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| *Title:* | **CE6.a: Chroma intra prediction based on residual luma samples** | | |
| *Status:* | Input Document to JCT-VC | | |
| *Purpose:* | Proposal | | |
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# Abstract

This contribution presents an additional chroma intra mode based on inter-channel correlation of residual samples. Predicted Cb/Cr values are sum of regular prediction (same as DM) and linear equation using reconstructed luma-residual values with a parameter alpha. The parameter alpha is derived and coded on the encoder side. Compared to the HM5.0, the average BD-bitrate gain is 0.1%, 2.6%, 2.5%, and 0.5% for all intra HE configuration respectively for Y, U, V, and YUV components. This contribution is part of the CE6.a "Intra Chroma Prediction."

# Introduction

In current Test Model (HM) of High Efficiency Video Coding (HEVC) standards, six modes are defined as chroma intra prediction; Vertical, Horizontal, DC, Planar, LM, and mode derived from luma intra direction.

The LM mode predicts chroma samples based on reconstructed luma with linear model. Parameter of the linear model is derived from adjacent blocks with linear least square solution. Since the parameter is affected by the quantization of adjacent blocks, prediction accuracy is degraded. Furthermore, it is hard to predict object boundaries where the correlation among adjacent blocks is low.

This contribution reports the results about chroma intra prediction as an additional chroma intra mode based on luma residual sample [1, 2]. The key feature of the proposed method is to utilize luma residual block for predicting chroma residual block of intra prediction under the same direction with luma block. A relation between both residual components is the linear model. The proposed coding mode is called RM in the following.

# RM prediction

## Overview

When RM mode is used, the prediction process of chroma samples is summarized as two steps. At the first step, the chroma samples are predicted by the mode derived from luma intra direction, named regular prediction. At the second step, residual chroma samples are predicted by residual luma samples of the same block. Final predicted chroma values are as follows,

Parameters are derived from another linear model, as follows,

Parameter is derived on the encoder side and is then quantized, coded. Quantization step is defined as from the preliminary experiments, and range of the parameter is set as

Parameter is not coded because it is constant value in a transform unit. It means that parameter is implicitly added to a DC coefficient.

RM mode introduces two restrictions as follows. A series of chroma processing is performed at coding unit size. TUDepth of coding unit is always set 0. RegularLumaReprediction is always performed in order to produce LumaResidual values which correspond to chroma-coding unit values.

## Syntax

RM mode is additional chroma prediction mode. Position of RM mode is after DM and LM and is before Planar, Horizontal, Vertical and DC.

Parameter is binarized into index in prediction unit of each chroma component. Since signs of Cb-alpha and Cr-alpha are frequently opposite, the index of Cr-alpha depends on the sign of Cb-alpha. Each index is coded by using truncated unary syntax. Actual binarization table is shown in Appendix.

## Encoder Optimization

An early termination technique in RDO reduces a lot of encoding runtime. Since RM mode uses the residual luma signals, gain of RM mode is not obtained from low activity units. Based on the size of coding unit and depth of transform unit, RDO of RM mode is skipped.

# Experimental results

The proposed method is integrated in HM5.0 software and compared with it as anchor. The experiments were performed with the common test configuration described in JCTVC-G1200 [3]. Since the gain is come from Cb/Cr improvement, YUV BD-bitrate assessment is added to the table. A detail of YUV BD-bitrate is described in JCTVC-F386 [4].

Table 1 shows average BD-bitrate gain of the proposed RM mode compared to the anchor HM5.0 software for the all intra condition. The average BD-bitrate saving of Y, Cb, and Cr components are 0.1%, 3.4%, 3.9% and 1.1% in all intra HE condition, and 1.2%, 6.3%, 7.3% and 2.4% in all intra LC condition. Table 2 shows average BD-bitrate gain for all intra condition with full set.

Since AI-LC condition sets LMChroma off, BD-bitrate gain of proposed RM mode in LC is larger than it in HE. Since summary (Full) contains two additional contents such as "NebutaFestival" and "SteamLocomotiveTrain", BD-bitrate gain of Class A in Summary (Full) is larger than it in Summary.

Table 1 Summary of BD-bitrate by the proposed RM mode for all intra condition

|  |  |  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- | --- | --- |
|  | **All Intra HE** | | | | **All Intra LC** | | | |
|  | Y | U | V | YUV | Y | U | V | YUV |
| Class A (8bit) | 0.0% | -2.3% | -1.6% | -0.3% | -0.3% | -4.3% | -2.7% | -0.8% |
| Class B | 0.0% | -3.2% | -2.6% | -0.5% | -0.3% | -6.0% | -3.8% | -1.1% |
| Class C | -0.2% | -2.9% | -3.4% | -0.7% | -0.5% | -5.0% | -5.7% | -1.4% |
| Class D | -0.1% | -2.6% | -2.8% | -0.6% | -0.3% | -4.2% | -4.5% | -1.0% |
| Class E | 0.0% | -1.3% | -1.2% | -0.2% | 0.0% | -2.1% | -2.0% | -0.4% |
| **Overall** | -0.1% | -2.6% | -2.5% | -0.5% | -0.3% | -4.5% | -3.9% | -1.0% |
|  | -0.1% | -2.6% | -2.4% | -0.5% | -0.3% | -4.5% | -3.9% | -1.0% |
| Class F | -0.5% | -3.4% | -3.9% | -1.1% | -1.2% | -6.3% | -7.3% | -2.4% |
| Enc Time[%] | 101.3% | | | | 102.5% | | | |
| Dec Time[%] | 100.9% | | | | 101.1% | | | |

Table 2 Summary (Full) of BD-bitrate by the proposed RM mode for all intra condition

|  |  |  |  |  |  |  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- |
|  | **All Intra HE** | | | | **All Intra LC** | | | | **All Intra HE-10** | | | |
|  | Y | U | V | YUV | Y | U | V | YUV | Y | U | V | YUV |
| Class A | -0.2% | -11.9% | -13.3% | -1.8% | -1.3% | -20.3% | -17.7% | -3.9% | -0.2% | -12.1% | -13.7% | -2.0% |
| Class B | 0.0% | -3.2% | -2.6% | -0.5% | -0.3% | -6.0% | -3.8% | -1.1% | 0.0% | -3.5% | -2.9% | -0.6% |
| Class C | -0.2% | -2.9% | -3.4% | -0.7% | -0.5% | -5.0% | -5.7% | -1.4% | -0.2% | -3.1% | -3.5% | -0.7% |
| Class D | -0.1% | -2.6% | -2.8% | -0.6% | -0.3% | -4.2% | -4.5% | -1.0% | -0.1% | -2.8% | -2.9% | -0.6% |
| Class E | 0.0% | -1.3% | -1.2% | -0.2% | 0.0% | -2.1% | -2.0% | -0.4% | 0.0% | -1.6% | -1.5% | -0.3% |
| Class F | -0.5% | -3.4% | -3.9% | -1.1% | -1.2% | -6.3% | -7.3% | -2.4% | -0.5% | -3.3% | -4.0% | -1.1% |
| **Overall** | -0.2% | -4.3% | -4.6% | -0.8% | -0.6% | -7.5% | -6.9% | -1.7% | -0.2% | -4.5% | -4.8% | -0.9% |
|  | -0.2% | -4.2% | -4.5% | -0.8% | -0.6% | -7.4% | -6.9% | -1.7% | -0.2% | -4.4% | -4.8% | -0.9% |
| Enc Time[%] | 101.2% | | | | 102.4% | | | | 101.3% | | | |
| Dec Time[%] | 100.9% | | | | 101.1% | | | | 100.9% | | | |

Table 3 shows average BD-bitrate gain of the RM mode without an early-termination in encoder side. Encoding runtime is about twice while additional YUV BD-bitrate gain is nearly 0.1%.

Table 3 Summary of BD-bitrate by the proposed RM mode w/o an early termination

|  |  |  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- | --- | --- |
|  | **All Intra HE** | | | | **All Intra LC** | | | |
|  | Y | U | V | YUV | Y | U | V | YUV |
| Class A (8bit) | 0.0% | -2.6% | -1.8% | -0.4% | -0.3% | -4.6% | -3.0% | -0.9% |
| Class B | 0.0% | -3.6% | -2.9% | -0.6% | -0.3% | -6.4% | -4.1% | -1.2% |
| Class C | -0.2% | -3.2% | -3.8% | -0.8% | -0.5% | -5.3% | -6.1% | -1.5% |
| Class D | -0.1% | -2.9% | -3.1% | -0.6% | -0.3% | -4.6% | -4.9% | -1.1% |
| Class E | 0.0% | -1.5% | -1.3% | -0.3% | -0.1% | -2.2% | -2.2% | -0.4% |
| **Overall** | -0.1% | -2.9% | -2.7% | -0.6% | -0.3% | -4.8% | -4.3% | -1.1% |
|  | -0.1% | -2.9% | -2.7% | -0.6% | -0.3% | -4.8% | -4.2% | -1.1% |
| Class F | -0.5% | -3.5% | -4.1% | -1.1% | -1.3% | -6.5% | -7.6% | -2.5% |
| Enc Time[%] | 102.7% | | | | 104.9% | | | |
| Dec Time[%] | 100.9% | | | | 101.2% | | | |

Table 4 shows average BD-bitrate gain for random access condition.

Table 4 Summary of BD-bitrate by the proposed RM mode for random access condition

|  |  |  |  |  |  |  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- |
|  | **Random Access HE** | | | | **Random Access LC** | | | | **Random Access HE-10** | | | |
|  | Y | U | V | YUV | Y | U | V | YUV | Y | U | V | YUV |
| Class A (8bit) | 0.0% | -2.7% | -2.0% | -0.4% | 0.0% | -7.4% | -4.3% | -0.9% | 0.2% | -14.9% | -13.7% | -1.5% |
| Class B | 0.0% | -3.9% | -2.7% | -0.6% | 0.0% | -9.2% | -5.6% | -1.3% | 0.0% | -4.2% | -3.2% | -0.6% |
| Class C | -0.1% | -3.0% | -3.2% | -0.6% | -0.1% | -6.9% | -7.5% | -1.4% |  |  |  |  |
| Class D | 0.0% | -2.8% | -2.4% | -0.5% | -0.1% | -6.3% | -6.4% | -1.2% |  |  |  |  |
| Class E |  |  |  |  |  |  |  |  |  |  |  |  |
| **Overall** | 0.0% | -3.2% | -2.6% | -0.5% | 0.0% | -7.6% | -6.2% | -1.2% | 0.1% | -9.0% | -7.9% | -1.0% |
|  | 0.0% | -3.2% | -2.6% | -0.5% | -1.2% | 0.0% | -7.5% | -6.2% | 0.1% | -9.0% | -7.8% | -1.1% |
| Class F | -0.3% | -3.3% | -3.6% | -0.8% | -0.4% | -7.6% | -8.5% | -1.9% |  |  |  |  |
| Enc Time[%] | 100.2% | | | | 100.3% | | | | 100.1% | | | |
| Dec Time[%] | 100.1% | | | | 100.6% | | | | 100.2% | | | |

# Core Experiments

The proposed method described in JCTVC-G346 is selected in CE6.a: Intra Chroma Prediction [5]. In this CE, three tools (JCTVC-G127, G244, G358) are also selected. All combination of four tools is tested according to the CE6.a description. KDDI Corp. provides results of four test cases; G346, G173+G346, G346+G358 and G244+G346+G358.

Table 5 Summary of BD-bitrate by G173+G346 for all intra condition

|  |  |  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- | --- | --- |
|  | **All Intra HE** | | | | **All Intra LC** | | | |
|  | Y | U | V | YUV | Y | U | V | YUV |
| Class A (8bit) | -0.4% | -2.2% | -5.0% | -0.9% | -0.5% | -4.2% | -5.4% | -1.2% |
| Class B | -0.1% | -3.1% | -4.9% | -0.7% | -0.1% | -5.6% | -4.4% | -0.9% |
| Class C | -0.6% | -4.1% | -6.1% | -1.4% | -0.9% | -5.9% | -8.1% | -2.1% |
| Class D | -0.6% | -3.9% | -5.6% | -1.3% | -0.8% | -5.3% | -7.5% | -1.8% |
| Class E | -0.3% | -1.7% | -3.7% | -0.7% | -0.3% | -2.7% | -4.3% | -0.8% |
| **Overall** | -0.4% | -3.2% | -5.2% | -1.0% | -0.5% | -5.0% | -6.0% | -1.4% |
|  | -0.4% | -3.1% | -5.1% | -1.0% | -0.5% | -4.9% | -5.9% | -1.4% |
| Class F | -0.9% | -4.4% | -5.6% | -1.7% | -1.7% | -6.9% | -9.6% | -3.0% |
| Enc Time[%] | 101.6% | | | | 102.6% | | | |
| Dec Time[%] | 101.2% | | | | 101.8% | | | |

Table 6 Summary of BD-bitrate by G346+G358 for all intra condition

|  |  |  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- | --- | --- |
|  | **All Intra HE** | | | | **All Intra LC** | | | |
|  | Y | U | V | YUV | Y | U | V | YUV |
| Class A (8bit) | -0.1% | -3.5% | -2.8% | -0.6% | -0.5% | -7.7% | -5.6% | -1.6% |
| Class B | -0.1% | -4.6% | -3.9% | -0.8% | -0.7% | -9.4% | -6.7% | -2.0% |
| Class C | -0.3% | -4.4% | -5.3% | -1.1% | -1.2% | -8.5% | -9.9% | -2.8% |
| Class D | -0.2% | -3.9% | -4.3% | -0.9% | -0.7% | -7.1% | -7.4% | -1.9% |
| Class E | -0.1% | -2.7% | -2.6% | -0.5% | -0.2% | -5.0% | -4.9% | -1.0% |
| **Overall** | -0.2% | -4.0% | -4.0% | -0.8% | -0.7% | -7.8% | -7.2% | -1.9% |
|  | -0.2% | -3.9% | -3.9% | -0.8% | -0.7% | -7.7% | -7.1% | -1.9% |
| Class F | -0.7% | -4.8% | -5.6% | -1.5% | -2.4% | -10.3% | -11.8% | -4.2% |
| Enc Time[%] | 108% | | | | 110% | | | |
| Dec Time[%] | 102% | | | | 101% | | | |

Table 7 Summary of BD-bitrate by G244+G346+G358 for all intra condition

|  |  |  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- | --- | --- |
|  | **All Intra HE** | | | | **All Intra LC** | | | |
|  | Y | U | V | YUV | Y | U | V | YUV |
| Class A (8bit) | -0.1% | -5.4% | -4.7% | -0.9% | -0.5% | -7.7% | -5.6% | -1.6% |
| Class B | -0.1% | -5.3% | -4.5% | -0.9% | -0.7% | -9.4% | -6.7% | -2.0% |
| Class C | -0.3% | -5.0% | -5.8% | -1.2% | -1.2% | -8.5% | -9.9% | -2.8% |
| Class D | -0.2% | -4.4% | -4.8% | -0.9% | -0.7% | -7.1% | -7.4% | -1.9% |
| Class E | -0.1% | -4.0% | -3.5% | -0.7% | -0.2% | -5.0% | -4.9% | -1.0% |
| **Overall** | -0.2% | -4.8% | -4.7% | -1.0% | -0.7% | -7.8% | -7.2% | -1.9% |
|  | -0.2% | -4.7% | -4.6% | -1.0% | -0.7% | -7.7% | -7.1% | -1.9% |
| Class F | -0.7% | -4.9% | -5.6% | -1.5% | -2.4% | -10.3% | -11.8% | -4.2% |
| Enc Time[%] | 108% | | | | 109% | | | |
| Dec Time[%] | 101% | | | | 102% | | | |

It is noted that JCTVC-G127 and the proposed method is unified as follows.

# References

1. K. Kawamura, " Chroma intra prediction based on residual luma samples," Joint Collaborative Team on Video Coding (JCT-VC) of ITU-T SG16 WP3 and ISO/IEC JTC1/SC29/WG11, Document: JCTVC-F095, 6th Meeting: Torino, IT, 14-22 July, 2011.
2. K. Kawamura, " Chroma intra prediction based on residual luma samples," Joint Collaborative Team on Video Coding (JCT-VC) of ITU-T SG16 WP3 and ISO/IEC JTC1/SC29/WG11, Document: JCTVC-G346, 7th Meeting: Geneva, CH, 21-30 November, 2011
3. F. Bossen, "Common test conditions and software reference configurations," Joint Collaborative Team on Video Coding (JCT-VC) of ITU-T SG16 WP3 and ISO/IEC JTC1/SC29/WG11, Document: JCTVC-G1200, 7th Meeting: Geneva, CH, 21-30 Nov, 2011.
4. T. K. Tan, F. Bossen, " Chroma RD cost computation in HM3.0," Joint Collaborative Team on Video Coding (JCT-VC) of ITU-T SG16 WP3 and ISO/IEC JTC1/SC29/WG11, 6th Meeting: Torino, 14-22 July, 2011.
5. A. Tabatabai, E. Francois and K. Chono, "CE6: Intra Coding Improvements," Joint Collaborative Team on Video Coding (JCT-VC) of ITU-T SG16 WP3 and ISO/IEC JTC1/SC29/WG11, Document: JCTVC-G1206, 7th Meeting: Geneva, CH, 21-30 November, 2011

# Patent rights declaration(s)

**KDDI Corporation may have current or pending patent rights relating to the technology described in this contribution and, conditioned on reciprocity, is prepared to grant licenses under reasonable and non-discriminatory terms as necessary for implementation of the resulting ITU-T Recommendation | ISO/IEC International Standard (per box 2 of the ITU-T/ITU-R/ISO/IEC patent statement and licensing declaration form).**

# Appendix: text for the working draft

### 7.3.7 Prediction unit syntax

|  |  |
| --- | --- |
| prediction\_unit( x0, y0, log2CUSize ) { | Descriptor |
| **...** |  |
| **intra\_chroma\_pred\_mode**[ x0 ][ y0 ] | ue(v) | ae(v) |
| SignaledAsChromaDC =   ( chroma\_pred\_from\_luma\_enabled\_flag ?  intra\_chroma\_pred\_mode[ x0 ][ y0 ] == 3 :  intra\_chroma\_pred\_mode[ x0 ][ y0 ] == 2 ) |  |
| if( intra\_chroma\_pred\_mod[ x0 ][ y0 ] == RM) { |  |
| **intra\_chroma\_pred\_rm\_cb**[ x0 ][ y0 ] | ae(v) |
| **intra\_chroma\_pred\_rm\_cr**[ x0 ][ y0 ] | ae(v) |
| } |  |
| } |  |
| ... |  |

### 7.4.7 Prediction unit semantics

**intra\_chroma\_pred\_mode**[ x0 ][ y0 ] specifies the intra prediction mode for chroma samples. The array indices x0, y0 specify the location ( x0, y0 ) of the top-left luma sample of the considered prediction block relative to the top-left luma sample of the picture.

**intra\_chroma\_pred\_rm\_cb**[ x0 ][ y0 ] and **intra\_chroma\_pred\_rm\_cr**[ x0 ][ y0 ] specifies the Cb and Cr prediction coefficient for chroma intra prediction of RM. The array indices cIdx specify the location ( x0, y0 ) of the top-left chroma sample of the considered prediction block relative to the top-left chroma sample of the picture.

The variable IntraCbAlpha[ x0 ][ y0 ] is derived from the value of intra\_chroma\_pred\_rm\_cb as defined in (a).

The variable IntraCrAlpha[ x0 ][ y0 ] is specified as

* If ( ( intra\_chroma\_pred\_rm\_cb[ x0 ][ y0 ] % 2 ) ) = = 0, IntraCrAlpha[ x0 ][ y0 ] is derived from the value of intra\_chroma\_pred\_rm\_cb as defined in Table 7-8(a).
* Otherwise, IntraCrAlpha[ x0 ][ y0 ] is derived from the value of intra\_chroma\_pred\_rm\_cb as defined in Table 7-8(b).

Table 7‑12 ‑ Parameter association to prediction mode and partitioning type

|  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- |
| Index | 0 | 1 | 2 | 3 | 4 | 5 | 6 | 7 | 8 | 9 | 10 | 11 | 12 | 13 | 14 | 15 |
| (a) | 0 | -1 | +1 | -2 | +2 | -3 | +3 | -4 | +4 | -5 | +5 | -6 | +6 | -7 | +7 | -8 |
| (b) | 0 | +1 | -1 | +2 | -2 | +3 | -3 | +4 | -4 | +5 | -5 | +6 | -6 | +7 | -7 | -8 |

### 8.3.2 Derivation process for chroma intra prediction mode

Table 8‑4 – Specification of IntraPredModeC according to the values of intra\_chroma\_pred\_mode and IntraPredMode[ xB ][ yB ] when chroma\_pred\_from\_luma\_enabled\_flag is equal to 1

|  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- |
| **intra\_chroma\_pred\_mode** | **IntraPredMode[ xB ][ yB ]** | | | | |
| **0** | **1** | **2** | **3** | **X ( 0 <= X < 35 )** |
| 0 | 7 | 0 | 0 | 0 | 0 |
| 1 | 1 | 7 | 0 | 0 | 1 |
| 2 | 2 | 2 | 7 | 1 | 2 |
| 3 | 3 | 3 | 3 | 7 | 3 |
| 4 | LM | LM | LM | LM | LM |
| 5 | RM | RM | RM | RM | RM |
| 6 | 0 | 1 | 2 | 3 | X |

Table 8‑5 – Specification of IntraPredModeC according to the values of intra\_chroma\_pred\_mode and IntraPredMode[ xB ][ yB ] when chroma\_pred\_from\_luma\_enabled\_flag is equal to 0

|  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- |
| **intra\_chroma\_pred\_mode** | **IntraPredMode[ xB ][ yB ]** | | | | |
| **0** | **1** | **2** | **3** | **X ( 0 <= X < 35 )** |
| 0 | 7 | 0 | 0 | 0 | 0 |
| 1 | 1 | 7 | 1 | 1 | 1 |
| 2 | 2 | 2 | 7 | 2 | 2 |
| 3 | 3 | 3 | 3 | 7 | 3 |
| 4 | 0 | 1 | 2 | 3 | X |
| 5 | RM | RM | RM | RM | RM |

##### 8.3.3.1.9 Specification of Intra\_FromLumaResidual prediction mode

Inputs to this process are:

– a sample location ( xB, yB ) specifying the top-left sample of the current block relative to the top‑left sample of the current picture of chroma,

– variables IntraCbAlpha and IntraCrAlpha specifying the prediction coefficients,

– a variable IntraPredMod specifying the luma intra prediction mode,

– a variable nS specifying the prediction size,

Output of this process is:

– predicted samples predSamples[ x, y ], with x, y =0..nS-1.

This intra prediction mode is invoked when intraPredModeC is equal to RM.

The values of the prediction samples predSamples[ x, y ], with x, y = 0..nS-1, are derived as the following ordered steps:

1. The chroma intra sample prediction process as specified in subclause is invoked with the location ( xB, yB ), the intra prediction mode intraPredMode, and the variable cIdx as the inputs and the output is a (nS)x(nS) array reguPredSamples. This is identical step of the regular chroma-intra-prediction.
2. The luma intra prediction process as specified in subclause is invoked with the location ( xB\*2, yB\*2 ), the intra prediction mode intraPredMode, and the variable cIdx set equal to 0 as the inputs and the output is a (nS\*2)x(nS\*2) array reguPredSamplesL. This is identical step of the regular luma-intra-prediction.
3. resSamplesL is derived as:

resSamplesL[ x, y ] = recSamplesL[ x, y ] – reguPredSamplesL[ x, y ], with x,y = 0..nS\*2-1. (8‑45-1)

1. Variable pY' are derived as:

pY'[ x, y ] = ( resSamplesL[ 2x, 2y ] + resSamplesL[ 2x, 2y+1 ] ), with x, y = 0..nS-1. (8‑45-2)

1. The value of the prediction samples predSamples[ x, y ] are derived as:

alpha[ cIdx ] = ( cIdx = = 1 ) ? IntraCbAlpha[ x0 ][ y0 ] : IntraCrAlpha[ x0 ][ y0 ] (8‑45-3)

predSamples[ x, y ] = Clip1C( reguPredSamples[ x, y ] + pY’[ x, y ] \* alpha[ cIdx ] ) >> 4 ) ,   
with x, y = 0..nS-1 (8‑45-4)

##### 9.3.1.1.1 Initialisation process for context variables

Table 9‑20 – Association of ctxIdx and syntax elements for each slice type in the initialisation process

|  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- |
|  | **Syntax element** | **ctxIdxTable** | **Slice Type** | | |
| **I** | **P** | **B** |
| prediction\_unit() | intra\_chroma\_pred\_mode |  | 0..1 | 2..3 | 4..5 |
| intra\_chroma\_pred\_cb | Table 9-28a | 0..1 | 2..3 | 4..5 |
| intra\_chroma\_pred\_cr | Table 9-28b | 0..1 | 2..3 | 4..5 |

Table 9‑28a – Values of variable m and n for intra\_chroma\_pred\_rm\_cb ctxIdx

|  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- |
| **Initialisation variables** | **intra\_chroma\_pred\_rm\_cb ctxIdx** | | | | | |
| **0** | **1** | **2** | **3** | **4** | **5** |
| **initValue** | 92 | 89 | 92 | 89 | 92 | 89 |

Table 9‑28b – Values of variable m and n for intra\_chroma\_pred\_rm\_cr ctxIdx

|  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- |
| **Initialisation variables** | **intra\_chroma\_pred\_rm\_cr ctxIdx** | | | | | |
| **0** | **1** | **2** | **3** | **4** | **5** |
| **initValue** | 92 | 89 | 92 | 89 | 92 | 89 |

### 9.3.2 Binarization process

| Table 9‑46 – Syntax elements and associated types of binarization, maxBinIdxCtx, ctxIdxTable, and ctxIdxOffset | | | | | |
| --- | --- | --- | --- | --- | --- |
| **Syntax element** |  | **Type of binarization** | **maxBinIdxCtx** | **ctxIdxTable** | **ctxIdxOffset** |
| intra\_chroma\_pred\_rm\_cb | I | TU, cMax = 15 | 1 | a | 0 |
| P | 1 | a | 2 |
| B | 1 | a | 4 |
| intra\_chroma\_pred\_rm\_cr | I | TU, cMax = 15 | 1 | b | 0 |
| P | 1 | b | 2 |
| B | 1 | b | 4 |

#### 9.3.3.1 Derivation process for ctxIdx

| Table 9‑51 – Assignment of ctxIdxInc to binIdx for all ctxIdxTable and ctxIdxOffset values | | | | | | | |
| --- | --- | --- | --- | --- | --- | --- | --- |
| **Syntax element** | **ctxIdxTable,  ctxIdxOffset** | | **binIdx** | | | | |
| **0** | **1** | **2** | **3** | **>=4** |
| intra\_chroma\_pred\_rm\_cb | a | 0 | 0 | 1 | 1 | 1 | 1 |
| 2 | 0 | 1 | 1 | 1 | 1 |
| 4 | 0 | 1 | 1 | 1 | 1 |
| intra\_chroma\_pred\_rm\_cr | a | 0 | 0 | 1 | 1 | 1 | 1 |
| 2 | 0 | 1 | 1 | 1 | 1 |
| 4 | 0 | 1 | 1 | 1 | 1 |