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| *Title:* | **Addition of the Chroma Sample Location as a code point in the CICP (23091-2) specification** | | |
| *Status:* | Input document to JCT-VC | | |
| *Purpose:* | Proposal | | |
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| *Source:* | Movielabs, Apple | | |

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# Abstract

This document proposes adding the chroma 4:2:0 sample location type (ChromaLocType) information to the Coding-Independent Code Point (CICP) for video signal type identification (ISO/IEC 23091-2 | ITU-T H.273) standard. ChromaLocType has traditionally been part of the AVC and HEVC video usability information (VUI), and was indicated by the bitstream elements chroma\_sample\_loc\_type\_top\_field and chroma\_sample\_loc\_type\_bottom\_field. The information conveyed by ChromaLocType has gained importance in systems that exchange more than one video signal types, such as ITU-R BT.2100 (HDR/WCG) and ITU-R BT.709 (SDR/NCG), where the location of the chroma (Cb, Cr) samples can differ among those types. Additional code points are also specified that, we believe, are needed to properly define the chroma sample location type code point.

# Introduction

The CICP part 2 standard [1] copies most of the key VUI elements from Annex E of the respective AVC and HEVC specifications that are exchanged in "color space" descriptor metadata needed to interpret the meaning of video or image samples coded within bitstreams. Typical code point combinations used in systems are provided in the CICP part 4 technical report [2]. In this document we propose adding additional code points, which will infer the chroma sample location type information, i.e. ChromaLocType, for content that utilize a subsampled chroma format. It is proposed to add the text from the latest VVC SEI draft [3]. Source code that generated the most recent ChromaLocType figures is available in [4].

# Proposed text additions

## 8.x Source indication

*Type: Binary*

*Range: 0 – 1, plus associated flag* [Ed. Note: Since both of these are flags, maybe this should be handled differently]

**ProgressiveSourceFlag** indicates, in association with the element InterlacedSourceFlag, how the source scan type of the signal should be interpreted.

**InterlacedSourceFlag** indicates, in association with the element ProgressiveSourceFlag, how the source scan type of the signal should be interpreted.

In particular, ProgressiveSourceFlag and InterlacedSourceFlag are interpreted as follows:

– If ProgressiveSourceFlag is equal to 1 and InterlacedSourceFlag is equal to 0, the source scan type of the pictures should be interpreted as progressive only.

– Otherwise, if ProgressiveSourceFlag is equal to 0 and InterlacedSourceFlag is equal to 1, the source scan type of the pictures should be interpreted as interlaced only.

– Otherwise, if ProgressiveSourceFlag is equal to 0 and InterlacedSourceFlag is equal to 0, the source scan type of the pictures should be interpreted as unknown or unspecified.

– Otherwise (ProgressiveSourceFlag is equal to 1 and InterlacedSourceFlag is equal to 1), the source scan type of each picture is indicated at the picture level through other means.

## 8.x Chroma format

*Type: Unsigned integer, enumeration*

*Range: : 0 – 3*

**ChromaFormatIdc** specifies the chroma sampling relative to the luma sampling as specified in Table 3. The value of ChromaFormatIdc shall be in the range of 0 to 3, inclusive.

The source and decoded pictures are each comprised of one or more sample arrays:

– Luma (Y) only (monochrome).

– Luma and two chroma (YCbCr or YCgCo).

– Green, blue, and red (GBR, also known as RGB).

– Arrays representing other unspecified monochrome or tri-stimulus colour samplings (for example, YZX, also known as XYZ).

For convenience of notation and terminology, the variables and terms associated with these arrays are referred to as luma (or L or Y) and chroma, where the two chroma arrays are referred to as Cb and Cr; regardless of the actual colour representation method in use. The actual colour representation method in use can be indicated using other syntax elements that may include and indicate the ColourPrimaries, TransferCharacteristics, and MatrixCoefficients of a signal.

Two variables, SubWidthC and SubHeightC, are specified in Table 3, which indicate the resolution scaling difference between luma versus chroma width and luma versus chroma height, respectively.

Table 3 – Definition of ChromaFormatIDC and its relationship with the luma/chroma width and height scaling factors SubWidthC and SubHeightC

|  |  |  |  |
| --- | --- | --- | --- |
| ChromaFormatIdc | Chroma Format | SubWidthC | SubHeightC |
| 0 | Monochrome | 1 | 1 |
| 1 | 4:2:0 | 2 | 2 |
| 2 | 4:2:2 | 2 | 1 |
| 3 | 4:4:4 | 1 | 1 |

Assuming a picture with resolution PicWidthInLumaSamples x PicHeightInLumaSamples, where PicWidthInLumaSamples is the width of the picture and PicHeightInLumaSamples is the height of the picture in luma samples, the resolution of the chroma planes can be computed as:

PicWidthInChromaSamples= PicWidthInLumaSamples / SubWidthC

PicHeightInChromaSamples = PicHeightInLumaSamples / SubHeightC

In monochrome sampling there is only one sample array, which is nominally considered the luma array.

In 4:2:0 sampling, each of the two chroma arrays has half the height and half the width of the luma array.

In 4:2:2 sampling, each of the two chroma arrays has the same height and half the width of the luma array.

In 4:4:4 sampling, each of the two chroma arrays has the same height and width as the luma array.

[Ed. Note: Should we also define the separate colour plane case?]

## 8.x Chroma location

*Type: Unsigned integer, enumeration*

*Range: : 0 – 5, plus associated flag*

**ChromaLocInfoPresentFlag** equal to 1 specifies that either ChromaSampleLocTypeFrame or both ChromaSampleLocTypeTopField and ChromaSampleLocTypeBottomField are present. ChromaLocInfoPresentFlag equal to 0 specifies that ChromaSampleLocTypeFrame, ChromaSampleLocTypeTopField, and ChromaSampleLocTypeBottomField are not present.

When ChromaFormatIdc is not equal to 1, ChromaLocInfoPresentFlag should be equal to 0.

[Ed. Note: Should we use "Location" instead of Loc?]

**ChromaSampleLocTypeFrame**, **ChromaSampleLocTypeTopField**, and **ChromaSampleLocTypeBottomField**, when present, specify the location of chroma samples as follows:

– If ProgressiveSourceFlag is equal to 1, InterlacedSourceFlag is equal to 0, and ChromaFormatIdc is equal to 1 (4:2:0 chroma format), ChromaSampleLocTypeFrame specifies the location of chroma samples for both fields of each frame shown in Figure 1.

– Otherwise, if ChromaFormatIdc is equal to 1 (4:2:0 chroma format), ChromaSampleLocTypeTopField and ChromaSampleLocTypeBottomField specify the location of chroma samples for each top field and bottom field, respectively, as shown in Figure 1.

– Otherwise (ChromaFormatIdc is not equal to 1), the values of the syntax elements chroma\_sample\_loc\_type, ChromaSampleLocTypeTopField and ChromaSampleLocTypeBottomField shall be ignored.

A picture containing building, large, lit, dark

Description automatically generated

Figure 1 – Location of chroma samples for top and bottom fields for ChromaFormatIdc equal to 1 (4:2:0 chroma format) as a function of ChromaSampleLocTypeTopField and ChromaSampleLocTypeBottomField in the range of 0 to 5, inclusive

When ChromaFormatIdc is equal to 2 (4:2:2 chroma format), the chroma samples are co-sited with the corresponding luma samples and the nominal locations in a picture are as shown in Figure 2.



Figure 2 – Nominal vertical and horizontal locations of 4:2:2 luma and chroma samples in a picture

When ChromaFormatIdc is equal to 3 (4:4:4 chroma format), all array samples are co-sited for all cases of pictures and the nominal locations in a picture are as shown in Figure 3.



Figure 3 – Nominal vertical and horizontal locations of 4:4:4 luma and chroma samples in a picture

When ChromaFormatIdc is equal to 0, there is no chroma sample array.

When present, the values of ChromaSampleLocTypeFrame, ChromaSampleLocTypeTopField and ChromaSampleLocTypeBottomField shall be in the range of 0 to 5, inclusive. [Ed. (GJS): Perhaps we should also allow the value 6 when these are present.]

When ChromaFormatIdc is equal to 1 and ChromaLocInfoPresentFlag is equal to 0, ChromaSampleLocTypeFrame is not present and is inferred to be equal to 6, which indicates that the the location of the chroma samples is unspecified. When ChromaSampleLocTypeTopField and ChromaSampleLocTypeBottomField are not present, the values of ChromaSampleLocTypeTopField and ChromaSampleLocTypeBottomField are inferred to be equal to ChromaSampleLocTypeFrame.

Figure 4 illustrates the indicated relative position of the top-left chroma sample when ChromaFormatIdc is equal to 1 (4:2:0 chroma format), and ChromaSampleLocTypeTopField or ChromaSampleLocTypeBottomField is equal to the value of a variable ChromaLocType. The region represented by the top-left 4:2:0 chroma sample (depicted as a large red square with a large red dot at its centre) is shown relative to the region represented by the top-left luma sample (depicted as a small black square with a small black dot at its centre). The regions represented by neighbouring luma samples are depicted as small grey squares with small grey dots at their centres.

A picture containing screenshot, game

Description automatically generated

Figure 4 – Location of the top-left chroma sample when ChromaFormatIdc is equal to 1  
(4:2:0 chroma format) as a function of ChromaLocType

The relative spatial positioning of the chroma samples, as illustrated in Figure 5, can be expressed by defining two variables HorizontalOffsetC and VerticalOffsetC as a function of ChromaFormatIdc and the variable ChromaLocType as given by Table 3, where HorizontalOffsetC is the horizontal (x) position of the centre of the top-left chroma sample relative to the centre of the top-left luma sample in units of luma samples and VerticalOffsetC is the vertical (y) position of the centre of the top-left chroma sample relative to the centre of the top-left luma sample in units of luma samples.

In a typical FIR filter design, when ChromaFormatIdc is equal to 1 (4:2:0 chroma format) or 2 (4:2:2 chroma format), HorizontalOffsetC and VerticalOffsetC would serve as the phase offsets for the horizontal and vertical filter operations, respectively, for separable downsampling from 4:4:4 chroma format to the chroma format indicated by ChromaFormatIdc.

A picture containing clock

Description automatically generated

Figure 5 – Location of the top-left chroma sample when ChromaFormatIdc is equal to 1  
(4:2:0 chroma format) when ChromaLocType is equal to 1

Table 3 – Definition of HorizontalOffsetC and VerticalOffsetC  
as a function of ChromaFormatIdc and ChromaLocType

|  |  |  |  |
| --- | --- | --- | --- |
| ChromaFormatIdc | ChromaLocType | HorizontalOffsetC | VerticalOffsetC |
| 1 (4:2:0) | 0 | 0 | 0.5 |
| 1 (4:2:0) | 1 | 0.5 | 0.5 |
| 1 (4:2:0) | 2 | 0 | 0 |
| 1 (4:2:0) | 3 | 0.5 | 0 |
| 1 (4:2:0) | 4 | 0 | 1 |
| 1 (4:2:0) | 5 | 0.5 | 1 |
| 2 (4:2:2) | – | 0 | 0 |
| 3 (4:4:4) | – | 0 | 0 |

When ChromaFormatIdc is equal to 1 (4:2:0 chroma format) and the decoded video content is intended for interpretation according to Rec. ITU-R BT.2020 or Rec. ITU-R BT.2100, ChromaLocInfoPresentFlag should be equal to 1, and ChromaSampleLocTypeFrame, ChromaSampleLocTypeTopField, and ChromaSampleLocTypeBottomField (as applicable) should be equal to 2.

# References

[1] ISO/IEC [23091-2](https://www.iso.org/standard/73412.html) | ITU-T [H.273](https://www.itu.int/rec/T-REC-H.273/en): "Coding-independent coding points for video signal type identification"

[2] ISO/IEC TR [23091-4](https://www.iso.org/standard/74418.html) | ITU-T [H Supplement 19](https://www.itu.int/ITU-T/recommendations/rec.aspx?rec=14096): "Usage of video signal type code points"

[3] JVET-[Q2007](http://phenix.int-evry.fr/jvet/doc_end_user/current_document.php?id=9679): "Supplemental enhancement information messages for coded video bitstreams (Draft 3)."

[4] JCTVC-[AC0039](http://phenix.int-evry.fr/jct/doc_end_user/current_document.php?id=10803): "Improved figures for chroma 4:2:0 location type"

# Patent rights declaration(s)

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