



# Modified Method for Coding Transform Coefficient Levels

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9<sup>th</sup> JCT-VC Meeting in Geneva  
27 April – 7 May 2012

# Overall Summary

- Proposes a modified method for coding transform coefficient levels by adding a new syntax flag to indicate if there is any coefficient with level  $> 1$  at the current pass for coding `coeff_abs_level_greater1_flag`
- Benefits: Reduce both the number of CABAC bins and the total number of the bins
- Results
  - Y BD-Rate differences
    - Main: 0.1%, 0.1%, and 0.2% for AI, RA:, LB, respectively
    - HiE10: 0.0 %, 0.0%, and 0.1% for AI, RA:, LB, respectively
  - Savings in the CABAC bin counts
    - Main: 3.0%, 3.7%,and 5.5% for AI, RA:, LB, respectively
    - HiE10 3.0%, 3.8%, and 5.7% for AI, RA:, LB, respectively

# Proposed Method

- Encode a new syntax flag **coeff\_abs\_level\_greater1\_group\_flag** at the beginning of the pass for coding **coeff\_abs\_level\_greater1\_flag** for each sub-block with **nonzero coefficients**
- Flag equal to 0 indicates that all coefficients subject to the current CABAC coding pass within the sub-block have **coeff\_abs\_level\_greater1\_flag** equal to 0 and the coding pass is skipped
- Otherwise, the regular pass proceeds except for the final coefficient level perhaps with an inferred **coeff\_abs\_level\_greater1\_flag** equal to 1

# Context Modeling

- Conditioned on the number of the nonzero coefficients within the sub-block
- Additionally conditioned on the sub-block position and significance of two neighboring sub-blocks for Luma
- 19 contexts (14 for Luma and 5 for Chroma)

```

ctxIdxInc = numNonZero <= 2 ? numNonZero-1 :
            (numNonZero <= 4 ? 2 : (numNonZero <= 8 ? 3 : 4));

ctxIdxInc = (text_type == Chroma) ? ctxIdxInc :
            (ctxIdxInc < 3 || (!coeff_abs_level_group_flag[xCG+1][yCG]
            && !coeff_abs_level_group_flag[xCG][yCG+1])) ?
            ((subSet == 0 ? 0 : 5) + ctxIdxInc) : ((subSet == 0 ? 0 : 2) +
            ctxIdxInc + 7)
  
```



Context Index	0	1	2	3	4
Number of Non-zero Coeffs	1	2	3, 4,	5, 6, 7, 8	> 8

# BD Rate Results (common test condition)

	All Intra Main			Random Access Main			Low delay B Main		
	Y	U	V	Y	U	V	Y	U	V
Class A	0.0%	0.4%	0.4%	0.2%	-0.1%	-0.1%			
Class B	0.1%	0.4%	0.4%	0.0%	0.1%	0.1%	0.2%	0.5%	0.4%
Class C	0.1%	0.3%	0.4%	0.1%	0.1%	0.0%	0.3%	0.5%	0.3%
Class D	0.0%	0.3%	0.2%	0.0%	0.1%	-0.1%	0.3%	1.0%	1.3%
Class E	0.1%	0.3%	0.3%				0.0%	-0.8%	0.1%
<b>Overall</b>	<b>0.1%</b>	<b>0.3%</b>	<b>0.3%</b>	<b>0.1%</b>	<b>0.0%</b>	<b>0.0%</b>	<b>0.2%</b>	<b>0.4%</b>	<b>0.6%</b>
	0.1%	0.3%	0.3%	0.0%	0.0%	0.0%	0.2%	0.5%	0.6%
Class F	0.1%	0.4%	0.3%	0.0%	0.1%	0.1%	0.0%	0.3%	0.3%

	All Intra HE10			Random Access HE10			Low delay B HE10		
	Y	U	V	Y	U	V	Y	U	V
Class A	0.0%	0.2%	0.3%	0.1%	0.2%	0.1%			
Class B	0.0%	0.3%	0.3%	0.0%	0.0%	0.1%	0.1%	0.5%	0.8%
Class C	0.0%	0.2%	0.2%	0.0%	0.0%	0.0%	0.1%	0.6%	0.7%
Class D	0.0%	0.2%	0.2%	0.0%	0.3%	-0.2%	0.2%	0.3%	0.2%
Class E	0.1%	0.1%	0.2%				-0.1%	-0.6%	0.1%
<b>Overall</b>	<b>0.0%</b>	<b>0.2%</b>	<b>0.2%</b>	<b>0.0%</b>	<b>0.1%</b>	<b>0.0%</b>	<b>0.1%</b>	<b>0.3%</b>	<b>0.5%</b>
	0.0%	0.2%	0.2%	0.0%	0.1%	0.0%	0.1%	0.3%	0.6%
Class F	0.1%	0.2%	0.2%	0.0%	0.0%	0.1%	0.1%	0.5%	0.6%

# Bin Count Statistics

- Common test condition
- Substantial savings in both the number of total bins and the number and CABAC bins

	All Intra			
	Main		HE10	
	Total	Context-coded	Total	Context-coded
Class A	-2.0	-2.9	-1.8	-2.8
Class B	-3.1	-4.2	-3.2	-4.5
Class C	-2.1	-3.0	-2.1	-3.0
Class D	-1.8	-2.6	-1.8	-2.7
Class E	-1.5	-2.1	-1.5	-2.2
Class F	-1.1	-1.7	-1.0	-1.7
<b>Overall (excl. F)</b>	<b>-2.1</b>	<b>-3.0</b>	<b>-2.1</b>	<b>-3.0</b>

	Random Access			
	Main		HE10	
	Total	Context-coded	Total	Context-coded
Class A	-2.0	-2.3	-1.8	-2.5
Class B	-4.7	-5.7	-4.8	-5.9
Class C	-2.8	-3.4	-2.7	-3.4
Class D	-2.7	-3.4	-2.7	-3.5
Class E	-1.4	-1.9	-1.3	-1.9
Class F	-1.4	-1.9	-1.3	-1.9
<b>Overall (excl. F)</b>	<b>-3.0</b>	<b>-3.7</b>	<b>-3.0</b>	<b>-3.8</b>

	Low Delay B			
	Main		HE10	
	Total	Context-coded	Total	Context-coded
Class A	-7.1	-7.8	-6.7	-7.7
Class B	-3.9	-4.5	-3.8	-4.7
Class C	-4.0	-4.6	-4.1	-4.9
Class D	-4.5	-5.0	-4.9	-5.7
Class E	-2.3	-2.9	-2.2	-2.8
Class F	-2.3	-2.9	-2.2	-2.8
<b>Overall (excl. F)</b>	<b>-4.9</b>	<b>-5.5</b>	<b>-4.9</b>	<b>-5.7</b>

# Comparison with Other Proposals

## ■ Proposed Method

- Developed to handle the sub-blocks having **no** coefficients with level values greater than 1
- Applied to the **trailing** coeff\_abs\_level\_greater1\_flag with a relatively askew probability distribution
- CABAC bin saving achieved by **group** coding of trailing flags

## ■ Other Proposals

- Developed to handle the sub-blocks having **some** coefficients with level values greater than 1
- Applied to the **leading** coeff\_abs\_level\_greater1\_flag with a relatively even probability distribution
- CABAC bin saving achieved by **bypass** coding of leading flags
- Minor or no saving in total bin count

# Conclusion and Discussion

- Extension of the two-level significance coding framework to the `coeff_abs_level_greater1_flag` pass
- Substantial savings in both total bin counts and CABAC bin counts with no important bitrate impacts
- Can jointly work with the other proposals for improved bit-stream parsing throughput for coding the trailing and leading flags, respectively