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SMPTE STANDARD

for Television — Transporting MPEG-2 Recoding Information through High-Definition Digital Interfaces



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1 Scope

This standard specifies an embedded transport mechanism for the MPEG-2 recoding data set as defined in SMPTE 327M for the representation of MPEG-2 recoding information on a SMPTE 274M interface and subsequently upon a SMPTE 292M bit-serial digital interface.

The recoding data set is derived from an ISO/IEC 13818-1/2 compliant MPEG bitstream during the decoding process, as described in the ISO/IEC 13818-1/2 standards.

For the minimum operation of this standard, the MPEG-2 recoding data set shall be spatially and temporally aligned to each decoded macroblock mapped into a SMPTE 274M/292M interface.

This standard specifies the spatially and temporally aligned transport of the MPEG-2 recoding data set within the active picture area on SMPTE 274M/292M interfaces for equipment that complies with the ISO/IEC 13818-1/2 standards, including 4:2:2P@HL and MP@HL for 60- and 50-Hz interlaced and 60-, 30-, 25-, and 24-Hz progressive video standards.

2 Normative references

The following standards contain provisions which, through reference in this text, constitute provisions of this standard. 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 274M-1998, Television — 1920 × 1080 Scanning and Analog and Parallel Digital Interfaces for Multiple Picture Rates

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

SMPTE 327M-2000, Television — MPEG-2 Video Recoding Data Set

ITU-T H.222.0 with amend 1-2, ISO/IEC 13818-1 (1996-04), Information Technology — Generic Coding of Moving Pictures and Associated Audio Information: Systems

ITU-T H.262 with amend 1/corr 1 and amend 2/corr 2, ISO/IEC 13818-2 (1996-05), Information Technology — Generic Coding of Moving Pictures and Associated Audio Information: Video

3 General

The principal application of this standard is to preserve the quality of the video signal when cascading MPEG-2 decoders and coders for editing or transcoding purposes by feeding forward previous coding decisions.

This transport mechanism for the MPEG-2 recoding data set permits the simultaneous processing of both the video and the MPEG-2 recoding data set and, consequently, of the MPEG bitstream. This allows lossless cascading, frame accurate editing, and logo/caption insertion to be performed.

The information contained in the MPEG-2 recoding data set is defined in SMPTE 327M.

This recoding information shall be temporally locked to the decoded (or partially decoded) video to the nearest MPEG-2 frame or field depending on the picture structure of the coded MPEG-2 bitstream. It shall also be spatially locked with the decoded video to the nearest MPEG-2 macroblock within the decoded frame/field.

To accrue the full benefits of the recoding information when cascading via a digital baseband interface, the following recommendations shall be adhered to:

- The transport mechanism shall preserve at least the 8 most significant bits of active video. The mechanism outlined uses the least significant bit of each 10-bit chrominance sample to transmit the data through the SMPTE 274M or 292M interface.

NOTE - Users should be aware that some equipment using SMPTE 274M/292M interfaces may alter or use the 10th bit of the video samples for other (nonstandardized) purposes. Where this occurs, the recoder will be unable to benefit from the MPEG-2 recoding information.

- It is also necessary for the recoding information to be aligned with the decoded MPEG macroblocks in the decoded pictures, both spatially and temporally. This standard is based on producing a SMPTE 274M/292M compliant output to cover HD-MPEG bitstreams up to and including 4:2:2P@HL and MP@HL for 1920 × 1080 60 (59.94) or 50 2:1, 1920 × 1080 30 (29.97), 25 or 24 (23.98) 1:1, and 1280 × 720 60 (59.94) 1:1 systems.

4 Definitions

4.1 aligned: [As applied usually to recoding information] arranged so that information relating to a macroblock (or other region) is embedded within that region of the decoded signal.

4.2 bitstream: An ordered series of bits conforming to ISO/IEC 13818-2.

4.3 bottom field: One of two fields that comprise a frame. Each line of a bottom field is spatially located immediately below the corresponding line of the top field.

4.4 cascading: This describes the process where video that has once been coded (compressed) is subsequently decoded and coded once more. This cascaded step could carry on for any number of generations.

4.5 chrominance: The color-difference samples defined in ITU-R BT.709-4.

4.6 coding: This is the process by which an uncompressed video sequence is compressed to a bitstream that conforms to ISO/IEC 13818-2.

4.7 column: A vertical column of macroblocks spanning the full height of the decoded picture (columns are numbered from left to right starting at zero).

4.8 CRC: Cyclic redundancy check. A class of error detecting codes used in this standard to detect errors when the recoding information and the decoded pictures are being edited or processed in a SMPTE 274M or 292M stream by external equipment.

4.9 decoded video, decoded picture: Output video, generated by an ISO/IEC 13818-2 compliant decoder that complies with the SMPTE 274M or 292M interface standard.

4.10 decoder: A compressed bitstream decoder that complies with ISO/IEC 13818-2.

4.11 DTS: Decoding time stamp (see ISO/IEC 13818-1).

4.12 embedded: [As applied usually to the recoding information] conveyed within a digital video signal so as to be capable of being passed through digital video equipment.

4.13 macroblock: Defined in ISO/IEC 13818-2 as a block of 16 × 16 luminance pixels.

4.14 macroblock rate information: This corresponds to the coding information from the ISO/IEC 13818-2 bitstream that relates to the individual macroblocks as defined in this standard.

4.15 MPEG profile/level: As defined in ISO/IEC 13818-2.

4.16 MPEG-2 recoding information: This comprises the elements defined in SMPTE 327M and the additional information described in this standard required for the practical transport and use of the MPEG-2 recoding data set.

4.17 picture: As defined in ISO/IEC 13818-2.

4.18 picture rate information This corresponds to the coding information from the ISO/IEC 13818-2 bitstream that relates to the whole picture as defined in this standard.

4.19 PTS: Presentation time stamp (see ISO/IEC 13818-1).

4.20 recoding data set: The set of information defined in SMPTE 327M.

4.21 stripe: A horizontal row of macroblocks spanning the full width of the decoded picture (stripes are numbered from top to bottom starting at zero).

4.22 sufficient: [As applied usually to the recoding data set] containing the necessary information to enable transparent recoding (in a mathematical sense) of the video signal.

4.23 top field: One of two fields that comprise a frame. Each line of a top field is spatially located immediately above the corresponding line of the bottom field.

4.24 transcoding: A conversion within the MPEG-2 stream domain, such as bitrate changing or changing the group of pictures (GOP) structure.

4.25 video: A signal conforming to SMPTE 274M in this standard.

5 MPEG-2 recoding information

MPEG-2 recoding information comprises:

- The elements defined in SMPTE 327M.
- Additional elements from both macroblock and picture rate information as described in this standard.

These additional elements are required to allow the video and the MPEG-2 recoding information to be simultaneously edited using SMPTE 274M/292M based equipment.

The MPEG-2 recoding information is subsequently aligned within the macroblock as described in figure 1.

6 Macroblock rate information

The contents of the MPEG-2 recoding data set relating to each macroblock shall be spatially as well as temporally aligned with the decoded video pixels relating to that macroblock.

The elements in table 1 are at picture rate in the MPEG-2 stream, but are inserted into MPEG-2 recoding information at both picture and macroblock level to create the alignment required to allow editing of the resultant SMPTE 274M/292M signal.

The elements in table 2 are required in the transport mechanism to synchronize the video information and the MPEG-2 recoding information.

Where reference is made to elements in ISO/IEC 13818-2, these are indicated in the text in italics.

7 MPEG-2 recoding information transport mechanism

This comprises 256 bits of data per macroblock that shall be placed bit by bit onto the least significant bit of each 10-bit chrominance sample in the decoded video.

The decoded 4:2:2 component video macroblock corresponds to a matrix of 16×16 luminance components and two matrices of 8×16 color-difference components. Hence, in total there are 256 pixels of luminance and 256 pixels of chrominance in each macroblock. In SMPTE 292M video, the multiplexed order for these pixels is C_b, Y, C_r, Y .

To increase the resilience of the detection of edits in the macroblock formatted recoding information, a form of parity scrambling is applied to the data before being placed in the least significant bit of the 10-bit chrominance samples.

The parity scrambling scheme used is shown in figure 4, where the bits represent the bits of 10-bit video (i.e., bits 2 through 9 correspond to the 8-bit video).