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| *Title:* | **HEVC Range Extensions Core Experiment 1 (RCE1): High bit rate coding at high bit depths** | | |
| *Status:* | Input Document to JCT-VC | | |
| *Purpose:* | CE description | | |
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| *Source:* | CE co-ordinators | | |

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# Abstract

This document is a description of the HEVC Range Extensions Core Experiment 1 on high bit rate coding at high bit depths.

# Technical Description

This document defines HEVC Range Extensions Core Experiment 1 (RCE1) on high bit rate coding at high bit depths to be performed for the upcoming January 2014 JCT-VC meeting..

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# Tools to be tested

The CE is set up to explore combinations of alignment mechanisms with alignment conditions and change of the point in the entropy coder where the bypass bins are used.

Two alignment mechanisms for bypass bins will be tested:

**Method 1** [M0178, N0190, O0046, O0207]**:** Alignment to 256. This can be expressed as:

ivlCurrRange = 256

Following this stage all subsequent EP bins can be interpreted as raw binary data.

**Method 2** [M0178, N0190, O0046]: Alignment to 384. This can be expressed as:

if (ivlCurrRange >= 384)

if (ivlOffset < 256) nextEPBitIsZero = true

else ivlOffset -= 128

ivlCurrRange = 256

Following this stage all subsequent EP bins can be interpreted as raw binary data.

## Bypass of context coded bins for coefficient coding (subtest A)

In this subtest, various positions for switching to bypass in transform coefficient coding are explored.

**Subtest A.1** [O0208, Qualcomm]: Bypass after the significance map depending on the initial Rice parameter value for the current 4×4 subblock or the Rice parameter value at the end of the previous 4×4 subblock. Using the initial Rice parameter value as in RCE2 for the decision to bypass the flags will also be tested. Different thresholds will be tested.

**Subtest A.2** [O0209, Qualcomm]: Bypass all the context-coded flags for the current 4×4 subblock (coded subblock flags, significance flags, greater than 1 flags and greater than 2 flags) depending on the initial Rice parameter value for the current 4×4 subblock or the Rice parameter value at the end of the previous 4×4 subblock. Using the initial Rice parameter value as in RCE2 for the decision to bypass the flags will also be tested. Different thresholds will be tested in all cases.

**Subtest A.3** [O0209 (ext.), Qualcomm]: Bypass all the context-coded flags in a transform block depending on the Rice parameter value at the end of the previous transform block. Using the initial Rice parameter value at the beginning of the current transform block as in RCE2 for the decision to bypass the flags will also be tested. Different thresholds will be tested. Other ways of sending the last coefficient will be tested (for example using a fixed number of bits dependent on block size).

**Subtest A.4** [meeting discussion]: All the bins (for coefficients as well as other syntax elements) are coded as raw. Residual data is modified according to subtest A.3. Additionally, the Golomb-Rice parameterization is changed.

## Combinations (subtest B)

**Subtest B.1** [M0178]: Always apply method 1 before any bypass bins in a 4×4 subblock.

**Subtest B.2** [M0178]: Always apply method 2 before any bypass bins in a 4×4 subblock.

**Subtest B.3.a** [O0046]: Method 1 before sign coding if any coeff\_abs\_level\_rem syntax elements are present for the 4x4 subblock..

**Subtest B.3.b** [O0207]: Method 1 based on sign data hiding condition for a 4×4 subblock.

**Subtest B.5**: Method 1 + A.1

**Subtest B.6**: Method 1 + A.2

**Subtest B.7**: Method 1 + A.3

# Crosschecks

|  |  |
| --- | --- |
| Test | Crosscheckers |
| A.1 | Mediatek |
| A.2 | Samsung |
| A.3 |  |
| A.4 | Canon |
| B.1 | Qualcomm |
| B.2 |  |
| B.3 |  |
| B.4 |  |
| B.5 | Canon |
| B.6 | Samsung |
| B.7 | Sharp |

# Test Conditions

RExt5.1 will be used for all experiments, with all default settings (unless specified otherwise), including RExt\_\_BACKWARDS\_COMPATIBILITY\_HM\_ENCODER\_INTER\_SEARCH set to 0.

## AHG5 CTC

The AHG5 CTC will be used. These will be used to evaluate the loss for standard picture-quality operating points, which might be used for 8K at 240P.

It is expected that AHG5 CTC will utilise the full set of RExt tools, rather than the restricted set used for the 4:2:2 and 4:2:0 profiles.

## AHG8 with lossless

The AHG8 lossless test conditions will be used to evaluate any potential issues at lossless operating points.

## AHG18 test conditions on high bit depths

High bit-depth test conditions are defined as follows:

|  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- |
| **Group** | **Sequence name** | **Number of frames tested** | | **Input bit depth** | **MSB Extended Bit Depth** |
| **AI** | **LD** |
| SVT  16 bit from 10 bit source  (intermediate processing) | CrowdRun\_1920x1080\_50\_16bit\_444.rgb | 50 | 50 | 16 | 0 |
| ParkJoy\_1920x1080\_50\_16bit\_444.rgb | 50 | -1 | 16 | 0 |
| DucksTakeOff\_1920x1080\_50\_16bit\_444.rgb | 50 | -[[1]](#footnote-1) | 16 | 0 |
| InToTree\_1920x1080\_50\_16bit\_444.rgb | 50 | -1 | 16 | 0 |
| OldTownCross\_1920x1080\_50\_16bit\_444.rgb | 50 | 50 | 16 | 0 |
| IBDI 4:4:4 | Traffic\_2560x1600\_30\_12bit\_444\_crop.rgb | 60 | 60 | 12 | 0 |
| 16 bit HDR | FruitStall\_1920x1080\_24\_16bit\_444.rgb | 120 | 120 | 16 | 0 |
| 16 bit from 16 bit HDR source | Bubbles\_4096x2160\_24\_16bit\_444.rgb | 60 | -[[2]](#footnote-2) | 16 | 0 |
| 16 bit HDR 4:0:0 Medical | AX\_Head\_1240x960\_16bit\_400.yuv3 | 250 | 250 | 16 | 0 |
| IBDI 4:0:0 | CT\_ Cardiac\_512x512\_12bit\_400.yuv[[3]](#footnote-3) | 250 | 250 | 12 | 0 |
| CT\_ LongrunShort\_512x512\_12bit\_400.yuv3 | 500 | 500 | 12 | 0 |
| ~~Synthesised 422 HDR~~ | ~~EBUHorse\_1920x1080\_50\_10bit\_422.yuv~~ | ~~100~~ | ~~50~~ | ~~10~~ | ~~12,14,16~~ |
| ~~EBUWaterRocksClose\_1920x1080\_50\_10bit\_422.yuv~~ | ~~100~~ | ~~50~~ | ~~10~~ | ~~12,14,16~~ |
| ~~Synthesised 444 HDR~~ | ~~EBURainFruits\_1920x1080\_50\_10bit\_444.yuv~~ | ~~100~~ | ~~50~~ | ~~10~~ | ~~12,14,16~~ |
| ~~Kimono1\_1920x1080\_24\_10bit\_444.yuv~~ | ~~120~~ | ~~50~~ | ~~10~~ | ~~12,14,16~~ |
| Synthesised RGB HDR | EBURainFruits\_1920x1080\_50\_10bit\_444.rgb | 50 | 50 | 10 | 12,14,16 |
| Kimono1\_1920x1080\_24\_10bit\_444.rgb | 60 | -1 | 10 | 12,14,16 |
|  | ~~Others…~~ |  |  |  |  |

Additional MSBs are used to simulate HDR-style material; the MSBExtendedBitDepth command line option has been provided in the RExt software to achieve this, with the parameter set to the value(s) shown (if there are multiple values, then multiple simulations are required). When MSBExtendedBitDepth is set to 0, it defaults to the input bit depth.

For the medical images where the frame rate is not defined, a frame rate of 50 FPS will be assumed for the purpose of reporting a bit rate. Hence the bit rate reported at 50FPS for lowdelay is the total number of bits, and the bit rate reported at 50FPS for intra is half the total number of bits.

For each sequence, a number of internal bit-depths and QPs are to be tested:

|  |  |  |
| --- | --- | --- |
| Internal bit depth | QPs – Medium Tier | QPs – High Tier |
| 16 | -16, -19, -22, -25 | -28, -31, -34, -37 |
| ~~14~~ | ~~-4, -7, -10, -13~~ | ~~-16, -19, -22, -25~~ |
| 12 | 8, 5, 2, -1 | -4, -7, -10, -13 |

Extended precision processing will be enabled, and the encoder’s high precision forward transform will be used. The software settings required will be:

• #define RExt\_\_HIGH\_BIT\_DEPTH\_SUPPORT 1

• Apply '--ExtendedPrecision=1'

Results will show BD-rate changes over the 4 QPs and the compression ratio.

Simulations will be run using the ‘encoder\_intra\_main\_rext.cfg’ and ‘encoder\_lowdelay\_main\_rext.cfg’, using the number of frames shown in the ‘AI’ and ‘LD’ columns respectively.

# Evaluation of CE results

Results of the CE will be evaluated on the basis of BD-rate results, throughput and complexity. The complexity assessment will be performed on the basis of hardware and encoding/decoding complexity.

## Throughput

To measure the throughput the following bin counts will be provided:

1. Total number of coded bins
2. The number of context coded bins
3. The number of bypass coded bins with CABAC
4. The number of bypass coded bins without CABAC (raw bits)

For each TU size, the actual worst case bin counts with respect to items 2, 3, and 4 will also be provided. An analysis of the worst case complexity should be provided for each method for a coefficient and a 4×4 subblock.

## Complexity

To measure software run times, range extension software with the provided configurations and the proposals implemented on range extension software shall be used. The computational time must be measured for each test sequence and test case for both anchor and proposals. Relative computational time calculated against the anchor must be presented.

Additional evaluation of the HW and SW complexity of the proposed tools for both encoder and decoder is encouraged.

# Timeline

* November 22, 2013: CE description finalized and uploaded.
* December 18, 2013: Test sequences and test conditions are finalized.
* December 4, 2013: Range extension reference software (RExt 5.1) available.
* December 18, 2013: Cross-check begins. Proponents for subtest A provide software, draft specification text and results to CE participants.
* December 25, 2013: Proponents for subtest B provide software, draft specification text and results to CE participants.
* January 3, 2014: Input documents and summary report uploaded.

1. This sequence is not run, as the results are likely to be similar to others in the same category. [↑](#footnote-ref-1)
2. This sequence is not run, as the memory requirements of a 4K 16-bit sequence may be prohibitive. [↑](#footnote-ref-2)
3. A password will need to be obtained from the proponents of O0172 in order to decode this. [↑](#footnote-ref-3)