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Withdrawal of SMPTE 346M-2000

Time Division Multiplexing Video Signals and Generic Data over High-Definition Interfaces

A document should be Withdrawn only if there is a significant possibility of its use causing harm. A Withdrawn document shall still be made available and offered for sale by the Society, but it shall be prefaced by a cover page explaining its current status including a statement that some or all of the content is no longer endorsed by the Society.

This document was approved in September 2000. Following 5-year review in 2005 it was determined that it does not represent current technology and accordingly was archived in January 2006.

The document was archived in 2006 when it was determined that SMPTE 346 did not represent current technology, and was unlikely to be used as the basis for new equipment designs.

Subsequently it was discovered that there was a conflict between Ancillary Data DID/SDID values allocated within SMPTE 346 and a range of values allocated in SMPTE RDD 8. This creates the possibility of harm, as Ancillary Data intended for one application could be misinterpreted by another application.

Consultation with the industry revealed that some equipment in the field was claimed to be SMPTE 346-compliant, but that no manufacturer would object to the withdrawal of the Standard.

Accordingly, SMPTE published an Advisory Notice stating that this Standard may be withdrawn, and seeking comment. No comment was received.

Accordingly, the withdrawal procedure was followed and SMPTE 346 is no longer endorsed by the Society.

ARCHIVED JANUARY 4, 2006

SMPTE 346M-2000

SMPTE STANDARD

for Television — Time Division Multiplexing Video Signals and Generic Data over High-Definition Interfaces

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1 Scope

1.1 This standard defines the time division multiplexing (TDM) of various standard-definition digital video and generic 8-bit data signals over high-definition serial digital interfaces (SMPTE 292M).

1.2 The objective of this high-definition multiplexing interface is to use a single physical link to transmit, distribute, route, and switch a complete family of existing 10-bit video formats and various data formats.

1.3 Active video and vertical blanking areas in the HD SDI stream are time divided into 19 interleaved channels. The word in the first channel is used to indicate the data validation of the remaining 18 channels.

1.4 A single video or data stream is multiplexed into one or multiple channels of the total 18 data channels. A control packet is multiplexed into the horizontal ancillary data space of the luminance parallel data area after the switching point of the HD stream for each video or data stream. The control packet indicates how and which channels are used for this video or data stream. It also contains stream clock reference information for clock recovery of the original clock signal.

1.5 Multiple standard definition video or data streams could be multiplexed in and demultiplexed from a single HD SDI stream with a total delay of a fraction of a horizontal line.

1.6 By dividing the payload into segments which are subdivided into channels, time-division multiplexing can be applied to several data sources in a way that very low latency will be generated during the demultiplexing process. A fixed number of channels in each segment provides an efficient implementation of different data by reducing the complexity of the multiplexing and demultiplexing processes.

2 Introduction

Given the wide variety of commercially accepted standards for both standard and high-definition television systems used in studio production, post-production, and distribution facilities, a large number of incompatible interfaces exists for the interconnection and routing of the various 4:2:2i, 4:4:4i, 4:2:2:4i, 4:4:4:4i, and 4:2:2p component and composite video signals throughout a given plant. In addition, major high-definition video signals used in a number of television facilities have a bandwidth at 1.485 Gbit/s.

A higher bandwidth interface such as that used to carry high-definition component video would be able to carry several lower-bandwidth component or composite video signals over a single physical link, reducing the number of cable or fiber routing signals throughout the plant and simplifying the routing overall. In fact, the lower-bandwidth signals could be formatted into digital active line areas of existing high-definition interfaces in such a way that the resulting signal would appear to most existing pieces of equipment as a regular high-definition video signal.

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In addition, the low-bandwidth signals could be any generic data stream including compressed standard and high-definition video, not just component video signals. The obvious benefit of the multiplexing scheme is that existing equipment for serializing and deserializing high-definition bit-parallel data signals for distribution throughout the plant could also be used to serialize and deserialize the high-bandwidth multiplexed data stream without any additional hardware. All that is needed to implement this method is hardware for multiplexing and demultiplexing between bit-parallel high- and low-bandwidth formats.

This standard defines a format for multiplexing multiple asynchronous standard definition video streams and generic data into the high-definition system interfaces as defined in SMPTE 274M and ANSI/SMPTE 296M in the bit-parallel source format for the bit-serial interface defined in SMPTE 292M. The major standard-definition systems interfaces are defined by ANSI/SMPTE 259M and ITU-R BT.601-5. They are the 4:2:2 digital component video signal interfaces defined in ANSI/SMPTE 125M, ANSI/SMPTE 267M, and ANSI/SMPTE 293M. These standards specify interfaces for 270-, 360-, and 540-Mbit/s bit-parallel formats. The standard also covers other serial video standards such as 143 Mbit/s 525-line and 177 Mbit/s 625-line composite digital signals.

This standard can be used for a 270-Mbit/s SDI interface to carry multiple streams of data and a single 8-bit or 10-bit composite digital video. The same is true for a 540-Mbit/s SDI to carry multiple streams of video and data. It can also be extended to future higher bit rate serial digital standards.

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 listed below.

ANSI/SMPTE 125M-1995, Television — Component Video Signal 4:2:2 — Bit-Parallel Digital Interface

ANSI/SMPTE 259M-1997, Television — 10-Bit 4:2:2 Component and $4f_{SC}$ Composite Digital Signals — Serial Digital Interface

ANSI/SMPTE 267M-1995, Television — Bit-Parallel Digital Interface — Component Video Signal 4:2:2 16×9 Aspect Ratio

ANSI/SMPTE 293M-1996, Television — 720 × 483 Active Line at 59.94-Hz Progressive Scan Production — Digital Representation

ANSI/SMPTE 294M-1997, Television — 720 × 483 Active Line at 59.94-Hz Progressive Scan Production — Bit-Serial Interfaces

ANSI/SMPTE 296M-1997, Television — 1280 × 720 Scanning, Analog and Digital Representation and Analog Interface

ANSI/SMPTE 299M-1997, Television — 24-Bit Digital Audio Format for HDTV Bit-Serial Interface

SMPTE 274M-1998, Television — 1920 × 1080 Scanning and Analog and Parallel Digital Interfaces for Multiple Picture Rates

SMPTE 291M-1998, Television — Ancillary Data Packet and Space Formatting

SMPTE 292M-1998, Television — Bit-Serial Digital Interface for High-Definition Television Systems

SMPTE RP 174-1993, Bit-Parallel Digital Interface for 4:4:4:4 Component Video Signal (Single Link)

ISO/IEC 13818-1:1996, Information Technology — Generic Coding of Moving Pictures and Associated Audio Information: Systems

ITU-R BT.601-5 (10/95), Studio Encoding Parameters of Digital Television for Standard 4:3 and Wide-Screen 16:9 Aspect Ratios

ITU-R BT.656-4 (02/98), Interfaces for Digital Component Video Signals in 525-Line and 625-Line Television Systems Operating at the 4:2:2 Level of Recommendation ITU-R BT.601 (Part A)

4 Definition of terms

4.1 ADF: The ancillary data flag, ADF, is one word in composite systems as described in ANSI/SMPTE 244M and three words in component systems as described in ANSI/SMPTE 125M and SMPTE 291M.

4.2 bandwidth: Data rate (equal to the clock frequency multiplied by the bit-parallel word width). Usually specified in bits per second.

4.3 data channel: Each data segment consists of one 20-bit segment header and eighteen 20-bit data words, each belonging to one of 18 data channels. A data channel consists of all data words in the same position in all segments. Multiple data channels can be combined to carry any uncompressed standard definition 10-bit video stream. For an example, in a 1080i system, a single data channel has a bandwidth of over 68 Mbit/s. Four data channels shall be used to construct a 270-Mbit/s video stream.

4.4 data segment: Each horizontal line of payload area for a HD signal is time divided into data segments, each 19 words long. Each segment contains one 20-bit segment header and eighteen 20-bit data words for the 18 data channels.

4.5 EAV and SAV: The timing reference signals (EAV/ and SAV) occur in every line, and shall be as described in SMPTE 274M and ANSI/SMPTE 296M.

4.6 HD: High-definition video signals.

4.7 payload area: The active video area and the vertical blanking area of a high-definition video stream are used as the payload area.

4.8 SD: Standard definition video (see annex A).

4.9 SDI: Serial digital interface.

4.10 segment header: A single 20-bit data word serving as a header for the eighteen 20-bit data samples each belonging to one of 18 data channels. The segment header contains one bit data valid information for every data word in the segment.

4.11 720p: 1280 × 720 progressive scan systems defined in ANSI/SMPTE 296M.

4.12 stream: A 10-bit parallel SD video signal or generic 8-bit data carried in one or multiple channels.

4.13 stream clock reference (SCR): A time stamp embedded in the stream header from which the demultiplexer can recover the original clock. The stream clock reference uses the same concepts as the program clock reference (PCR) in the MPEG standard defined in ISO/IEC 13818-1.

4.14 stream header: A formatted multiple-word data structure located in the luminance portion of the horizontal ancillary data space of high-definition data. The stream header contains information including how many and which channels have been used for this stream. A stream header also includes other information such as the stream type and the stream clock reference.

4.15 TDM: Time division multiplexing is a scheme in which numerous signals are combined for transmission on a single communications line. Each signal is broken up into many segments, each having very short duration.

4.16 1080i: 1920 x 1080 interlaced scan systems defined in SMPTE 274M.

5 General specification

The integrated transmission, distribution, and routing format proposed in this standard is to recognize simple studio systems and reduce interface costs of digital production facilities handling various video formats. The goal is to use a single serial digital interface not only to carry all HD SDI signals specified in SMPTE 292M, but also all SD video signals (see annex A), compressed video, and other data.

5.1 This standard describes the assembly of those multiple 10-bit standard definition video streams and 8-bit data streams into a single 20-bit high-definition video stream. The resulting 20-bit word HD stream shall be scrambled and serialized in accordance with SMPTE 292M.

5.2 The word clock rate shall be 74.25 MHz or 74.25/1.001 MHz in accordance with SMPTE 274M.

5.3 The HD data word length shall be 20 bits with the top 10 MSB bits as chrominance component and the bottom 10 bits as luminance component.

5.4 The timing reference signals (EAV and SAV) occur on every line in accordance with SMPTE 274M or ANSI/SMPTE 296M.

5.5 All SD video and data signals are time division multiplexed into the space between SAV and EAV of HD lines, including HD vertical blanking lines. That space is the HD payload area. Every word of an uncompressed stream of 10-bit video is multiplexed into HD payload area. That includes active video words, EAV, SAV, all vertical and horizontal ancillary data. EAV, SAV, and ADF contain $3FF_h$ and 000_h which cannot be multiplexed directly to the HD payload area. Special coding shall be provided to map them into the HD video payload area.

5.6 A stream header packet for every SD video and data stream is placed after EAV/LN/CRC in the luminance component of the HD stream.

5.7 For each SD stream, only one stream header shall be sent per one HD frame. The stream header may be placed on any line after the switching point and the following 17 lines. The switch point for a 1080i system is at line 7 as specified in ANSI/SMPTE 299M.

5.8 HD SDI signals defined in SMPTE 292M should be treated as a special case where original source formats are used. Thus, the payload area is not divided into multiple channels. The stream header is optional for HD SDI; however, it is recommended for easier stream identification.

6 Payload data format

The payload data format is the multiplexing scheme used to pack a number of asynchronous 10-bit SD video component and composite video streams and 8-bit generic data into the payload area of high-definition interfaces.

6.1 Payload area

The payload area is defined as the active video area of the HD format plus its vertical blanking area. The bit-serial digital interface for high-definition systems, defined in SMPTE 292M, specifies a source format (bit parallel input) for the bit serialization of two parallel data components (chrominance and luminance, respectively), providing a combined word width of 20 bits. Hence, the payload word width is also 20 bits.

The active video/vertical blanking area of a horizontal line is further segmented to a 19-word structure. When a length of active video line is indivisible by 19, all luminance and chrominance words in a remaining segment of a line will be set to 040_h and 200_h, respectively.

6.2 Payload segment and data format

A payload segment is a 19-word structure that contains the multiplexed data from the source data streams. The first 20-bit word is the payload segment header and the remaining 18 words each contain one 20-bit word corresponding to each of the 18 channels as shown in table 1

Table 1 – Payload segment

Words	Channel status
0	Segment header
1	Channel 0 data
2	Channel 1 data
3	Channel 2 data
4	Channel 3 data
5	Channel 4 data
6	Channel 5 data
7	Channel 6 data
8	Channel 7 data
9	Channel 8 data
10	Channel 9 data
11	Channel 10 data
12	Channel 11 data
13	Channel 12 data
14	Channel 13 data
15	Channel 14 data
16	Channel 15 data
17	Channel 16 data
18	Channel 17 data

The segment header provides one extra bit for each of the 18 channels of data in the segment. This extra bit is a data valid bit. Alternatively, this bit can be considered the twenty-first data bit of each data word.

The payload segment header identifies valid data words within the segment. The format for the segment header is shown in table 2.

Bits 0 to 8 and bits 10 to 18 are used to indicate the data validation of the following 18 data channels. Bit 9 is the complement of bit 8 and bit 19 is the complement of bit 18. This ensures that the 10-bit word in the active video area can only be in the range of 004_h to $3FB_h$.

Table 2 – Segment header

Bit	Channel status
19	Not bit 18
18	Ch. 17 word valid
17	Ch. 16 word valid
16	Ch. 15 word valid
15	Ch. 14 word valid
14	Ch. 13 word valid
13	Ch. 12 word valid
12	Ch. 11 word valid
11	Ch. 10 word valid
10	Ch. 9 word valid
9	Not bit 8
8	Ch. 8 word valid
7	Ch. 7 word valid
6	Ch. 6 word valid
5	Ch. 5 word valid
4	Ch. 4 word valid
3	Ch. 3 word valid
2	Ch. 2 word valid
1	Ch. 1 word valid
0	Ch. 0 word valid

6.3 10-bit video stream data format

For standard definition video signals including 480p (540 Mbit/s) or 480i at 270 Mb/s, the 10-bit parallel data word is mapped to 20-bit words.

Luminance is mapped to luminance space and chrominance is mapped to chrominance space.

The timing references (i.e., EAV and SAV) and ancillary data headers in the SD video stream to be multiplexed are remapped when they are inserted into the payload segment data fields so that they are not confused with the timing references in the HD SDI. Both higher 10-bit and lower 10-bit data are within the code range of 004_h to $3FB_h$. The word values that need to be remapped are 000_h, 001_h, 002_h, 003_h, $3FC_h$, $3FD_h$, $3FE_h$, and $3FF_h$.

Multiplexed 20-bit words, derived from SD SDI 10-bit words, fall into one of three possible cases:

6.3.1 Both the upper and lower 10 bits do not violate the code range. The word is multiplexed as is and the corresponding valid bit for this channel in the segment header will be set to logic 1.

6.3.2 The total bandwidth of channels assigned to the input video or data stream is always higher than the bit rate of the input video and data stream. Therefore, at a multiplexer, the input FIFO could be empty from time to time. When FIFO is empty, the data to be multiplexed are not available and the channel valid bit will be set to 0 as well as force the data word to be 200_h and 040_h at the multiplexer.

6.3.3 When the input words contain the EAV, SAV, or ADF in HANC and VANC space in a video stream to be multiplexed, they may be confused with the HD timing reference signal and violate the coding range in the HD data format. To avoid this occurrence in the multiplexer, bits 12 through 19 and 2 through 9 are examined. If one of them is 00_h or FF_h, the corresponding header valid bit will be set to 0 and toggle bits 19, 18, 9, and 8. At the demultiplexer end, if the header valid bit is found to be 0, and the corresponding data word is neither 200_h nor 040_h, the demultiplexer will interpret the word as part of the original EAV, SAV, or ADF. Bits 19, 18, 9, and 8 shall then be toggled back.

The unused channels will have the default value of 200_h and 040_h. The corresponding valid bit shall be set to logic 0.

6.4 Generic data stream format

In addition to uncompressed video source data streams, compressed video data and generic 8-bit source data streams are also supported. For purposes of error detection and to prevent the possibility of inserting values that might be confused with timing references in the high-definition interface, each 8-bit word is appended with a 2-bit parity field in the most significant position. Bit 8 is the even parity of the 8 data bits and bit 9 is its complement as shown in table 3.

Table 3 – Generic 8-bit data format

Bit No.	Bit field
19	Complement of bit 18
18	Even parity of bits 10 to 17
10 … 17	Second byte: Data bits 0 to 7
9	Complement of bit 8
8	Even parity of bits 0 to 7
0 … 7	First byte: Data bits 0 to 7

7 Stream header

Stream headers shall be embedded in the luminance component of the horizontal ancillary data space in HD SDI. They are used to identify specific video or data embedded in the payload area. The stream header contains the configuration information about streams, the channels in the payload area, and the payload packets that are organized into channels.

Each stream header shall conform to SMPTE 291M ancillary data packet type 2, as shown in table 4.

Table 4 – Stream header format

Word	Name	Data (Y)	Description
0	ADF	000_h	Ancillary data flag
1		$3FF_h$	
2		$3FF_h$	
3	DID	143_h	Data ID
4	SDID	113_h	Secondary DID
5	DC	$11D_h$	Data count
6-32	HCD	Data	Header control data
33	RD0	040_h	Reserved data 1
34	RD1	040_h	Reserved data 2
35	CS	CS	Checksum

Horizontally, a stream header shall be left justified after the EAV/LN/CRC or any preexisting ancillary data packet. Vertically, it shall be inserted within 18 lines after the switching point. For every stream, it shall have at least one stream header per HD frame. The rest of the ancillary data space is left free to carry any other ancillary data.

7.1 Ancillary data format

The ancillary data packet shall be type 2. The ADF, DID, SDID, DC, and CS shall conform to SMPTE 291M.

7.1.1 Data ID (DID)

The ancillary data packet shall have the data ID set to XX_h.

7.1.2 Secondary data ID (SDID)

The secondary data ID shall be used to represent the number of channels in the HD payload area. For example, 101_h represents a single channel and 113_h represents 19 channels.

7.1.3 Data count (DC)

The data count shall represent 27 words of header control data and 2 words of user reserved data for bit 7 through bit 0. Bit 8 is the even parity for bit 7 through bit 0 and bit 9 is the complement of bit 8. The resulting value is $11D_h$.

7.1.4 Checksum (CS)

Checksum shall be calculated from upper and lower 10-bit data independently. Each checksum word shall consist of 9 bits (MSBs of the 10-bit words are not used in the checksum calculation). The checksum word is used to determine the validity of the word ID through user data. Bit 19 shall be the complement of bit 18, and bit 9 shall be the complement of bit 8.

7.2 Header control data

The header control data contain information regarding the stream ID, stream type, and channel usage which specifies how many and which channels belong to the data stream. The stream header also contains stream clock reference for clock recovery at receiver side as well as source and destination addresses for intelligent routing. A CRC word for header data for the stream header packet is also included for the data integrity check (see table 5).

Table 5 – Stream header format

Word	Data	Description
6	SID	Stream ID
7	STP	Stream type
8-9	CUS	Channel usage
10-13	SCR	Stream clock reference
14	AAI	Format of the addresses
15-22	DA	Destination address
23-30	SA	Source address
31-32	CRC	Header data CRC

7.2.1 Stream ID (Word 6)

Stream ID shall have 256 values to distinguish the various video and data streams (see table 6).

Table 6 – Bit assignment for stream ID

Bit	Data	Description
9	Not P1	Complementary P1
8	P1	Even parity B7-B0
7-0	SID	Stream ID

7.2.2 Stream data type (Word 7)

The stream data type is intended to identify the stream format of the source video or data. The SDT shall be registered with SMPTE (see table 7).

Table 7 – Bit assignment for stream type

Bit	Data	Description
9	Not P1	Complementary P1
8	P1	Even parity B7-B0
7-0	STP	Stream DATA type

A possible stream type assignment is shown as an example. For 20-bit uncompressed HD SDI video at 1.485 Gbit/s, it is proposed to include stream header, although the payload data will not be partitioned to 19 channels. They will conform to the SMPTE 292M standard (see table 8).

Table 8 – Stream types

STP	Description	Bit rate	Max # ch
01_h	1080i/60i	1.485G	1
02_h	720p/60p	1.485G	1
20_h	480p/60p	540M	2
21_h	480p/60p/4:2:0	360M	3
22_h	480p/60i	270M	4
30_h	525 composite	143M	8
31_h	625 composite	177M	6
70_h	Data	Up to 68M	18

7.2.3 Channel usage (Words 8-9)

Channel usage is made of two 10-bit control words that specify what channels belong to this video/data stream. Bit 9 of both words is used to make the word conform to SMPTE 292M. Each of the remaining 9 bits shall indicate whether the corresponding channel is used for this stream (see table 9).

Table 9 – Channel usage

Word 8

Bit No.	Bit field
9	Complement of bit 18
8	Channel 17 is used if active 1
7	Channel 16 is used if active 1
6	Channel 15 is used if active 1
5	Channel 14 is used if active 1
4	Channel 13 is used if active 1
3	Channel 12 is used if active 1
2	Channel 11 is used if active 1
1	Channel 10 is used if active 1
0	Channel 9 is used if active 1

Word 9

Bit No.	Bit field
9	Complement of bit 8
8	Channel 8 is used if active 1
7	Channel 7 is used if active 1
6	Channel 6 is used if active 1
5	Channel 5 is used if active 1
4	Channel 4 is used if active 1
3	Channel 3 is used if active 1
2	Channel 2 is used if active 1
1	Channel 1 is used if active 1
0	Channel 0 is used if active 1

7.2.4 Stream clock reference (SCR)

SCR uses a similar concept as the program clock reference (PCR) in the MPEG system specification. A 32-bit SCR is carried by four 10-bit words as shown in table 10.

Table 10 – Stream clock reference data format

Word	Bit No.	Bit field
10	9	Complement of P3
	8	P3, even parity of SCR (31: 24)
	7-0	SCR (31: 24)
11	9	Complement of P2
	8	P2, even parity of SCR (23: 16)
	7-0	SCR (23: 16)
12	9	Complement of P1
	8	P1, even parity of SCR (15: 8)
	7-0	SCR (15: 8)
13	9	Complement of P1
	8	P0, even parity of SCR (7: 0)
	7-0	SCR (7: 0)

At a multiplexer, each SD SDI video and data stream has a 32-bit counter incrementing at corresponding clock rate. Whenever it is time to embed another stream header, the current value of the counter is embedded into the HD stream.

The demultiplexer may reconstruct the original stream clock from the SCR and their respective arrival times. At the demultiplexer, the SCR is compared with a 32-bit counter incremented by the local stream clock generator and a PLL could be used to speed up or slow down the local clock depending on the difference of the SCR and local counter. Since a stream header is embedded every frame, SCR is updated every HD frame.

The SCR accuracy should be ± 1 SD sample period for an asynchronous SD stream (with respect to HD carrier) and ± 0 sample periods for a synchronous SD stream. Since the HD stream clock is very stable, a reliable SD clock can be generated in the receiver clock recovery unit.

7.2.5 Authorized address identifier (AAI)

The AAI is intended to identify the format of the destination and source address words with 256 different states. Bits 0 to 7 of word 14 shall be used as actual AAI data and bit 8 is even parity of bits 0 to 7. Bit 9 is the complement of bit 8. Word 00_h is reserved for unspecified address and word 01_h is for the IPV6 address. The AAI shall be registered with SMPTE.

7.2.6 Destination and source addresses

The destination and source addresses represent the addresses of the devices within the connection according to the AAI. Sixteen bytes are allocated for both destination (words 15-22) and source (words 23-30) addresses with the following structure (see table 11).

When all 16 bytes are zero filled, it shall indicate the universal address to all devices connected to the interface.

Table 11 – Destination and source address data format

Word	Bit No.	Bit field
15/23	9	Complement of P1
	8	P1, even parity of ADDRESS (15: 8)
	7-0	ADDRESS (15: 8)
16/24	9	Complement of P0
	8	P0, even parity of ADDRESS (7: 0)
	7-0	ADDRESS (7: 0)
17/25	9	Complement of P3
	8	P3, even parity of ADDRESS (31: 24)
	7-0	ADDRESS (31: 24)
18/26	9	Complement of P2
	8	P2, even parity of ADDRESS (23: 16)
	7-0	ADDRESS (23: 16)
19/27	9	Complement of P5
	8	P5, even parity of ADDRESS (47: 40)
	7-0	ADDRESS (47: 40)
20/28	9	Complement of P4
	8	P4, even parity of ADDRESS (39: 32)
	7-0	ADDRESS (39: 32)
21/29	9	Complement of P7
	8	P7, even parity of ADDRESS (63: 56)
	7-0	ADDRESS (63: 56)

7.2.7 Header data CRC

The header CRC covers the entire header data starting from the beginning of the header data and ending with two reserved words. The generator polynomial for the header CRC shall be $G(X) = X^{18} + X^5 + X^4 + 1$, which conforms to ITU-T X.25.

Header CRC is an 18-bit long data. It shall occupy a single 20-bit word. Header CRC shall be placed as shown in table 12. Bit 9 and bit 19 are the complement of CRC(8) and CRC(17), respectively, again to conform to the SMPTE 292M standard.

Table 12 – Header CRC bit locations

Word	Bit No.	Bit field
31	9	Complement of CRC (17)
	8-0	CRC (17: 9)
32	9	Complement of CRC (8)
	8-0	CRC (8: 0)

Annex A (informative)
Standard definition video formats

A.1 Standard definition video formats referred to in this standard include (see table A.1):

Interlaced scan: 13.5-MHz and 18-MHz sampling frequency member of the families with 4:2:2, 4:4:4, or 4:4:4:4 sampling structures for both 525-line 60/59.94-field and 625-line 50-field systems defined in ITU-R BT.601-5, ITU-R BT.656-4, and ANSI/SMPTE 259M.

Progressive scan: 525-line 60/59.94-frame and 625-line 50-frame systems with 4:2:0 or 4:2:2 sampling structure (ANSI/SMPTE 293M and ANSI/SMPTE 294M).

$4f_{sc}$ composite: 525-line and 625-line systems with the serial interface defined in ANSI/SMPTE 259M.

A.2 The bandwidth of the 10-bit SD video formats ranges from:

720 Mb/s: 525×59.94/625×50 16×9 wide-screen systems sampling at 18 MHz with 4:4:4:4i, 8:4:4i, or 4:2:2p sampling structures.

540 Mb/s: 525×59.94/625×50 16×9 wide-screen systems sampling at 18 MHz with 4:2:2:4i, 4:4:4i, or 4:2:0p sampling structures, or 525×59.94/625×50 4×3 systems sampling at 13.5 MHz with 4:4:4:4i, 8:4:4i, or 4:2:2p sampling structures.

360 Mb/s: 525×59.94/625×50 16×9 wide-screen systems sampling at 18 MHz with 4:2:2i sampling structure, or 525×59.94/625×50 4×3 systems sampling at 13.5 MHz with 4:2:2:4i, 4:4:4i, or 4:2:0p sampling structures.

270 Mb/s: 525×59.94/625×50 4×3 interlaced scan systems sampling at 13.5 MHz with 4:2:2 sampling structures.

180 Mb/s: 525×59.94/625×50 16×9 wide-screen systems sampling at 18 MHz with 4:0:0i sampling structure for black-and-white pictures or a keying channel in a production mixer.

177 Mb/s: 625×50 4×3 interlaced scan composite system sampling at $4f_{sc}$.

143 Mb/s: 525×59.94 4×3 interlaced scan composite system sampling at $4f_{sc}$.

135 Mb/s: 525×59.94/625×50 4×3 systems sampling at 13.5 MHz with 4:0:0i sampling structure for black-and-white pictures or a keying channel in a production mixer.

Table A.1 – Summary of SD video formats

SD system/sampling structure	525×60 or 625×50 4×3 13.5 MHz	525×59.94 or 625×50 16×9 18 MHz
4:0:0i	135 Mb/s	180 Mb/s
4:2:2i	270 Mb/s ANSI/SMPTE 267M	360 Mb/s ANSI/SMPTE 267M
4:2:2:4i	360 Mb/s	540 Mb/s
4:4:4i	360 Mb/s ITU-R BT.601-5	540 Mb/s ITU-R BT.601-5
4:2:0p	360 Mb/s	540 Mb/s
4:4:4:4i	540 Mb/s SMPTE RP 174	720 Mb/s
8:4:4i	540 Mb/s	720 Mb/s
4:2:2p	540 Mb/s ANSI/SMPTE 293M	720 Mb/s

Annex B (informative)
TDM bandwidth versus HD formats

Bit rates in the variety of HD formats described in SMPTE 292M, SMPTE 274M, and ANSI/SMPTE 296M are almost the same, except for a minor variation, 1000/1001, in some of the formats. However, TDM data are only multiplexed in the active video and the vertical blanking area, and the active video and the vertical blanking area are all different for different HD formats. Therefore, bandwidth for a TDM channel in the different HD formats is different. Table B.1 shows the channel bandwidth and total bandwidth for various HD formats. Since there are 18 TDM channels in the active video area, the total bandwidth is the product of 18 and the channel bandwidth.

Table B.1 – TDM channel bandwidth

HD formats		Segments in a line	Channel BW (Mbit/s)	Total BW (Mbit/s)
SMPTE 274M	1080i/60 or 59.94	101	68.0	1224
	1080i/50	101	56.8	1022
	1080p/30 or 29.97	101	68.0	1124
	1080p/25	101	56.8	1022
	1080p/24 or 23.98	101	54.4	979
	1080sf/30 or 23.98	101	54.4	979
SMPTE 296M	720p/60 or 59.94	67	60.3	1085
	720p/50	67	50.2	903
	720p/30 or 29.97	67	30.1	541
	720p/25	67	25.1	451
	720p/24 or 23.98	67	24.0	432

Annex C (informative)
Maximum number of SD streams in HD TDM format

Since the channel bandwidth for different HD formats is not the same, the number of channels to construct a given bandwidth video/data stream may also differ. Table C.1 shows examples of possible configurations (A through I) of video and data streams carried on a 1080i/60 or 59.94 HD SDI stream.

Table C.2 shows examples of possible configurations (A through I) of video and data streams carried on a 720p/60 or 59.94 HD SDI stream.

Table C.1 – Number of 1080i/60 multiplexing channels

Configurations	A	B	C	D	E	F	G	H	I
720 Mb/s	1								
540 Mb/s 480p		2							
360 Mb/s 480p420			3						
270 Mb/s 4:2:2				4					
180 Mb/s 4:0:0 16×9					6				
177 Mb/s PAL						7			
143 Mb/s NTSC							8		
135 Mb/s 4:0:0								9	
<68 Mb Data		2		2			2		18

Table C.2 – Number of 720p/60 multiplexing channels

Configurations	A	B	C	D	E	F	G	H	I
720 Mb/s	1								
540 Mb/s 480p		2							
360 Mb/s 480p420			3						
270 Mb/s 4:2:2				3					
180 Mb/s 4:0:0 16×9					6				
177 Mb/s PAL						6			
143 Mb/s NTSC							8		
135 Mb/s 4:0:0								9	
<68 Mb Data				2			2		18

Annex D (informative)
TDM mapping based on 1080i/59.94 HD format

TDM mapping based on 1080i/59.94 HD format for one horizontal line is as shown in figure D.1.

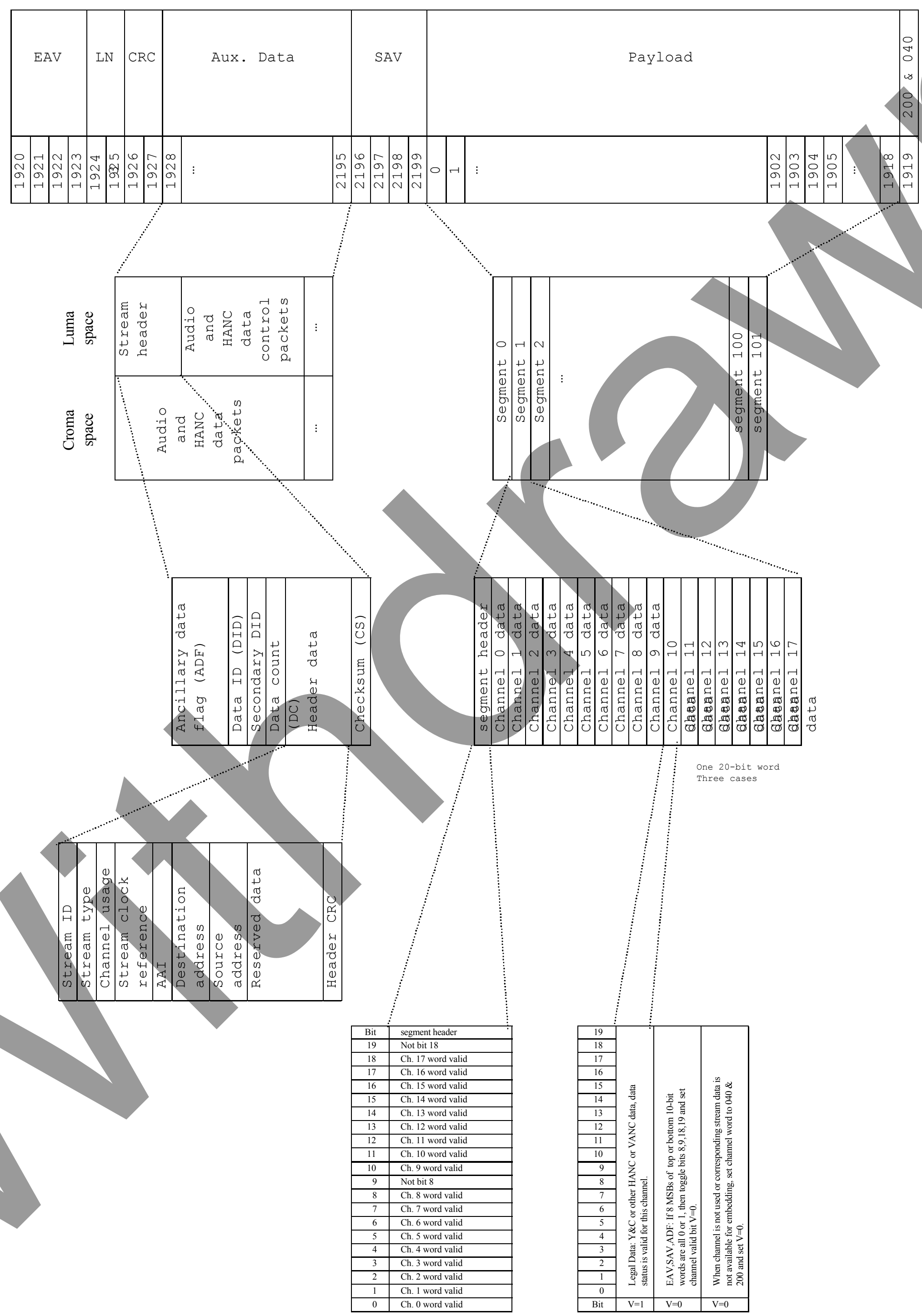

Figure D.1 – TDM mapping based on 1080i/59.94 HD format for one horizontal line

Annex E (informative)
TDM mapping based on 720p/59.94 HD format

TDM mapping based on 720p/59.94 HD format for one horizontal line is shown in figure E.1.

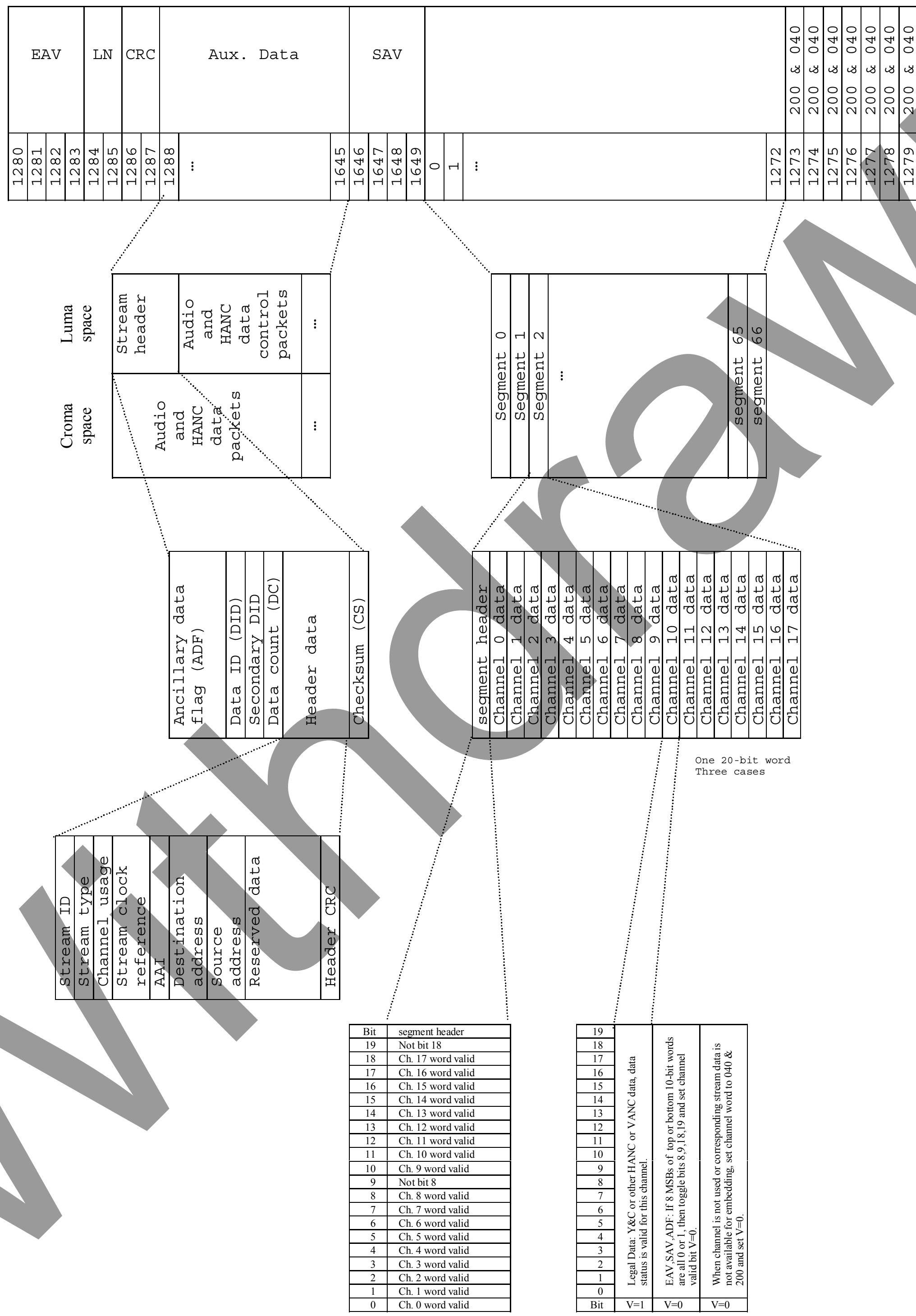

Figure E.1 – TDM mapping based on 720p/59.94 HD format for one horizontal line

Annex F (informative)
Bibliography

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