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| *Title:* | **AHG7: Chroma sampling filter hint SEI** | | |
| *Status:* | Input Document to JCT-VC | | |
| *Purpose:* | Proposal | | |
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# Abstract

Although most of video format standardizations specify the colour transform matrix and bit-depth, filter coefficient set for up-sampling and down-sampling of chroma format have not been specified until recently. In order to reduce conversion losses of chroma format, this contribution proposes a method of SEI message for chroma sampling.

# Introduction

The first version of HEVC [1] has specified a profile for 4:2:0 chroma format and 8-bit depth pixel sample. In the next version, a specification for 4:2:2 and 4:4:4 chroma format and n-bit depth pixel sample is planned. Although most of video format standardization specifies the colour transform matrix and bit-depth, filter coefficient set for up-sampling and down-sampling of chroma format have not been specified until recently. For example, it is known that there is a problem of chroma shift when two or more 4:2:0 codecs are concatenated because the codecs are usually connected via HD-SDI (a 4:2:2 interconnect) resulting in up-sampling and down-sampling of the chroma component. In order to avoid those problems, SMPTE RP-2050-1:2012 [2], which defines filter sets for 4:2:2 / 4:2:0 and 4:2:0 / 4:2:2 conversions, has been published recently. In this contribution, we propose a method of SEI message for chroma sampling which can solve those problems generally. In the next section, the detailed specification is described.

# Chroma sampling filter hint SEI

|  |  |
| --- | --- |
| sei\_payload( payloadType, payloadSize ) { | Descriptor |
| ... |  |
| else if( payloadType = = XXX) |  |
| chroma\_sampling\_filter\_hint( payloadSize) |  |
| else |  |
| reserved\_sei\_message( payloadSize ) |  |
| if( !byte\_aligned( ) ) { |  |
| **bit\_equal\_to\_one** /\* equal to 1 \*/ | f(1) |
| while( !byte\_aligned( ) ) |  |
| **bit\_equal\_to\_zero** /\* equal to 0 \*/ | f(1) |
| } |  |
| } |  |

### D.1.X Chroma sampling filter hint SEI syntax

|  |  |
| --- | --- |
| chroma\_sampling\_filter\_hint(payloadSize) { | **Description** |
| **coded\_format\_idc** | ue(v) |
| **coded\_data\_bit\_depth** | ue(v) |
| **target\_format\_idc** | ue(v) |
| **target\_bit\_depth** | ue(v) |
| **max\_value** | ue(v) |
| **min\_value** | ue(v) |
| if( (coded\_fromat\_idc = = 1 && target\_format\_idc > 1) | |  (coded\_fromat\_idc > 1 && target\_format\_idc = = 1) ) { |  |
| **progressive\_flag** | u(1) |
| **implicit\_vertical\_flag** | u(1) |
| if( implicit\_vertical\_flag = = 1 ) |  |
| **vertical\_filter\_idc** | u(4) |
| else { |  |
| **tap\_length\_vertical\_minus1** | ue(v) |
| for( i = 0; i <= tap\_length\_vertical\_minus1; i++) |  |
| **ver\_filter\_coeff[i]** | se(v) |
| } |  |
| if( !progressive\_flag &&  coded\_fromat\_idc = = 1 && target\_format\_idc > 1 ) |  |
| if( implicit\_vertical\_flag = = 1 ) |  |
| **second\_vertical\_filter\_idc** | u(4) |
| else { |  |
| **tap\_length\_second\_vertical\_minus1** | ue(v) |
| for( i = 0; i <= tap\_length\_second\_vertical\_minus1; i++) |  |
| **second\_ver\_filter\_coeff[i]** | se(v) |
| } |  |
| } |  |
| if( ((coded\_format\_idc = =1 | | coded\_format\_idc = = 2) &&  target\_format\_idc = = 3)) | |  (coded\_format\_idc = = 3 &&  (target\_format\_idc = = 1| | target\_format\_idc = = 2))) { |  |
| **implicit\_horizontal\_flag** | u(1) |
| if( implicit\_horizontal\_flag = = 1 ) |  |
| **horizontal\_filter\_idc** | u(4) |
| else { |  |
| **tap\_length\_horizontal\_minus1** | ue(v) |
| for( i = 0; i <= tap\_length\_horizontal\_minus1; i++) |  |
| **hor\_filter\_coeff[i]** | se(v) |
| } |  |
| } |  |
| } |  |

### D.2.X Chroma sampling filter hint SEI semantics

**coded\_format\_idc** specifies thechroma\_format\_idc of the chroma component of the coded video sequence. It is used to identify the chroma sampling filter hint SEI message that is intended for use with the coded video sequence. If chroma sampling filter hint SEI messages are present that have coded\_format\_idc that is not equal to chroma\_format\_idc, these refer to the hypothetical result of a transcoding operation performed to convert the coded video to the chroma\_format\_idc corresponding to the value of coded\_format\_idc. The value of coded\_format\_idc shall be in the range of 1 to 3, inclusive.

**coded\_data\_bit\_depth** specifies the BitDepthC of the chroma component of the coded video sequence. It is used to identify the chroma sampling filter hint SEI message that is intended for use with the coded video sequence. If chroma sampling filter hint SEI messages are present that have coded\_data\_bit\_depth that is not equal to BitDepthC, these refer to the hypothetical result of a transcoding operation performed to convert the coded video to the BitDepthC corresponding to the value of coded\_data\_bit\_depth. The value of coded\_data\_bit\_depth shall be in the range of 8 to 14, inclusive.

**target\_format\_idc** specifies the output of chroma sampling relative to the luma sampling as specified in subclause 6.2. The value of target\_format\_idc shall be in the range of 0 to 3, inclusive.

**target\_bit\_depth** specifies the bit depth of the output samples of the chroma array. target\_bit\_depth shall be in the range of 1 to 16, inclusive.

**max\_value** specifies the maximum value in the signalled target\_bit\_depth. All values in the coded data that are larger than or equal to max\_value are mapped to this maximum value in the target\_bit\_depth representation.

**min\_value** specifies the minimum value in the signalled target\_bit\_depth. All values in the coded data that are less than or equal to min\_value are mapped to this minimum value in the target\_bit\_depth representation.

**progressive\_flag** qual to 1 indicates that the scan type of the associated picture should be interpreted as progressive. progressive\_flag equal to 0 indicates that the scan type of the associated picture should be interpreted as interlaced.

**implicit\_vertical\_flag** equal to 1 specifies that the filter coefficient of vertical direction as specified in Table D-X. implicit\_vertical\_flag equal to 0 specifies the vertical filter coefficient information explicitly.

**vertical\_filter\_idc** indicates the value and tap-length of the filter coefficient of vertical direction as specified in Table D-X. The value of vertical\_filter\_idc shall be in the range of 0 to 6, inclusive.

**tap\_length\_vertical\_minus1** + 1specifies the number of tap length of vertical filter. The value of tap\_length\_vertical\_minus1 shall be in the range of 0 to 15, inclusive.

**ver\_filter\_coeff[i]** specifies the filter coefficient value for vertical direction. The value of ver\_filter\_coeff[i] shall be in the range of −231 + 1 to 231 − 1, inclusive.

**second\_vertical\_filter\_idc** indicates the value and tap-length of the filter coefficient of vertical direction as specified in Table D-X. The value of second\_vertical\_filter\_idc shall be in the range of 0 to 6, inclusive.

**tap\_length\_second\_vertical\_minus1** + 1specifies the number of tap length of second vertical filter. The value of tap\_length\_vertical\_minus1 shall be in the range of 0 to 15, inclusive.

**second\_ver\_filter\_coeff[i]** specifies the filter coefficient value for vertical direction. The value of second\_ver\_filter\_coeff[i] shall be in the range of −231 + 1 to 231 − 1, inclusive.

**implicit\_horizontal\_flag** equal to 1 specifies that the filter coefficient of horizontal direction as specified in Table D-X. implicit\_horizontal\_flag equal to 0 specifies the horizontal filter coefficient information explicitly.

**horizontal\_filter\_idc** indicates the value and tap-length the filter coefficient of horizontal direction as specified in Table D-X. The value of horizontal\_filter\_idc shall be in the range of 0 to 6, inclusive.

**tap\_length\_horizontal\_minus1** + 1specifies the number of tap length of horizontal filter. The value of tap\_length\_horizontal\_minus1 shall be in the range of 0 to 15, inclusive.

**hor\_filter\_coeff[i]** specifies the filter coefficient value for horizontal direction. The value of hor\_filter\_coeff[i] shall be in the range of −231 + 1 to 231 − 1, inclusive.

Table D-X Implicit filter coefficients

|  |  |  |  |  |
| --- | --- | --- | --- | --- |
| **Value** | **Tap length** | **Filter coefficients** | **Divisor** | **Informative remark** |
| 0 | 8 | -3,-19,34,500,500,34,-19,-3 | 1024 | Down-sampling filter coefficients for 4:2:2 / 4:2:0 conversion for progressive source SMPTE RP2050-1:2012 |
| 1 | 4 | 19,103,1037,-135 | 1024 | Up-sampling filter coefficients for 4:2:0 / 4:2:2 conversion for Even Lines of progressive source (Reverse order coefficients for Odd Lines) SMPTE RP2050-1:2012 |
| 2 | 8 | -8,-26,115,586,409,-48,-4,0 | 1024 | Down-sampling filter coefficients for 4:2:2 / 4:2:0 conversion for the top field of interlace source (Reverse order coefficients for the bottom field) SMPTE RP2050-1:2012 |
| 3 | 4 | 24,-41,1169,-128 | 1024 | Up-sampling filter coefficients for 4:2:0 / 4:2:2 conversion for Even Lines of the top field of interlace source (Reverse order coefficients for Odd Lines of the bottom field) SMPTE RP2050-1:2012 |
| 4 | 4 | -76,783,330,-13 | 1024 | Up-sampling filter coefficients for 4:2:0 / 4:2:2 conversion for Odd Lines of the top field of interlace source (Reverse order coefficients for Even Lines of the bottom field) SMPTE RP2050-1:2012 |
| 5 | 7 | -29,0,88,138,88,0,-29 | 256 | Down-sampling filter coefficients MPEG93/N0400 TM5 |
| 6 | 4 | -3,35,35,-3 | 64 | Up-sampling filter coefficients MPEG93/N0400 TM5 |
| 7..15 | Reserved |  |  | For future use by ITU-T | ISO/IEC |

NOTE1 – SMPTE EG2050-2:2012 provides details on a possible implementation of the filter defined in SMPTE RP2050-1:2012.

# References

[1] B. Bross, W.-J. Han, J.-R. Ohm, G. J. Sullivan and T. Wiegand, “High Efficiency Video Coding (HEVC) text specification draft 8,” Joint Collaborative Team on Video Coding, JCTVC-J1003r7, Stockholm, July 2012.

[2] “4:2:2 / 4:2:0 Format Conversion Minimizing Color Difference Signal Degradation in Concatenated Operations – Filtering,” SMPTE RP2050-1:2012, Jan. 2012.

[3] “Test Model 5,” ISO/IEC JCT1/SC29/WG11 MPEG93/N0400, ITU-T Q.2/15 AVC-491b, April 1993.

[4] “4:2:2 / 4:2:0 Format Conversion Minimizing Color Difference Signal Degradation in Concatenated Operations – Application,” SMPTE EG2050-2:2012, Jan. 2012.

# Patent rights declaration(s)

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