shall contain the most significant 10 bits of all the Y' channel samples plus the most significant 10 bits of all the even-numbered C'$_B$, C'$_R$ samples. Link B data stream shall contain the least significant 2 bits of Y', C'$_B$, C'$_R$ samples at even-numbered sample points, and the least significant 2 bits of Y' (only) at odd-numbered sample points, plus the A (alpha) channel (see Figures 9 and 10).

5.5.3 Y'C'$_B$C'$_R$n:0-1, Y'n;0-1 Y' Channel Data Mapping

Mapping of the least significant 2 bits from the even-numbered samples of Y', C'$_B$ and C'$_R$, and the least significant 2 bits from the odd-numbered samples of Y' (only), onto the nominal Y' channel of Link B, is shown in Table 3, Table 4, and Figure 9.

Table 3 – Y'C'$_B$C'$_R$n:0-1 Y' channel mapping structure

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

Table 4 – Y' n:0-1 Y' channel mapping structure

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

SOURCE SAMPLE NUMBER[2]

	0	1	2	3	
	Y':2-11	Y':2-11	Y':2-11	Y':2-11	
LINK A	C'_B:2-11		C'_B:2-11		
	C'_R:2-11		C'_R:2-11		
LINK B	$Y'C'_BC'_R$:0-1	Y':0-1	$Y'C'_BC'_R$:0-1	Y':0-1	← Y' channel
	A	A	A	A	← $C'_BC'_R$ channel

Figure 9 – 4:2:2:4 ($Y'C'_BC'_RA$)/12-bit — Link A/B word interleaving

5.5.4 Multiplex Structure

Link A data structure:

The video data words shall be conveyed in the following order:

C'_B0:2-11, Y'0:2-11, C'_R0:2-11, Y'1:2-11, C'_B 2:2-11, Y'2:2-11, C'_R2:2-11, Y'3:2-11 …

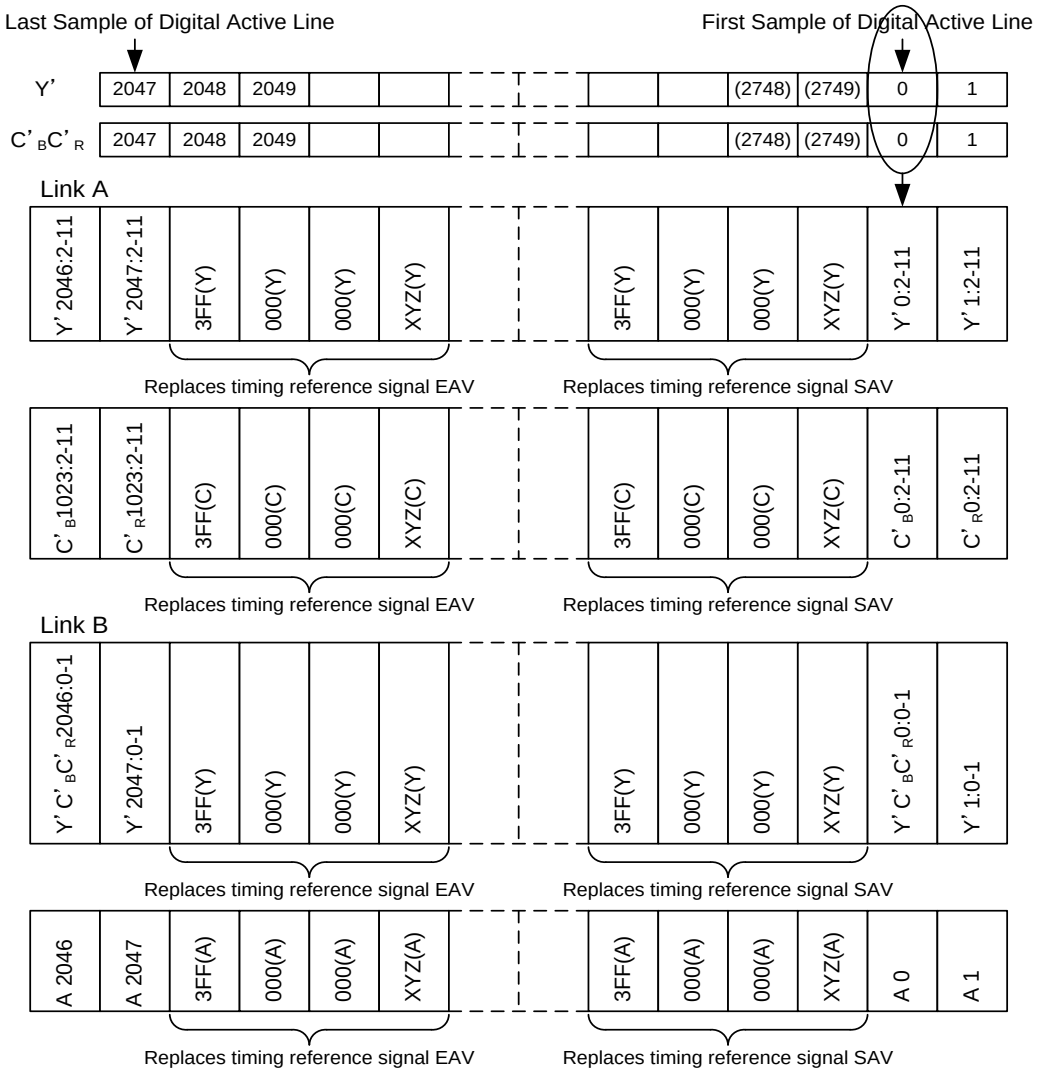
Link B data stream:

A0, $Y'C'_BC'_R$0:0-1, A1, Y'1:0-1, A2, $Y'C'_BC'_R$2:0-1, A3, Y'3:0-1 …

See Figures 9 and 10.

5.5.5 Alpha Channel

See § 5.2.4.



Reference SMPTE Standard	Frame/ Field rate/ Pixel Depth	Total words per transmission package	Total words of active image data per transmission package	Last sample number
ST 274	60 or 60/1.001 fields, 30 or 30/1.001 frames or PsF; 12-bit	2200	1920	2199
ST 2048-2	30 or 30/1.001 frames or PsF; 12-bit	2200	2048	2199
ST 274	50 fields, 25 frames or PsF; 12-bit	2640	1920	2639
ST 2048-2	25 frames or PsF; 12-bit	2640	2048	2639
ST 274	24 or 24/1.001 frames or PsF; 12-bit	2750	1920	2749
ST 2048-2	24 or 24/1.001 frames or PsF; 12-bit	2750	2048	2749

Figure 10 – 4:2:2:4 (Y'C'$_B$C'$_R$A)/12-bit — Link A/B output data format

6 Interface

6.1 Signal Timing Considerations

The timing difference between Link A and Link B shall not exceed 400 ns at the source. This difference should be taken into consideration when designing systems and destination equipment input stages.

6.2 Ancillary Data-Optional

Ancillary data if present shall be mapped into the blanking area of Link A and Link B, and shall be in conformance with SMPTE ST 291. The ancillary data shall be mapped onto Link A first and any remaining data shall then be mapped onto Link B. In some cases it is required by specific applications that data be mapped into both Link A and Link B; eg, Payload ID.

6.3 Progressive Formats

For Progressive Video Formats above 30 Frames per second, mapped according to § 5.1, the recommended line numbers for placement of ancillary data shall refer to the digital interface Line Number and not the picture source line numbers.

6.4 Audio Data

When present audio data shall be mapped into the ancillary data space of Link A and Link B, and shall be in conformance with SMPTE ST 299-1. The audio data shall be mapped onto Link A first any remaining data shall then be mapped onto Link B.

When 12 channels of 48-kHz audio data are mapped, all of the 12 channels shall be mapped onto Link A.

When 20 channels of 48-kHz audio data are mapped, 16 channels shall be mapped onto Link A and 4 channels shall be mapped onto Link B.

6.4.1 Audio Clock Phase

CLK (audio clock phase data) of SMPTE ST 299-1 shall be calculated at the clock frequency of 74.25 (/1.001) MHz for all source image formats regardless of the interface sampling frequency of the source image format document.

6.5 Time Code

When present, the time code shall be mapped into the ancillary data space of Link A. For Progressive Video Formats above 30 Frames per second, mapped according to § 5.1, the SMPTE ST12-2 recommended line numbers for placement of time code shall refer to the digital interface Line Number and not the picture source line numbers and the time code formatting shall follow the SMPTE ST12-2 rules for interlaced video.

7 Payload Identification

A payload identifier shall be inserted into both links in conformance with SMPTE ST 352. The precise definition of the 4 byte payload identifier packet shall be as defined below and these definitions shall supersede the definitions contained in Annex B of SMPTE ST 352.

Note: Some legacy implementations of this interface may not include a payload identifier.

7.1 Ancillary Data Packet Specifications

Table 5 shows the payload identifier definitions for 1080-active line payloads on a dual-link 1.485 Gb/s serial digital interface.

Table 5 – Payload identifier definitions for 1080-line payloads on a dual-link 1.485 Gb/s (nominal) serial digital interface

<table>
<tr><th>Bits</th><th>Byte 1</th><th>Byte 2</th><th>Byte 3</th><th>Byte 4</th></tr>
<tr><td>Bit 7</td><td>1</td><td>Interlaced (0) or progressive (1) transport</td><td>Reserved</td><td>Reserved</td></tr>
<tr><td>Bit 6</td><td>0</td><td>Interlaced (0) or progressive (1) picture</td><td>Horizontal pixel array size
1920 (0) or 2048 (1)</td><td>Channel assignment of dual link
Link A (0) or Link B (1)</td></tr>
<tr><td>Bit 5</td><td>0</td><td>Reserved</td><td>Aspect ratio
16:9 (1), unknown (0)</td><td>Reserved</td></tr>
<tr><td>Bit 4</td><td>0</td><td>Reserved</td><td>Reserved</td><td>Reserved</td></tr>
<tr><td>Bit 3</td><td>0</td><td rowspan="4">Picture rate
(see Table 2 SMPTE ST 352)</td><td rowspan="4">Sampling structure
see Table 6</td><td>Reserved</td></tr>
<tr><td>Bit 2</td><td>1</td><td>Reserved</td></tr>
<tr><td>Bit 1</td><td>1</td><td rowspan="2">Bit depth
8-bit (0_h), 10-bit (1_h),
12-bit (2_h),
Reserved (3_h)</td></tr>
<tr><td>Bit 0</td><td>1</td></tr>
</table>

When identifying 1080-active line payloads mapped onto a dual-link 1.485 Gb/s serial digital interface, the following values shall apply: Reserved values shall be set to (0_h).

- **Byte 1** shall be set to (87_h).
- **Byte 2**

  - The second byte shall be used to identify the picture rate and the picture and transport scanning methods.
  - Bit b7 shall be used to identify whether the digital interface uses a progressive or interlaced transport structure such that:

    b7 =(0) identifies an interlaced transport

    b7 = (1) identifies a progressive transport

  - Bit b6 shall be used to identify whether the picture has a progressive or interlaced structure such that.

    b6 = (0) identifies an interlaced structure

    b6 = (1) identifies a progressive structure

  Note: Progressive Video Formats above 30 Frames per second, mapped according to § 5.1, are identified by the progressive payload transported over an interlaced digital interface. For example, carrying a pair of progressive video frames across both links as a first and second image within the transport frame duration. These first and second images are indicated by the first and second field indicators in the digital interface transport.

- Bits b5 and b4 shall be set to (0).
- Bits b3 to b0 shall be used to identify the picture rate in Hz in accordance with the frame rates listed in Table 1.

– **Byte 3**

- The third byte shall be used to identify the aspect ratio and sampling structure of the video payload as shown in Table 5.
- Bit b6 shall be used to identify horizontal Pixel count
  b6=(0) identifies 1920 Pixels
  b6=(1) identifies 2048 Pixels
- Bit b5 identifies a 16x9 aspect ratio image image(1), Aspect ratio unknown (0).
- Bits b3 to b0 of byte 3 shall be used to identify the horizontal sampling structure in accordance with Table 6 of this standard.

– **Byte 4**

- The channel assignment in bit b6 of byte 4 shall be set to a value of (0) for the first link Link A and to (1) for the second link Link B,
- The bit depth of the sample quantization shall be identified by bits b1 and b0 of byte 4 having the following values:

  (0_h) identifies quantization using 8 bits per sample;
  (1_h) identifies quantization using 10 bits per sample;
  (2_h) identifies quantization using 12 bits per sample.
  (3_h) Reserved

Table 6– Default assignment of sampling structure values

Value	Sampling	Value	Sampling	Value	Sampling	Value	Sampling
0_h	4:2:2 (Y'/C'$_B$/C'$_R$)	1_h	4:4:4 (Y'/C'$_B$/C'$_R$)	2_h	4:4:4 (G'/B'/R')	3_h	4:2:0
4_h	4:2:2:4 (Y'/C'$_B$/C'$_R$/A)	5_h	4:4:4:4 (Y'/C'$_B$/C'$_R$/A)	6_h	4:4:4:4 (G'/B'/R'/A)	7_h	SMPTE ST 2048-2 FS[5]
8_h	4:2:2:4 (Y'/C'$_B$/C'$_R$/D)	9_h	4:4:4:4 (Y'/C'$_B$/C'$_R$/D)	A_h	4:4:4:4 (G'/B'/R'/D)	B_h	Reserved
C_h	Reserved	D_h	Reserved	E_h	4:4:4 (*X'Y'Z'*)	F_h	Reserved

Note 1: The term 4:4:4 identifies the ratio of component sampling independently of the resolution.

Note 2: In the 4:2:2:4 and 4:4:4:4 fields, the A nomenclature refers to a picture channel, whereas the D nomenclature refers to a non-picture (i.e., data) channel.

5 Sampling details are contained in the Color VANC packet defined in SMPTE ST 2048-2.

7.2 Placement of Payload Identifier Ancillary Data Packet

As this packet defines a basic payload type, the preferred horizontal placement of the ancillary data packet is immediately following the word YCR1 as defined in SMPTE ST 292-1.

Implementers should be aware that the preferred horizontal and vertical locations for the Payload Identification ancillary packets are recommendations only. The actual packet location may vary on a case by case basis. Decoder manufactures shall not depend on the recommended location for the detection and extraction of the payload packet.

Annex A Bibliography (Informative)

Note: All references in this document to other SMPTE documents use the current numbering style (e.g. SMPTE ST 12-1:2008) although, during a transitional phase, the document as published (printed or PDF) may bear an older designation (such as SMPTE 12M-2-2008). Documents with the same root number (e.g. 12-1) and publication year (e.g. 2008) are functionally identical.

SMPTE ST 12-1:2008, Television — Time and Control Code

SMPTE ST 428-1:2006, D-Cinema Distribution Master — Image Characteristics

SMPTE ST 428-11:2009, Additional Frame Rates for D-Cinema

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

Annex B Document Road Map (Informative)