SMPTE ST 425-1:2017
Revision of SMPTE ST 425-1:2014

SMPTE STANDARD

Source Image Format and Ancillary Data Mapping for the 3 Gb/s Serial Interface

Table of Contents

Approved
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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 425-1 was prepared by Technology Committee 32NF.

Intellectual Property

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

Introduction

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

SMPTE ST 292-1 was originally developed to provide a serial digital connection between HDTV equipment operating largely with 10-bit $Y'C'_BC'_R$ 4:2:2 signals to a maximum frame rate of 30 frames per second. Over time, SMPTE ST 292-1 applications were expanded to include larger picture formats, higher refresh rates and to provide support for R'G'B' and 12-bit source signal formats and the carriage of packetized data.

The total data rate required to support these additional applications is 2.970 Gb/s or 2.970/1.001 Gb/s and the digital interface used to carry these payloads has been realized using a dual-link structure as defined in SMPTE ST 372.

This standard defines the mapping of various source image formats onto a single link serial digital interface operating at a nominal rate of 3 Gb/s.

1 Scope

This standard defines three mapping formats: Level A, Level B Dual-Link mapping and Level B Dual-Stream mapping as described below;

Level A specifies:

The direct mapping of various uncompressed video image formats as defined in Table 1;

The direct mapping of packetized data;

The carriage of ancillary data such as the audio data, the audio control packets, the payload ID, the time code, etc.; into a serial digital interface operating at a nominal rate of 3 Gb/s.

Level B Dual-Link mapping specifies:
The mapping of the SMPTE ST 372 Dual Link interface (Dual-Link mapping) as defined in Table 13 into a serial digital interface operating at a nominal rate of 3 Gb/s.

Level B Dual-Stream mapping specifies:
The mapping of 2 x SMPTE ST 292-1 (HD-SDI) interfaces (Dual-Stream mapping) as defined in Table 14 into a serial digital interface operating at a nominal rate of 3 Gb/s.

Informative Annex A provides further details on the differences between Level A and Level B mapping.

Uncompressed video image formats or packetized data, and all applicable ancillary data such as the audio data, the audio control packets, the payload ID, the time code, etc. are mapped into SMPTE ST 372 Dual Link and 2 x SMPTE ST 292-1 interfaces prior to mapping into the virtual interfaces.

It is not necessary for implementations to include support for all formats defined in Table 1, Table 13 and Table 14 to conform to this standard. Implementers are encouraged to indicate supported formats in commercial publications.

2 Conformance Notation

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

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

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

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

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

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

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

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

3 Normative References

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

SMPTE RP 2077:2013, Full Range Image Mapping

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

SMPTE ST 274:2008, Television — 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 ST 292-1:2012, 1.5 Gb/s Signal/Data Serial Interface

SMPTE ST 296:2012, Television — 1280 x 720 Progressive Image 4:2:2 and 4:4:4 Sample Structure — Analog and Digital Representation and Analog Interface

SMPTE ST 299-1:2009, 24-Bit Digital Audio Format for SMPTE ST 292-1 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 372:20xx, Dual Link 1.5 Gb/s Digital Interface for 1920 x 1080 and 2048 × 1080 Picture Formats

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 x 1080 Digital Cinematography Production Image FS/709 Formatting for Serial Digital Interface

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

4 Level A — Direct Mapping of Source Image Formats

For this interface, the source data shall be an uncompressed 10-bit or 12-bit video signal corresponding to the source image formats identified in Table 1.

Note that this interface might carry packetized data as defined by other application documents providing the constraints defined in this standard and that of the source image formats are observed.

An auxiliary component signal designated A or Alpha may optionally accompany the R'G'B', $R'_{FS}G'_{FS}B'_{FS}$ (hereafter R'G'B' indicates both R'G'B' and $R'_{FS}G'_{FS}B'_{FS}$) or $Y'C'_BC'_R$ or IC_TC_P video signal. If present it shall have the same characteristics as the Y' or G' or I channel as defined for the source image formatting interface. Interfaces containing the auxiliary component are denoted as R'G'B+A, $Y'C'_BC'_R$+A and IC_TC_P+A.

Table 1 – Source Image Formats

Mapping Structure	Reference Standard	Image Format	Signal Format Sampling Structure/Pixel Depth	Frame/Field Rates	Transport
1	ST 274 Recommendation ITU-R BT.2100	1920 × 1080	4:2:2 ($Y'C'_BC'_R$)/10-bit 4:2:2 (IC_TC_P)/10-bit	60, 60/1.001 and 50 Frames Progressive	Progressive
	ST 2048-2	2048 x 1080[*6]	4:2:2 ($Y'C'_BC'_R$)/10-bit	60, 60/1.001, 50, 48 and 48/1.001 Frames Progressive	Progressive
2	ST 296	1280 x 720	4:4:4 (R'G'B'), 4:4:4:4 (R'G'B' +A)/10-bit[*4] 4:4:4 ($Y'C'_BC'_R$), 4:4:4:4 ($Y'C'_BC'_R$+A)/10-bit[*4]	60, 60/1.001 and 50 Frames Progressive	Progressive
				30, 30/1.001, 25, 24 and 24/1.001 Frames Progressive	Progressive
	ST 274	1920 x 1080	4:4:4 (R'G'B'), 4:4:4:4 (R'G'B' +A)/10-bit[*4] 4:4:4 ($Y'C'_BC'_R$), 4:4:4:4 ($Y'C'_BC'_R$+A)/10-bit[*4]	60, 60/1.001 and 50 Fields Interlaced	Interlaced
	ST 274 Recommendation ITU-R BT.2100		4:4:4 (R'G'B'), 4:4:4:4 (R'G'B'+A)/10-bit[*4] 4:4:4 ($Y'C'_BC'_R$), 4:4:4:4 ($Y'C'_BC'_R$+A)/10-bit[*4] 4:4:4 (IC_TC_P) 4:4:4:4 (IC_TC_P+A)/10-bit[*4]	30, 30/1.001, 25, 24 and 24/1.001 Frames Progressive	Progressive
				30, 30/1.001, 25, 24 and 24/1.001 Frames Progressive	PsF[*1]
	ST 2048-2	2048 x 1080[*6]	4:4:4 (R'G'B')[*7], 4:4:4:4 (R'G'B' +A)/10-bit[*4] 4:4:4 ($Y'C'_BC'_R$), 4:4:4:4 ($Y'C'_BC'_R$+A)/10-bit[*4]	30, 30/1.001, 25, 24 and 24/1.001 Frames Progressive	Progressive
				30, 30/1.001, 25, 24 and 24/1.001 Frames Progressive	PsF[*1]
3	ST 274	1920 x 1080	4:4:4 (R'G'B')/12-bit 4:4:4 ($Y'C'_BC'_R$)/12-bit	60, 60/1.001 and 50 Fields Interlaced	Interlaced
	ST 274		4:4:4 (R'G'B')/12-bit 4:4:4 ($Y'C'_BC'_R$)/12-bit	30, 30/1.001, 25, 24 and 24/1.001 Frames Progressive	Progressive

	Recommendation ITU-R BT.2100		4:4:4 (IC_TC_P)/12-bit		
	ST 2048-2	2048 x 1080[*6]	4:4:4 (R'G'B')[*7]/12-bit	30, 30/1.001, 25, 24 and 24/1.001 Frames Progressive	Progressive
			4:4:4 ($Y'C'_BC'_R$)/12-bit	30, 30/1.001, 25, 24 and 24/1.001 Frames Progressive	PsF[*1]
	ST 428-9	2048 x 1080[*5]	4:4:4 ($X'Y'Z'$)/12-bit	24 Frames Progressive	Progressive
				24 Frames Progressive	PsF[*2]
	ST 428-19	2048 x 1080[*5]	4:4:4 ($X'Y'Z'$)/12-bit	25 and 30 Frames Progressive	Progressive
				25 and 30 Frames Progressive	PsF[*3]
4	ST 274	1920 x 1080	4:2:2 ($Y'C'_BC'_R$)/12-bit	60, 60/1.001 and 50 Fields Interlaced	Interlaced
	ST 274 Recommendation ITU-R BT.2100		4:2:2 ($Y'C'_BC'_R$)/12-bit 4:2:2 (IC_TC_P)/12-bit	30, 30/1.001, 25, 24 and 24/1.001 Frames Progressive	Progressive
				30, 30/1.001, 25, 24 and 24/1.001 Frames Progressive	PsF[*1]
	ST 2048-2	2048 x 1080[*6]	4:2:2 ($Y'C'_BC'_R$)/12-bit	30, 30/1.001, 25, 24 and 24/1.001 Frames Progressive	Progressive
			4:2:2:4 ($Y'C'_BC'_R$+A)/12-bit[*8]	30, 30/1.001, 25, 24 and 24/1.001 Frames Progressive	PsF[*1]

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

*1 PsF structure as defined in SMPTE ST 274.

*2 PsF structure as defined in SMPTE ST 428-9.

*3 PsF structure as defined in SMPTE ST 428-19.

*4 Definition of the A channel is application dependent for mapping of these 10-bit signal structures:

– when used for non-picture data, the payload is constrained to 8-bit maximum, B8 is even parity for B7 through B0, and B9 is the complement of B8.

– when used for picture data, code words 000h to 003h and 3FCh to 3FFh are used exclusively for synchronization.

*5 This is the image container size, the active image does not always fill the container.

*6 This is the maximum pixel array, the active image does not always fill the maximum array.

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

*8 Definition of the A channel is application dependent for mapping of this 12-bit signal structure:

– when the A channel is used for non-picture data, the payload is constrained to 8-bit words maximum, B10 is even parity for data word B9 through B2, B11 is the complement of B10, and B1 through B0 are zero.

– when used for picture data, the raster format and frame rate are the same as the Y' signal carried on the virtual interface.

4.1 20-Bit Virtual Interface

R', G', B',/ Y', C'_B, C'_R,/ X', Y', Z' / IC_TC_P and A components shall be mapped into a virtual interface consisting of two parallel 10-bit data streams – data stream one and data stream two, as shown in Figures 1 through 4.

Each data stream shall have an interface frequency of 148.5 MHz or 148.5/1.001 MHz.