|  |  |
| --- | --- |
| **Joint Collaborative Team on Video Coding (JCT-VC)**  **of ITU-T SG16 WP3 and ISO/IEC JTC1/SC29/WG11**  7th Meeting: Geneva, CH, 21-30 November, 2011 | Document: JCTVC-G366 |

|  |  |  |  |
| --- | --- | --- | --- |
| *Title:* | Context reduction of significance map coding with CABAC | | |
| *Status:* | Input Document to JCT-VC | | |
| *Purpose:* | Proposal | | |
| *Author(s) or Contact(s):* | Cheung Auyeung 1730 N. First Street, MD:3NW San Jose, CA 95112 USA | Tel: Email: | 1-408-352-4725 [cheung.auyeung@am.sony.com](mailto:cheung.auyeung@am.sony.com) |
|  | Jun Xu 1730 N. First Street, MD:3NW San Jose, CA 95112 USA | Tel: Email: | 1- 408-352-4086 [jun.xu@am.sony.com](mailto:jun.xu@am.sony.com) |
| *Source:* | Sony Electronics Inc. | | |

\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_

# Abstract

This contribution reduced the number of context for coding the significant\_coeff\_flag of transform coefficients by 24 with an average BD-Rate of 0.0% for all test cases specified in CE11 for context modeling/selection for transform coefficient related syntax elements. When the proposed 24 context reductions is combined with the 36 contexts reductions from CE11 JCTVC-G121/F132 for a total of 60 context reductions, the BD-Rate for I\_HE, RA\_HE, LDB\_HE are 0.1%, 0.0%, 0.0% respectively.

# Introduction

For the coding of the significant\_coeff\_flag of the transform coefficients with CABAC, HM4 has 30 contexts for 4x4 transform block, 16 contexts for 8x8 transform blocks, and 26 contexts for 16x16 and 32x32 blocks for a total of 88 contexts.

This contributions reduces the 88 contexts by 24 contexts with 0.0% average BD-Rate for all test cases specified in the studying of context modeling in CE11 [1]. In particular, this contribution resulted in 0.0% average BD-Rate for AI\_HE, RA\_HE, and LD\_HE at QP=22, 27, 32, 37 with and without RDOQ. It also resulted in 0.0% average BD-Rate for I\_HE, RA\_HE, LD\_HE at QP=12, 17, 22, 27.

# Proposal

To reduce the number of contexts for coding the significance map from 88 to 64, this contribution proposes to merge some of the contexts together. To maintain coding gain, this contribution also proposes to provide separate context for the DC component in 8x8 blocks.

## Context reduction of 4x4 blocks

HM4 has 15 contexts for coding the significant\_coeff\_flag of a 4x4 luminance block. To reduce the number of contexts, this contribution proposes to merge some of the contexts together as in Figure 1. In particular, the context with index 3, 7, and 11 are merged to context with index 3. The contexts with index 12, 13, and 14 are merged to the context with index 12.

By merging contexts, this proposal reduces 4 luminance and 4 chrominance contexts.



Figure : Context assignment of 4x4 significance map coding with CABAC in (a) HM4 and (b) the proposed.

## Context reductions of 8x8 blocks

HM4 has 16 contexts for coding the significant\_coeff\_flag of an 8x8 luminance block. To reduce the number of contexts, this contribution propose to merge some of the contexts together as in Figure 2. In particular, the context 3 and 7 are merged to context 3. The context 6, 9, and 10 are merged to context 10. The context 12 and 13 are merged to context 12. The context 11, 14, and 15 are merged to context 11.

In HM4, the lower 4 frequency components shared the same context 0. To improve coding efficiency, this contribution splits the DC component from the context 0 so that it has a separate context 15\*. The context 15\* re-use the context 15 but with the same context initialization as context 0.

By merging and splitting contexts, this proposal reduced 5 contexts for the 8x8 luminance block and 5 contexts for the 8x8 chrominance block.



Figure : Context assignment of 8x8 significance map coding with CABAC in (a) HM4 and (b) the proposed.

## Context reductions of 16x16 and 32x32 blocks

### HM4 significance map context assignments for 16x16 and 32x32 blocks

As shown in Figure 3, HM4 from JCTVC-F288 [2] divides the significance map of 16x16 and 32x32 in three regions: yellow region, orange region, green region. Each region uses a different method to determine the context for the coding of the significance map.

Let (xC, yC) be the current coefficient scan position. The yellow region consists of the positions with xC + yC < 2. The orange region consists of the positions with 2 ≤ xC + yC < 5. The green region consists of the positions with 5 ≤ xC + yC.

In HM4, each position in the yellow region has its own context. The yellow region has a total of 3 contexts for the luminance 16x16 and 32x32 blocks.



Figure : HM4 divides the 16x16 and 32x3 significance map into three regions. Each region use a different method to determine the context for the coding of the significance map with CABAC.

To determine the context for the significant\_coeff\_flag at position (xC, yC) in the orange and green region, let

significant\_coeff\_flag[ i ][ j ] = 0 if (i,j) is outside the transform block

And let

I = significant\_coeff\_flag[ xC+1 ][ yC ]

H = significant\_coeff\_flag[ xC+2 ][ yC ]

F = significant\_coeff\_flag[ xC ][ yC +1]

E = significant\_coeff\_flag[ xC+1 ][ yC+1 ]

B = significant\_coeff\_flag[ xC ][ yC+2 ]

The context increment of the significant\_coeff\_flag[xC][yC] in the orange region is

ctxInc = min(4, I + H +F +E+ B)

Therefore the orange region has 5 contexts for the luminance block.

The context increment of significant\_coeff\_flag[xC][yC] in the greem region is derived as follows:

If (I+H+F+E) < 4

ctxInc = I + H + F + E + B

else

ctxInc = I + H + F + E

Therefore the green region has 5 contexts for the luminance block.

### Proposed significance map context assignments for 16x16 and 32x32 blocks

To reduce the number of contexts for the coding of significance map of 16x16 and 32x32 transform blocks, this contribution propose to determine the context increment in the orange region as follows:

Int map[] = {0, 1, 1, 3, 3, 3}

ctxInc = map[ I + H + F + E + B]

Therefore, the orange region has 3 contexts for the luminance block and a reduction of 2 luminance contexts and 2 chrominance contexts. This contribution propose to determine the context increment in the orange region as

ctxInc = min(3, I + H +F +E+ B)

Therefore the green region has 4 contexts for the luminance block and a reduction of 1 luminance context and 1 chrominance context.

# Simulation results

The context reductions were integrated into HM4.0. The simulations were performed in three Microsoft HPC clusters, the common test conditions and reference configurations specified by CE11are followed:

* All intra simulations are performed on AMD Opteron Processor 6136 cluster @ 2.4GHz.
* All RA simulations are performed on Intel Xeon X5690 cluster @ 3.47GHz.
* All LD simulations are performed on Intel Xeon X5680 cluster @ 3.33GHz.

As show in Table 1, the proposed 24 context reduction for the coding of significance map resulted in average BD-Rate of 0.0% for all test cases in CE11 [1] Sub Experiment CE.A for context modeling/selection for transform coefficient related syntax elements. In particular, CE11.A [1] requires the followings:

* BDR-rate at QP = 22, 27, 32, 37 with RDOQ on.
* BDR rate at QP = 12, 17, 22, 27 with RDOQ on.
* BD-rate at QP = 22, 27, 32, 37 with RDOQ off.

Table 2 provide the BD-Rate of 60 context reductions by combining the proposed 24 significance map context reductions with the 36 level context reductions from CE11 on JCTVC-G121/F132 [4, 3].

|  |  |  |  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- | --- | --- | --- |
|  | **All Intra HE** | | | **All Intra (Low QP)** | | | **All Intra (RDOQ off)** | | |
|  | Y | U | V | Y | U | V | Y | U | V |
| Class A | 0.02% | 0.00% | 0.04% | 0.02% | -0.01% | -0.02% | 0.01% | 0.10% | 0.07% |
| Class B | 0.04% | 0.03% | 0.05% | 0.10% | 0.06% | 0.07% | 0.00% | 0.04% | 0.09% |
| Class C | 0.01% | 0.01% | -0.01% | 0.02% | 0.04% | 0.04% | -0.04% | -0.02% | 0.01% |
| Class D | 0.00% | -0.03% | -0.03% | 0.00% | -0.01% | -0.02% | -0.06% | -0.04% | -0.04% |
| Class E | 0.03% | 0.04% | 0.01% | 0.05% | -0.06% | -0.02% | 0.01% | 0.15% | 0.12% |
| Class F |  |  |  |  |  |  |  |  |  |
| **Overall** | 0.02% | 0.01% | 0.01% | 0.04% | 0.01% | 0.02% | -0.02% | 0.04% | 0.05% |
|  | 0.02% | 0.01% | 0.02% | 0.04% | 0.00% | 0.01% | -0.02% | 0.04% | 0.04% |
| Enc Time[%] | 101% | | | 102% | | | 100% | | |
| Dec Time[%] | 100% | | | 100% | | | 101% | | |
|  |  |  |  |  |  |  |  |  |  |
|  | **Random Access HE** | | | **Random Access (Low QP)** | | | **Random Access(RDOQ off)** | | |
|  | Y | U | V | Y | U | V | Y | U | V |
| Class A | 0.03% | -0.06% | 0.06% | 0.02% | 0.01% | 0.03% | -0.01% | -0.03% | -0.01% |
| Class B | 0.00% | 0.19% | 0.16% | 0.05% | 0.06% | -0.03% | 0.01% | 0.01% | -0.01% |
| Class C | -0.02% | -0.09% | 0.00% | -0.02% | 0.00% | 0.02% | -0.03% | -0.12% | 0.04% |
| Class D | 0.02% | -0.08% | 0.02% | -0.02% | -0.10% | -0.11% | -0.10% | 0.07% | -0.10% |
| Class E |  |  |  |  |  |  |  |  |  |
| Class F |  |  |  |  |  |  |  |  |  |
| **Overall** | 0.01% | 0.00% | 0.06% | 0.01% | 0.00% | -0.02% | -0.03% | -0.02% | -0.02% |
|  | 0.01% | -0.04% | 0.07% | 0.01% | -0.02% | -0.01% | -0.03% | -0.02% | -0.02% |
| Enc Time[%] | 101% | | | 102% | | | 101% | | |
| Dec Time[%] | 100% | | | 101% | | | 101% | | |
|  |  |  |  |  |  |  |  |  |  |
|  | **Low delay B HE** | | | **Low delay B (Low QP)** | | | **Low delay B (RDOQ off)** | | |
|  | Y | U | V | Y | U | V | Y | U | V |
| Class A |  |  |  |  |  |  |  |  |  |
| Class B | 0.02% | -0.07% | -0.16% | 0.04% | 0.00% | -0.03% | -0.02% | 0.00% | -0.09% |
| Class C | 0.03% | -0.01% | -0.24% | -0.02% | -0.14% | -0.14% | -0.01% | 0.28% | 0.14% |
| Class D | -0.03% | 0.11% | -0.42% | -0.05% | -0.27% | -0.14% | -0.01% | 0.03% | -0.17% |
| Class E | 0.12% | -1.01% | 0.97% | 0.03% | -0.77% | -0.08% | -0.08% | -0.50% | -0.64% |
| Class F |  |  |  |  |  |  |  |  |  |
| **Overall** | 0.03% | -0.19% | -0.03% | 0.00% | -0.24% | -0.10% | -0.03% | -0.02% | -0.15% |
|  | 0.03% | -0.20% | -0.05% | 0.00% | -0.27% | -0.12% | -0.03% | 0.02% | -0.16% |
| Enc Time[%] | 101% | | | 102% | | | 100% | | |
| Dec Time[%] | 101% | | | 102% | | | 101% | | |

**Table 1: The 24 context reduction proposed in this contribution resulted in average BD-Rate of 0.0% for all test cases in CE11 Sub Experiment CE.A for context modeling/selection for transform coefficient related syntax elements.**

|  |  |  |  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- | --- | --- | --- |
|  | **All Intra HE** | | | **All Intra (Low QP)** | | | **All Intra (RDOQ off)** | | |
|  | Y | U | V | Y | U | V | Y | U | V |
| Class A | 0.06% | 0.03% | 0.08% | 0.08% | 0.03% | 0.04% | 0.04% | 0.12% | 0.11% |
| Class B | 0.11% | 0.08% | 0.08% | 0.18% | 0.12% | 0.15% | 0.05% | 0.08% | 0.12% |
| Class C | 0.06% | 0.07% | 0.06% | 0.12% | 0.12% | 0.14% | 0.00% | 0.04% | 0.09% |
| Class D | 0.08% | 0.07% | 0.08% | 0.11% | 0.11% | 0.10% | 0.01% | 0.00% | 0.00% |
| Class E | 0.05% | 0.03% | 0.06% | 0.12% | -0.05% | 0.03% | 0.04% | 0.23% | 0.16% |
| Class F |  |  |  |  |  |  |  |  |  |
| **Overall** | 0.07% | 0.06% | 0.07% | 0.12% | 0.08% | 0.10% | 0.03% | 0.09% | 0.10% |
|  | 0.08% | 0.06% | 0.06% | 0.13% | 0.07% | 0.08% | 0.03% | 0.09% | 0.09% |
| Enc Time[%] | 101% | | | 102% | | | 100% | | |
| Dec Time[%] | 101% | | | 101% | | | 100% | | |
|  |  |  |  |  |  |  |  |  |  |
|  | **Random Access HE** | | | **Random Access (Low QP)** | | | **Random Access(RDOQ off)** | | |
|  | Y | U | V | Y | U | V | Y | U | V |
| Class A | 0.05% | -0.07% | 0.07% | 0.06% | 0.01% | -0.02% | 0.02% | 0.23% | 0.13% |
| Class B | 0.04% | 0.08% | -0.22% | 0.08% | 0.03% | -0.08% | 0.01% | 0.03% | 0.12% |
| Class C | 0.02% | -0.08% | -0.04% | 0.02% | -0.01% | 0.08% | -0.02% | 0.06% | -0.06% |
| Class D | 0.02% | -0.05% | -0.42% | 0.02% | -0.06% | -0.22% | 0.00% | -0.03% | -0.14% |
| Class E |  |  |  |  |  |  |  |  |  |
| Class F |  |  |  |  |  |  |  |  |  |
| **Overall** | 0.03% | -0.02% | -0.16% | 0.05% | 0.00% | -0.06% | 0.00% | 0.07% | 0.02% |
|  | 0.04% | -0.05% | -0.17% | 0.04% | -0.01% | -0.05% | 0.00% | 0.05% | 0.01% |
| Enc Time[%] | 101% | | | 102% | | | 100% | | |
| Dec Time[%] | 100% | | | 102% | | | 100% | | |
|  |  |  |  |  |  |  |  |  |  |
|  | **Low delay B HE** | | | **Low delay B (Low QP)** | | | **Low delay B (RDOQ off)** | | |
|  | Y | U | V | Y | U | V | Y | U | V |
| Class A |  |  |  |  |  |  |  |  |  |
| Class B | 0.00% | -0.10% | -0.43% | 0.05% | 0.02% | -0.08% | -0.02% | -0.06% | 0.00% |
| Class C | 0.00% | 0.01% | -0.34% | 0.00% | -0.07% | -0.05% | -0.03% | 0.43% | -0.04% |
| Class D | 0.05% | 0.31% | 0.31% | 0.00% | -0.14% | 0.00% | 0.01% | 0.01% | 0.06% |
| Class E | -0.01% | -0.50% | 1.27% | 0.05% | -0.34% | -0.20% | -0.08% | -0.07% | -0.66% |
| Class F |  |  |  |  |  |  |  |  |  |
| **Overall** | 0.01% | -0.04% | 0.10% | 0.03% | -0.11% | -0.07% | -0.03% | 0.08% | -0.12% |
|  | 0.01% | -0.08% | 0.09% | 0.03% | -0.10% | -0.13% | -0.03% | 0.05% | -0.10% |
| Enc Time[%] | 101% | | | 102% | | | 100% | | |
| Dec Time[%] | 102% | | | 101% | | | 100% | | |

Table : BD-Rate of 60 context reduction: the proposed 24 significance map context reductions combined with 36 level context reductions from JCTVC-F132.

# Summary

This contribution reduced 24 contexts for the coding of significance map with CABAC and resulted in average luminance BD-Rate of 0.0% for all test cases in Table 1.

|  |  |  |  |
| --- | --- | --- | --- |
|  | I\_HE | RA\_HE | LD\_HE |
| QP(22,27,32,37) | 0.02 | 0.01 | 0.03 |
| LQP(12,17,22,27) | 0.04 | 0.01 | 0.00 |
| RDOQ-OFF | -0.02 | -0.03 | -0.03 |

Table : Average BD-Rate of proposed 24 significance map context reduction.

When this contribution is combined with the 36 level context reductions from CE11 [1] on JCTVC-G121/F132 [3, 4] for a total of 60 context reductions, the BD-Rate became the results in Table 4.

|  |  |  |  |
| --- | --- | --- | --- |
|  | I\_HE | RA\_HE | LD\_HE |
| QP(22,27,32,37) | 0.07 | 0.03 | 0.01 |
| LQP(12,17,22,27) | 0.12 | 0.05 | 0.03 |
| RDOQ-OFF | 0.03 | 0.00 | -0.03 |

Table : Average BD-Rate of proposed significance map context reduction combined with level context reduction from JCTVC-G121/F132 for a total of 60 context reductions.

# References

1. Vivienne Sze, Tung Nguyen, Jianle Chen, Joel Sole, Krit Panusopone, “Description of Core Experiment (CE11): Coefficient scanning and coding”, JCTVC-F911, 6th Meeting: Torino, IT, 14-22 July, 2011.
2. Joel Sole, Rajan Joshi, Marta Karczewicz, “CE11: Unified scans for the significance map and coefficient level coding in high efficiency”, JCTVC-F288, 6th Meeting: Torino, IT, 14-22 July, 2011.
3. Vivienne Sze, “Reduction in contexts used for significant\_coeff\_flag and coefficient level”, JCTVC-F132, 6th Meeting: Torino, IT, 14-22 July, 2011.
4. Vivienne Sze, “CE11: Reduction in contexts used for coefficient level”, JCTVC-G121, 7th Meeting: Geneva, CH, 21-30 November, 2011.

# Patent rights declaration(s)

**Sony Electronics Inc. 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: Proposed WD text based on JCTVC-F803-v7

The changes relative to WD4 are highlighted in yellow.

Table 9‑41 – Values of variable m and n for significant\_coeff\_flag ctxIdx (A)

|  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- |
| **Initialisation variables** | **significant\_coeff\_flag ctxIdx** | | | | | | | | | | | | | | | |
| **0** | **1** | **2** | **3** | **4** | **5** | **6** | **7** | **8** | **9** | **10** | **11** | **12** | **13** | **14** | **15** |
| **m** |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  | -8 |
| **n** |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  | 90 |
|  | **16** | **17** | **18** | **19** | **20** | **21** | **22** | **23** | **24** | **25** | **26** | **27** | **28** | **29** | **30** | **31** |
| **m** |  |  |  |  |  |  |  |  |  |  |  |  |  |  | -8 |  |
| **n** |  |  |  |  |  |  |  |  |  |  |  |  |  |  | 90 |  |
|  | **32** | **33** | **34** | **35** | **36** | **37** | **38** | **39** | **40** | **41** | **42** | **43** | **44** | **45** | **46** | **47** |
| **m** |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |
| **n** |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |
|  | **48** | **49** | **50** | **51** | **52** | **53** | **54** | **55** | **56** | **57** | **58** | **59** | **60** | **61** | **62** | **63** |
| **m** |  |  |  |  |  |  |  |  |  |  |  | 14 |  |  |  |  |
| **n** |  |  |  |  |  |  |  |  |  |  |  | 48 |  |  |  |  |
|  | **64** | **65** | **66** | **67** | **68** | **69** | **70** | **71** | **72** | **73** | **74** | **75** | **76** | **77** | **78** | **79** |
| **m** |  |  |  |  |  |  |  |  |  |  | 14 |  |  |  |  |  |
| **n** |  |  |  |  |  |  |  |  |  |  | 48 |  |  |  |  |  |
|  | **80** | **81** | **82** | **83** | **84** | **85** | **86** | **87** |  |  |  |  |  |  |  |  |
| **m** |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |
| **n** |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |

Table 9‑42 – Values of variable m and n for significant\_coeff\_flag ctxIdx (B)

|  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- |
| **Initialisation variables** | **significant\_coeff\_flag ctxIdx** | | | | | | | | | | | | | | | |
| **0** | **1** | **2** | **3** | **4** | **5** | **6** | **7** | **8** | **9** | **10** | **11** | **12** | **13** | **14** | **15** |
| **m** |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  | 2 |
| **n** |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  | 61 |
|  | **16** | **17** | **18** | **19** | **20** | **21** | **22** | **23** | **24** | **25** | **26** | **27** | **28** | **29** | **30** | **31** |
| **m** |  |  |  |  |  |  |  |  |  |  |  |  |  |  | 2 |  |
| **n** |  |  |  |  |  |  |  |  |  |  |  |  |  |  | 61 |  |
|  | **32** | **33** | **34** | **35** | **36** | **37** | **38** | **39** | **40** | **41** | **42** | **43** | **44** | **45** | **46** | **47** |
| **m** |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |
| **n** |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |
|  | **48** | **49** | **50** | **51** | **52** | **53** | **54** | **55** | **56** | **57** | **58** | **59** | **60** | **61** | **62** | **63** |
| **m** |  |  |  |  |  |  |  |  |  |  |  | 18 |  |  |  |  |
| **n** |  |  |  |  |  |  |  |  |  |  |  | 31 |  |  |  |  |
|  | **64** | **65** | **66** | **67** | **68** | **69** | **70** | **71** | **72** | **73** | **74** | **75** | **76** | **77** | **78** | **79** |
| **m** |  |  |  |  |  |  |  |  |  |  | 18 |  |  |  |  |  |
| **n** |  |  |  |  |  |  |  |  |  |  | 31 |  |  |  |  |  |
|  | **80** | **81** | **82** | **83** | **84** | **85** | **86** | **87** |  |  |  |  |  |  |  |  |
| **m** |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |
| **n** |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |

Table 9‑43 – Values of variable m and n for significant\_coeff\_flag ctxIdx (C)

|  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- |
| **Initialisation variables** | **significant\_coeff\_flag ctxIdx** | | | | | | | | | | | | | | | |
| **0** | **1** | **2** | **3** | **4** | **5** | **6** | **7** | **8** | **9** | **10** | **11** | **12** | **13** | **14** | **15** |
| **m** |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  | 2 |
| **n** |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  | 61 |
|  | **16** | **17** | **18** | **19** | **20** | **21** | **22** | **23** | **24** | **25** | **26** | **27** | **28** | **29** | **30** | **31** |
| **m** |  |  |  |  |  |  |  |  |  |  |  |  |  |  | 2 |  |
| **n** |  |  |  |  |  |  |  |  |  |  |  |  |  |  | 61 |  |
|  | **32** | **33** | **34** | **35** | **36** | **37** | **38** | **39** | **40** | **41** | **42** | **43** | **44** | **45** | **46** | **47** |
| **m** |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |
| **n** |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |
|  | **48** | **49** | **50** | **51** | **52** | **53** | **54** | **55** | **56** | **57** | **58** | **59** | **60** | **61** | **62** | **63** |
| **m** |  |  |  |  |  |  |  |  |  |  |  | 18 |  |  |  |  |
| **n** |  |  |  |  |  |  |  |  |  |  |  | 31 |  |  |  |  |
|  | **64** | **65** | **66** | **67** | **68** | **69** | **70** | **71** | **72** | **73** | **74** | **75** | **76** | **77** | **78** | **79** |
| **m** |  |  |  |  |  |  |  |  |  |  | 18 |  |  |  |  |  |
| **n** |  |  |  |  |  |  |  |  |  |  | 31 |  |  |  |  |  |
|  | **80** | **81** | **82** | **83** | **84** | **85** | **86** | **87** |  |  |  |  |  |  |  |  |
| **m** |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |
| **n** |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |

**9.3.3.1.1.4 Derivation process of ctxIdxInc for the syntax element significant\_coeff\_flag**

Inputs to this process are the color component index cIdx, the current coefficient scan position ( xC , yC ) and the transform block size log2TrafoSize.

Output of this process is ctxIdxInc.

The variable sigCtx depends on the current position ( xC, yC ), the transform block size and previsously decoded bins of the syntax element significant\_coeff\_flag. For the derivation of sigCtx, the following applies.

* If log2TrafoSize is less than or equal to 2, sigCtx is derived from sigCtxTable[shift][sigCtxInc] in Table as follows.

sigCtxTemp = ( ( yC << 2 ) + xC ) (9‑55)

sigCtx = sigCtxTab[0][sigCtxTemp]

* If log2TrafoSize is equal to 3, sigCtx is derived from sigCtxTable[shift][sigCtxInc] in Table 6 as follows.

sigCtxTemp = ( ( yC >> 1 ) << 2 ) + ( xC >> 1 ) (9‑56)

sigCtx = ( (xC+yC) == 0 ) ? 30 : ( 15 + sigCtxTab[1][sigCtxTemp] )

* Otherwise if xC + yC is less than 2, sigCtx is derived as follows.

sigCtx = 31 + ( yC << 1 ) + xC (9‑57)

* Otherwise if xC + yC is less than 5, sigCtx is derived as follows.

temp = significant\_coeff\_flag[ xC + 1 ][ yC ] + significant\_coeff\_flag[ xC + 2 ][ yC ] +   
 significant\_coeff\_flag[ xC ][ yC + 1 ] + significant\_coeff\_flag[ xC + 1 ][ yC + 1 ] +   
 significant\_coeff\_flag[ xC ][ yC + 2 ] (9‑58)

if (temp==0)

sigCtx = 34

else if (temp < 3)

sigCtx = 35

else

sigCtx = 37

* Otherwise (xC + yC is greater than 4), sigCtx is derived using previously decoded bins of the syntax element significant\_coeff\_flag as follows.
* The variable sigCtx is initialized as follows.

sigCtx = 0 (9‑59)

* When xC is less than ( 1 << log2TrafoSize ) − 1, the following applies.

sigCtx = sigCtx + significant\_coeff\_flag[ xC + 1 ][ yC ] (9‑60)

* When xC and yC are less than ( 1 << log2TrafoSize ) − 1, the following applies.

sigCtx = sigCtx + significant\_coeff\_flag[ xC + 1 ][ yC + 1 ] (9‑61)

* When xC is less than ( 1 << log2TrafoSize ) − 2, the following applies.

sigCtx = sigCtx + significant\_coeff\_flag[ xC + 2 ][ yC ] (9‑62)

* When yC is less than ( 1 << log2TrafoSize ) − 1, the following applies.

sigCtx = sigCtx + significant\_coeff\_flag[ xC ][ yC + 1 ] (9‑63)

* When yC is less than ( 1 << log2TrafoSize ) − 2, the following applies.

sigCtx = sigCtx + significant\_coeff\_flag[ xC ][ yC + 2 ] (9‑64)

* Then

sigCtx = 39 + min(3, sigCtx)

The context index increment ctxIdxInc is derived using the color component index cIdx and sigCtx as follows.

* If cIdx is equal to 0, ctxIdxInc is derived as follows.

ctxIdxInc = sigCtx (9‑65)

* Otherwise (cIdx is greater than 0), ctxIdxInc is derived as follows.

ctxIdxInc = 44 + sigCtx (9‑66)

[Ed. (BB): The context derivation assumes maximum transform sizes less than or equal to 32x32 for luma and 16x16 for chroma and minimum transform sizes greater than or equal to 4x4.]

|  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- |
| shift | sigCtxTemp | | | | | | | | | | | | | | | |
| 0 | 1 | 2 | 3 | 4 | 5 | 6 | 7 | 8 | 9 | 10 | 11 | 12 | 13 | 14 | 15 |
| 0 | 0 | 1 | 2 | 3 | 4 | 5 | 6 | 3 | 8 | 9 | 10 | 3 | 12 | 12 | 12 |  |
| 1 | 0 | 1 | 2 | 3 | 4 | 5 | 10 | 3 | 8 | 10 | 10 | 11 | 12 | 12 | 11 | 11 |

Table 6 Specification of sigCtxTable[shift][sigCtxInc].