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| *Title:* | **AHG8: Use of inter RDPCM for blocks using intra block copy mode** | | |
| *Status:* | Input Document to JCT-VC | | |
| *Purpose:* | Proposal | | |
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# Abstract

At the 14th JCT-VC meeting intra block copy and inter residual DPCM were adopted into the HEVC Range Extensions text specification draft 4. As per the text specification, inter residual DPCM is applied to inter blocks. But, in the updated HM12.0-RExt-4.1 software inter RDPCM is applied to inter blocks as well as blocks using intra block copy. It is proposed that the text specification be changed to align it with the software. Furthermore, it is proposed that the residual\_dpcm\_inter\_enabled\_flag be used to control the application of inter residual DPCM to inter blocks as well as blocks using intra block copy.

# Technical Description

## Use of inter RDPCM for intra block copy

In the 14th JCT-VC meeting, intra block copying (INTRA\_BC) [1] and inter residual DPCM (RDPCM) [2] were adopted into the HEVC Range Extensions text specification draft 4 [3].

As per the text specification, inter RDPCM is applied only to inter blocks (predMode = “MODE\_INTER”). However, in the updated HM12.0-RExt-4.1 software inter RDPCM is applied to inter blocks as well as INTRA\_BC blocks (predMode = “MODE\_INTRABC”). Thus there is a discrepancy between the software and the text specification.

It is proposed to change the text specification to align it with the software. Simulation results to support this recommendation are presented in Section 2.

## Semantics for SPS flags for RDPCM

SPS level flags *residual\_dpcm\_intra\_enabled\_flag* and *residual\_dpcm\_inter\_enabled\_flag* were introduced to control the use of intra and inter RDPCM, respectively.

Currently, in the software, *residual\_dpcm\_intra\_enabled\_flag* is used to control whether inter RDPCM is applied to INTRA\_BC blocks. For an encoder to use inter RDPCM for INTRA\_BC blocks, it needs to perform a search and signal the RDPCM mode explicitly. In contrast, for intra RDPCM, no encoder search and signalling is necessary. Hence it is undesirable that both intra RDPCM and inter RDPCM for INTRA\_BC blocks are controlled by the same flag. Since encoder complexity implications of using inter RDPCM for inter blocks and INTRA\_BC blocks are similar, it is more logical for a single SPS flag to control this behavior.

We propose that the text specification be further amended to use the *residual\_dpcm\_inter\_enabled\_flag* to control the application of inter RDPCM to inter and INTRA\_BC blocks.

# Results

The coding efficiency improvement resulting from the use of inter RDPCM for INTRA\_BC blocks was measured under AHG8 test sequences and conditions. Table 1 shows the BD-rate degradation for lossy coding when the use of inter RDPCM for INTRA\_BC blocks is turned off (that is, when setting the software as in the text specification). Table 2 shows the savings for lossless conditions.





Table 1: BD-rate results for disabling inter RDPCM for INTRA\_BC blocks (lossy)







Table 2: BD-rate results for disabling inter RDPCM for INTRA\_BC blocks (lossless)

# Conclusion

Use of inter RDPCM for INTRA\_BC blocks results in gains for most screen content sequence classes for AI configuration at the cost of very little run-time complexity. It is recommended that the HEVC Range Extension text specification be changed to align it with the test model software. Furthermore, it is recommended that the *residual\_dpcm\_inter\_enabled\_flag* be used to control the application of inter RDPCM to inter as well as INTRA\_BC blocks.

# References

[1] C. Pang, J. Sole, L. Guo, M. Karczewicz, R. Joshi, “Non-RCE3: Intra Motion Compensation with 2-D MVs”, JCTVC-N0256, Vienna, AT, August 2013.

[2] M. Naccari, M. Mrak, “RCE2: Experimental results for Test C.1”, JCTVC-N0074, Vienna, AT, August 2013.

[3] D. Flynn, J. Sole, T. Suzuki, “Range Extensions Draft 4”, JCTVC-N1005, Vienna, AT, August 2013.

# Working Draft Specification

**7.3.8.11 Residual coding syntax**

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| ~~if( CuPredMode[ x0 ][ y0 ] = = MODE\_INTER &&   residual\_dpcm\_inter\_enabled\_flag && transform\_skip\_flag[ x0 ][ y0 ][ cIdx ] ) {~~ |  |
| **~~inter\_rdpcm\_flag~~**~~[ x0 ][ y0 ]~~ | ~~ae(v)~~ |
| ~~if( inter\_rdpcm\_flag[ x0 ][ y0 ] )~~ |  |
| **~~inter\_rpdcm\_dir\_flag~~**~~[ x0 ][ y0 ]~~ | ~~ae(v)~~ |
| if( ( CuPredMode[ x0 ][ y0 ] = = MODE\_INTER || intra\_bc\_flag[ x0 ][ y0 ] ) &&   residual\_dpcm\_inter \_enabled\_flag &&   ( transform\_skip\_flag[ x0 ][ y0 ][ cIdx ] || cu\_transquant\_bypass\_flag) ) { |  |
| **inter\_rdpcm\_flag**[ x0 ][ y0 ][ cIdx ] | ae(v) |
| if( inter\_rdpcm\_flag[ x0 ][ y0 ][ cIdx ] ) |  |
| **inter\_rdpcm\_dir\_flag**[ x0 ][ y0 ][ cIdx ] | ae(v) |

|  |  |
| --- | --- |
| ~~if( cu\_transquant\_bypass\_flag | |  | | ( CuPredMode[ xC ][ yC ] = = MODE\_INTRA &&   residual\_dpcm\_intra\_enabled\_flag && transform\_skip\_flag[ x0 ][ y0 ][ cIdx ] &&   ( predModeIntra = = 10 | | predModeIntra = = 26 ) )  | | ( CuPredMode[ xC ][ yC ] = = MODE\_INTER &&   residual\_dpcm\_inter\_enabled\_flag && inter\_rdpcm\_flag[ x0 ][ y0 ][ cIdx ] ) )~~ |  |
| if( cu\_transquant\_bypass\_flag | |  | | ( CuPredMode[ xC ][ yC ] = = MODE\_INTRA && !intra\_bc\_flag[ x0 ][ y0 ] &&  residual\_dpcm\_intra\_enabled\_flag && transform\_skip\_flag[ x0 ][ y0 ][ cIdx ] && ( predModeIntra = = 10 | | predModeIntra = = 26 ) )  | | ( ( CuPredMode[ xC ][ yC ] = = MODE\_INTER || intra\_bc\_flag[ x0 ][ y0 ] ) &&   residual\_dpcm\_inter\_enabled\_flag && inter\_rdpcm\_flag[ x0 ][ y0 ][ cIdx ] ) ) |  |
| signHidden = 0 |  |

**7.4.3.2 Sequence parameter set RBSP semantics**

**residual\_dpcm\_intra\_enabled\_flag** equal to 1 specifies that the residual modification process for blocks using a transform bypass may be used for intra blocks (except blocks coding with intra\_bc\_flag equal to 1) in the CVS. residual\_dpcm\_intra\_enabled\_flag equal to 0 specifies that the residual modification process is not used for intra blocks (except blocks coding with intra\_bc\_flag equal to 1) in the CVS. When not present, the value of residual\_dpcm\_ intra \_enabled\_flag is inferred to be equal to 0.

**residual\_dpcm\_inter\_enabled\_flag** equal to 1 specifies that the residual modification process for blocks using a transform bypass may be used for inter blocks and intra blocks with intra\_bc\_flag euqal to 1 in the CVS. residual\_dpcm\_inter\_enabled\_flag equal to 0 specifies that the residual modification process is not used for inter blocks and intra blocks with intra\_bc\_flag euqal to 1 in the CVS. When not present, the value of residual\_dpcm\_ inter \_enabled\_flag is inferred to be equal to 0.

**8.4.4.1 General decoding process for intra blocks**

3. ……

The variable residualDpcm is derived as follows:

* + If residual\_dpcm\_intra\_enabled\_flag is equal to 1, predModeIntraBc is equal to 0 and one or more of the following conditions are true, residualDpcm is set equal to 1.
    - cu\_transquant\_bypass\_flag is equal to 1
    - transform\_skip\_flag[ xTb0 ][ yTb0 + yTbOffset ][ cIdx ] is equal to 1
  + Otherwise, residualDpcm is set equal to 0.

6. Depending upon the value of predModeIntraBc, the following applies

When predModeIntraBc is equal to 0, ~~W~~when residualDpcm is equal to 1 and either predModeIntra is equal to 10, or predModeIntra is equal to 26, the directional residual modification process for blocks using a transform bypass as specified in subclause 8.6.5 is invoked with the variable mDir set equal to predModeIntra / 26, the variable nTbS, and the (nTbS)x(nTbS) array r set equal to the array resSamples as inputs, and the output is a modified (nTbS)x(nTbS) array resSamples.

Otherwise( predModeIntraBc is equal to 1), when inter\_rdpcm\_flag[ xTb0 ][ yTb0 + yTbOffset ][ cIdx ] is equal to 1, the directional residual modification process for blocks using a transform bypass as specified in subclause 8.6.5 is invoked with the variable mDir set equal to inter\_rdpcm\_dir\_flag[ xTb0 ][ yTb0 + yTbOffset ][ cIdx ], the variable nTbS, and the (nTbS)x(nTbS) array r set equal to the array resSamples as inputs, and the output is a modified (nTbS)x(nTbS) array resSamples.

# Patent rights declaration(s)

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