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Title: **Common test conditions for high bit depth and high bit rate video coding**

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Abstract

This document proposes common test conditions (CTC) and software reference configurations to be used in the context of high bit depth and high bit rate video coding experiments after the 20th JVET meeting. These common test conditions are recommended for use in technical contributions to the 21st and following JVET meetings, as applicable.

1 Introduction

Common test conditions (CTC) are desirable to conduct experiments in a well-defined environment and to ease the comparison of the outcome of experiments.

This document defines three test conditions for high bit depth and high bit rate content, reflecting intra-only, random-access, and low-delay settings:

- Intra, 12 and 16 bit
- Random access, 12 and 16 bit
- Low delay, 12 and 16 bit

A subset of these test conditions might be used for a particular experiment. For example, when testing an intra coding tool, only intra configurations might be used.

The test conditions define tests at bit depths of 12 and 16 bits. For 12 bit tests, PQ, HLG and RGB sequences have been defined. For 16 bit tests, only RGB sequences are used.

Version 11.0 or later of the VTM software is expected to be used for most experiments. More recent versions are encouraged where applicable.

Any input contributions to JVET related to high bit depth, high bit rate or high frame rate video coding should provide a set of results using these test conditions that is as complete as possible.

The following sections define the software configuration, test sequences, quantization parameter values, evaluation processes, and encoder configuration files to be used.

2 Software configuration

Version 11.0 (or later if available) of VTM shall be configured for high bit depth processing by defining the following macro in the source code (TypeDef.h)

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#define JVET_R0351_HIGH_BIT_DEPTH_ENABLED 1

In addition, VTM shall be enabled with HDRLib functionality. For more information see the HDR CTC[2].

3 Test sequences

Tables 1, 2 and 3 define the sets of test sequences to be used for intra, random-access, and low-delay in both lossy and lossless experiment conditions. All frames (as defined by frame count in the table) shall be encoded for all sequences in the random-access and low-delay test cases described below. For the intra configuration, the first of every eight frames shall be encoded starting with the first frame in the sequence for all sequences, and bit rates shall be calculated using the sequence frame rate (as defined by frame rate in the table) divided by eight. Please note that temporal sub-sampling may be enabled in the VTM software using the parameter TemporalSubsampleRatio. For random access and low delay configurations, if there is no number in the "encoded frame count" column for the configuration, the test case is not requested in the CTC.

Class	Sequence	Frame rate	Encoded frame count			Input bit depth	Internal bit depth
			AI	RA	LDB		
SVT (HD)	OldTownCross	50	100	97	50	16	12 and 16
	CrowdRun	50	100	97	50	16	12 and 16
	ParkJoy	50	100			16	12 and 16
	DucksTakeOff	50	100			16	12 and 16
	InToTree	50	100			16	12 and 16

Table 1. RGB 4:4:4 content

RGB sequences are mandatory in both 12 and 16 bit tests.

Class	Sequence	Frame rate	Encoded frame count			Input bit depth	Internal bit depth
			AI	RA	LDB		
PQ (HD)	BallonFestival	24	100	97	50	12	12
	EBU_04_Hurdles	50	100	97	50	12	12
	Market3Clip4000	50	100			12	12
	EBU_06_Starting	50	100			12	12

Table 2. PQ YUV 4:4:4 and 4:2:2 content

PQ sequences are in both YUV 4:4:4 and YUV 4:2:2 format and are mandatory in 12 bit tests.

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Class	Sequence	Frame rate	Encoded frame count			Input bit depth	Internal bit depth
			AI	RA	LDB		
HLG (4K)	DayStreet	60	100	97	25	12	12
	PeopleInShoppingCenter	60	100	97	25	12	12
	NightStreet	60	100			12	12
	StainedGlass	60	100			12	12

Table 3. HLG YUV 4:4:4 and 4:2:2 content

HLG sequences are in both YUV 4:4:4 and YUV 4:2:2 format and are mandatory in 12 bit tests.

Tables 4 indicates which test configurations are required for each type of content. The column corresponding to each configuration is interpreted as follows:

- "M" indicates that the test sequence is mandatory in the CTC for the given configuration
- "O" indicates that the test sequence is optional (but encouraged) in the CTC for the given configuration
- "-" indicates that the test sequence is not requested in the CTC for the given configuration

Class	Chroma sub-sampling	12 bit			16 bit		
		AI	RA	LDB	AI	RA	LDB
SVT	4:4:4	M	M	M	M	O	M
PQ	4:4:4	M	M	M	-	-	-
	4:2:2	M	O	O	-	-	-
HLG	4:4:4	M	M	M	-	-	-
	4:2:2	M	O	O	-	-	-

Table 4. Required test conditions for lossy coding.

Class	Chroma sub-sampling	12 bit			16 bit		
		AI	RA	LDB	AI	RA	LDB
SVT	4:4:4	O	O	O	O	O	O
PQ	4:4:4	O	O	O	-	-	-
	4:2:2	O	O	O	-	-	-
HLG	4:4:4	O	O	O	-	-	-
	4:2:2	O	O	O	-	-	-

Table 5. Required test conditions for lossless coding.

Original versions of the test sequences in Table 1, 2 and 3 are available on ftp://jvet@ftp.ient.rwth-aachen.de/ctc/hbd/. (Properly qualified participants of JVET may please contact the JVET chairs for login information).

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4 Quantization parameter values

Results shall be provided using two sets of six quantization parameter values, one for 12 bit test cases and the other for 16 bit test cases as follows:

- 12 bit: 12, 7, 2, -3, -8 and -13
- 16 bit: -8, -13, -18, -23, -28, -33

These values define the initial QP values that are used to derive respective QP for I- and B-frames in a sequence.

The method for calculating six point BD-rates described in JVET-H0030[3] should be used.

5 Configuration

Configuration files for the three requested test conditions are provided with the VTM software in the cfg directory and shall be used. The three configurations provided are as follows:

- "All Intra" (AI): encoder_intra_vtm.cfg
- "Random access" (RA): encoder_randomaccess_vtm.cfg
- "Low-delay B" (LDB): encoder_lowdelay_vtm.cfg

In addition to the three test conditions, format and class specific parameter files are also provided with the VTM software and shall be used as follows:

SVT: cfg/per-class/formatRGB.cfg

PQ (both 4:4:4 and 4:2:2): cfg/per-class/classH1.cfg

HLG (both 4:4:4 and 4:2:2): cfg/per-class/classH2.cfg

To reduce simulation times and use the consistent configuration, the high bit depth and high bit rate CTC also introduce some configuration changes to enable / disable certain tools and limit the maximum size of partitioning. These changes are included in the file cfg/hbd/hbd.cfg which shall be used.

Additional configuration, including the setting for the extended precision flag, is required separately for 12 bit and 16 bit test cases. The specific changes for different bit depths described are included in the two configuration files cfg/hbd/12-bit.cfg and cfg/hbd/16-bit.cfg and shall be used for 12 and 16 bit test cases respectively.

For lossless simulations, a further series of configurations is additionally required. For SVT content the settings contained in cfg/lossless/lossless.cfg and cfg/lossless/losslessRGB.cfg shall be used. The lossless configuration files set the internal bit depth to 0. For 12 bit SVT simulations only, this shall be overwritten by 12 by applying the configuration file cfg/hbd/12-bit.cfg after cfg/lossless/lossless.cfg. For PQ and HLG content the settings contained in cfg/lossless/lossless.cfg and cfg/lossless/lossless444.cfg shall be used.

Finally, sequence specific parameters are provided with the VTM software in the cfg/per-sequence-HBD directory and shall used.

6 HM Anchor

For the purposes of comparison an HM anchor can be created using the latest version of HM (16.22 or later) built with the following macro defined:

#define REXt__HIGH_BIT_DEPTH_SUPPORT 1

When creating an HM anchor the following configuration files shall be used for each test case:

- "All Intra" (AI): encoder_intra_main_rext.cfg

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- “Random access” (RA): encoder_randomaccess_main_rext.cfg
- “Low-delay B” (LDB): encoder_lowdelay_main_rext_vtm.cfg

These files shall be used in conjuction with the files cfg/12-bit.cfg and cfg/16-bit.cfg for 12 and 16 bit test cases respectively.

7 Evaluation

Results reported for PQ sequences shall include the following metrics:

- PSNR for Y′, Cb and Cr
- wPSNR for Y’, Cb and Cr (for more information see the HDR CTC[2])

Results reported for the HLG and SVT sequences class shall include the following metrics:

- PSNR for Y’, Cb and Cr

An Excel template for reporting test results is provided alongside this document.

8 MD5

8.1 SVT

```
6004ff26cafcf2b066faa00c935a7621  CrowdRun_1920x1080_50_16bit_444.rgb
2ab943d7b1c6e3b26a2c6da416b69828  ParkJoy_1920x1080_50_16bit_444.rgb
d882efad39ae3d360896ec09d9213424  DucksTakeOff_1920x1080_50_16bit_444.rgb
6f7d413472f856741e95543217f9795d  InToTree_1920x1080_50_16bit_444.rgb
ae5bab60c3dfb16399971b9afff120da  OldTownCross_1920x1080_50_16bit_444.rgb
```

8.2 PQ

8.2.1 PQ 4:2:2

```
b029dace9f10af78aa6c3363531b1768  BalloonFestival_1920x1080p_24_12b_pq_709_ct2020_422.yuv
716c1ec421a72c46011f31754077eec4  Market3Clip4000r2_1920x1080p_50_12b_pq _709_ct2020_422.yuv
b9f22e80fa8eb33e3c00633e6824844f  EBU_04_Hurdles_1920x1080p_50_12b_pq_709_ct2020_422.yuv
a480ed6fc9e9f4e6b84b1ab6e7bc4f1b  EBU_06_Starting_1920x1080p_50_12b_pq_709_ct2020_422.yuv
```

8.2.2 PQ 4:4:4

```
1664a322cf91934872afd07035819a05  BalloonFestival_1920x1080p_24_12b_pq_709_ct2020_444.yuv
564904c4001957472483a3d79b55f17d  Market3Clip4000r2_1920x1080p_50_12b_pq_709_ct2020_444.yuv
544b1b8816d0003e69ce6a28bbd01810  EBU_04_Hurdles_1920x1080p_50_12b_pq_709_ct2020_444.yuv
f6761039392e76336493effdc257bf1a  EBU_06_Starting_1920x1080p_50_12b_pq_709_ct2020_444.yuv
```

8.3 HLG

8.3.1 HLG 4:2:2

```
136cbeb9cea1fd6969366b5979b89eb8  DayStreet_3840x2160_60p_12bit_422_hlg.yuv
8fc91ff312f3a729bf6c5e149bbaaf5e  PeopleInShoppingCenter_3840x2160_60p_12bit_422_hlg.yuv
a9773f3df122061379888a5268d0d50e  NightStreet_3840x2160_60p_12bit_422_hlg.yuv
5cf45f6880652eb9b9ddac84f3d20e66  StainedGlass_3840x2160_60p_12bit_422_hlg.yuv
```

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8.3.2 HLG 4:4:4

```
22d84b5024ff0477a729d5a16b29bf61  DayStreet_3840x2160_60p_12bit_444_hlg.yuv
dcdc82fcbf693c0bb0dcf16abad64c75  PeopleInShoppingCenter_3840x2160_60p_12bit_444_hlg.yuv
da10d72731df64910269f7a193021cae  NightStreet_3840x2160_60p_12bit_444_hlg.yuv
cc6f6f8c1d5c7143210e602c3d9b7471  StainedGlass_3840x2160_60p_12bit_444_hlg.yuv
```

9 References

[1] F. Bossen, J. Boyce, X. Li, V. Seregin, K. Sühring, “JVET common test conditions and software reference configurations for SDR video”, JVET-T2010, JVET, 20th Meeting: by teleconference, 7-16 Oct. 2020

[2] A. Segall, E. François, W. Husak, S. Iwamura, D. Rusanovskyy , “JVET common test conditions and evaluation procedures for HDR/WCG video”, JVET-T2011, JVET, 20th Meeting: by teleconference, 7-16 Oct. 2020

[3] A. M. Tourapis, D. Singer, Y. Su, K. Mammou, “BD-Rate/BD-PSNR Excel extensions”, JVET-H0030, JVET, 8th Meeting: Macao, CN, 18–25 Oct. 2017

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