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Information technology — Coded representation of immersive media —

Part 20:
Conformance for V-PCC

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Contents

Page

Foreword

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This document was prepared by Joint Technical Committee ISO/IEC JTC 1, *Information technology*, Subcommittee SC 29, *Coding of audio, picture, multimedia and hypermedia information*.

A list of all parts in the ISO 23090 series can be found on the ISO and IEC websites.

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Introduction

This document outlines the conformance testing specification for ISO/IEC 23090-5.

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Information technology — Coded representation of immersive media —

Part 20:
Conformance for V-PCC

1 Scope

This document specifies a set of tests and procedures designed to indicate whether encoders or decoders meet the requirements specified in ISO/IEC 23090-5.

2 Normative references

The following documents are referred to in the text in such a way that some or all of their content constitutes requirements of this document. For dated references, only the edition cited applies. For undated references, the latest edition of the referenced document (including any amendments) applies.

ISO/IEC 23090-5[1], *Information technology — Coded representation of immersive media — Part 5: Visual Volumetric Video-based Coding (V3C) and Video-based Point Cloud Compression (V-PCC)*

ISO/IEC 23090-19, *Information technology — Coded representation of immersive media — Part 19: Reference Software for V-PCC*

3 Terms and definitions

For the purposes of this document, the terms and definitions given in ISO/IEC 23090-5 apply, and the following apply.

ISO and IEC maintain terminology databases for use in standardization at the following addresses:

— ISO Online browsing platform: available at https://www.iso.org/obp

— IEC Electropedia: available at https://www.electropedia.org/

3.1
bitstream
sequence of bits that conforms to specified syntax requirements or sequence of bits to be tested for conformance to such syntax requirements

3.2
decoder
embodiment of the decoding process to be tested for conformance to such a decoding process specification

Note 1 to entry: The decoder does not include the rendering and display process, which are outside the scope of this document.

3.3
encoder
embodiment of a process, not specified in this document (except in respect to identification of the reference software encoder), that produces a *bitstream* (3.1).

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1) Under preparation. Stage at the time of publication: ISO/IEC FDIS 23090-5:2023.

3.4
reference software decoder
particular *decoder* (3.2) provided as a software package for use as an example available for study, as a potential starting basis for the development of other decoders, as a way of testing *bitstreams* (3.1) for conformance to a decoding process specification, or as a reference for comparison with the behaviour of other decoders.

3.5
reference software encoder
particular *encoder* (3.3) provided as a software package for use as an example available for study, as a potential starting basis for the development of other encoders, or as a reference for comparison with the behaviour of other encoders.

3.6
V3C output unit
particular structure containing decoded and normalized V3C components that correspond to a specific composition time.

3.7
V-PCC reconstruction
particular recommendation of the reconstruction process to be tested for conformance to such a reconstruction process specification.

4   Abbreviated terms and acronyms

The relevant abbreviated terms and acronyms are specified in Clause 4 of ISO/IEC 23090-5:—.

5   Conventions

The relevant conventions are specified in Clause 5 of ISO/IEC 23090-5:—.

6   Conformance for ISO/IEC 23090-5

6.1   Introduction

The following clauses specify normative tests for verifying the conformance of V3C bitstreams as well as decoders. Those normative tests make use of test data (bitstream test suites) provided at https://standards.iso.org/iso-iec/23090/-20/ed-1/en/ and the reference software decoder specified in ISO/IEC 23090-5.

6.2   Bitstream conformance

The bitstream conformance is specified by Clause E.4 of ISO/IEC 23090-5:—.

6.3   Decoder conformance

The decoder conformance is specified by Clause E.5 of ISO/IEC 23090-5:—.

6.4   Reconstruction conformance

The reconstruction conformance of ISO/IEC 23090-5 is specified by Annex B and H.10, H.11, and H.12 according to the chosen reconstruction profile indicated in ISO/IEC 23090-5:—, H.15. The voxelized representation of the decoded point cloud shall be used for conformance testing. Therefore, the adaptation process specified in the ISO/IEC 23090-5:—, H.13 shall be ignored.

Decoders conforming to a V-PCC profile with a reconstruction profile component shall perform reconstruction operations required by this reconstruction profile component. Conformance is assessed at conformance point A, as shown in Figure 1, examining the decoded attribute, geometry, and occupancy bitstreams together with the decoded atlas and appropriate information that can associate the decoded patch metadata with the decoded video signal (e.g., patch to block map information). For conformance point A, conformance is exact.

Conformance is assessed at conformance point B, as shown in Figure 1, when the decoder selects to operate in a particular reconstruction profile. Associated reconstruction information to a specific reconstruction profile is provided as reference only. A conformant V-PCC decoder to a particular reconstruction profile may implement alternative processes that produce similar or better visual quality. The definition of similar or better visual quality is outside the scope of this document.

For conformance testing, post-decoding conversion of the decoded V3C video components to a nominal video format is performed.

The process specified in Annex B of ISO/IEC 23090-5 is recommended to be used for the decoded to the nominal video format conversion. The reconstruction process follows a specified order of operations for reconstruction conformance. It is suggested to follow the implementation in ISO/IEC 23090-19.

The process of synchronizing the V3C components is specified in Annex B of ISO/IEC 23090-5. An example containing a detailed description of the V3C component synchronization process can be found in Reference [1].

It is a recommendation of this document that the decoded V3C output units are stored in an intermediate buffer for reconstruction purposes. The decoded V3C output units may be placed into the intermediate buffer at the output time of the corresponding V3C output unit processing. The reconstruction process can start when all required V3C units are available for processing.
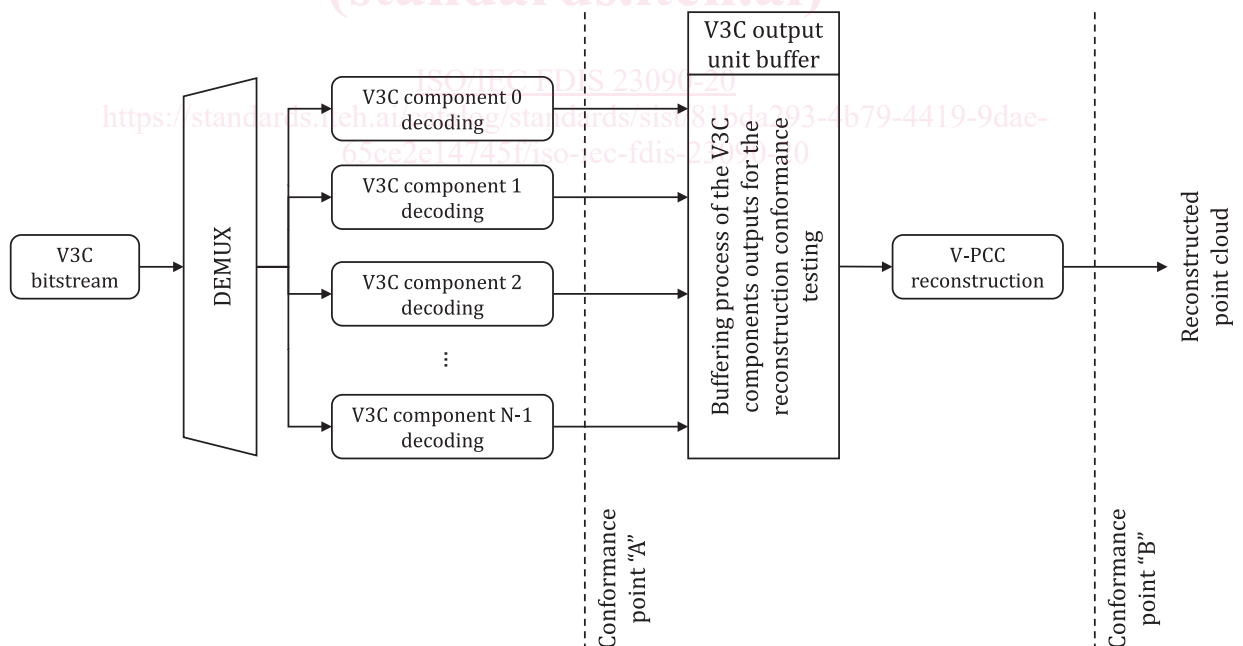
Figure 1 — V3C bitstream conformance evaluation for V-PCC content

6.5   Procedure to test bitstreams

A bitstream that claims conformance with ISO/IEC 23090-5 shall pass the following normative tests:

The bitstream shall be decoded by processing it with the reference software decoder. When processed by the reference software decoder, the bitstream shall not cause any error or non-conformance messages to be reported by the reference software decoder. This test should not be applied to

bitstreams that are known to contain errors introduced by transmission, as such errors are likely to result in bitstreams that lack conformance to ISO/IEC 23090-5. The decoding process is performed at best effort to decode atlas, occupancy, geometry, and attribute components of the V3C bitstream. It is a minimum requirement that the atlas component of the V3C bitstream is present for conformance testing.

Additional tests may be required to thoroughly check that the bitstream appropriately meets all the requirements specified in ISO/IEC 23090-5, including the hypothetical reference decoder (HRD) conformance (based on Annexes E, F, and G). These complementary tests may be performed using other point cloud bitstream verification solutions or decoders that perform additional tests compared to checks implemented by the reference software decoder.

ISO/IEC 23090-5 contains several informative recommendations that are not an integral part of that document. When testing a bitstream for conformance, it may also be helpful to test whether the bitstream follows those recommendations.

To check the correctness of a bitstream, it is necessary to parse the entire bitstream and extract all the syntax elements and other values derived from those syntax elements and used by the decoding process specified in ISO/IEC 23090-5.

The verification process shall not necessarily perform all stages of the decoding process specified in ISO/IEC 23090-5 to verify bitstream correctness. Some tests can be performed on syntax elements in a state before their use in corresponding processing stages.

6.6   Procedure to test decoder conformance

6.6.1   Conformance bitstreams

A bitstream has values of ptl_profile_codec_group_idc, ptl_profile_toolset_idc, ptl_profile_reconstruction_idc, and ptl_level_idc corresponding to a set of specified constraints on a bitstream for which a decoder conforming to a specified profile and level is required in Annex A of ISO/IEC 23090-5 to perform the decoding process properly.

6.6.2   Contents of the bitstream file

The conformance bitstreams available at https://standards.iso.org/iso-iec/23090/-20/ed-1/en/. The information indicated in Table 1 is included in a single zipped file for each such bitstream.

In cases where the decoded pictures or hashes of decoded pictures are not available, the reference software decoder shall be used to generate the necessary reference decoded pictures from the bitstream.

Table 1 — List of the files for conformance testing

Item	Extension	Description	Requirement
1	*.bin	coded bitstream	mandatory
2	*_dscr_bitstr.txt	a short description of the bitstream	mandatory
3	*.cfg	the configuration files used to generate bitstream with a software encoder provided in ISO/IEC 23090-20.	optional, if reference software is used.
4	*_bitstream_md5.txt	the MD5 checksum of the entire coded V3C bitstream file	mandatory
5	*_hls_md5.txt	the MD5 checksum of the HLS and SEI units, if present, of the coded V3C bitstream file	mandatory for HLS optional for SEI
6	*_picture_log.txt	Contains the logs for occupancy, geometry, and attribute components	optional
7	*_atlas_log.txt	output atlas log	optional*

Table 1 *(continued)*

Item	Extension	Description	Requirement
8	*_tile_log.txt	output tile log	optional*
9	*_pcframe_log.txt	output point cloud frame log before post-reconstruction	optional
10	*_rec_pcframe_log.txt	the output of post-reconstruction point cloud frame log	optional
11	*_dec_[frm_no].ply	A collection of decoded point cloud frames per indicated reconstruction profile containing the unordered reconstructed decoded point cloud frames.	optional

6.6.3 Requirements on the output of the decoding process, reconstruction process, and timing

The output of the decoding process is specified in Clauses 8, 9, and Annexes E, F, G, and H of ISO/IEC 23090-5:—. The output of the decoding process is used as the input of the reconstruction process and timing, as defined in Annex B of ISO/IEC 23090-5:—.

For output order conformance, it is a requirement that all the decoded V3C component frames (point cloud frames) specified for output in Annex E of ISO/IEC 23090-5:— shall be output by a conforming decoder in the specified order and that the values of the decoded samples in all the V3C component frames that are output shall be equal to the values specified in Clause 8 of ISO/IEC 23090-5:—.

For output timing conformance, it is a requirement that a conforming decoder shall also output the decoded samples at the rates specified in Annex E of ISO/IEC 23090-5:—.

For the reconstruction conformance, it is a requirement that all the decoded components are normalized to the nominal frame rate. An example is provided in Annex B of ISO/IEC 23090-5:—.

The visualization and display processes, which ordinarily follow the output of the reconstruction process, are outside the scope of this document.

6.6.4 Bitstream validation

The uploaded bitstreams should be validated, and the following aspects should be verified.

— Confirm that the decoded V3C components are identical at conformance point A,

— Confirm that all intended features are included in the bitstream.

The outputs for conformance point A, comprised of the V3C components representing a point cloud frame at a given time instance, are used as an input for the decoder reconstruction process that specifies soft conformance check for conformance point B.

6.6.5 Recommendations (informative)

This clause does not form an integral part of this document.

In addition to the requirements, conforming decoders should implement various informative recommendations specified in ISO/IEC 23090-5 that are not an integral part of that document. This clause lists some of these recommendations.

It is recommended that a conforming decoder can resume the decoding process as soon as possible after the loss or corruption of part of a bitstream. In most cases, it is possible to continue decoding at the following V3C tile unit header. It is recommended that a conforming decoder can perform concealment for the patches or V3C packets for which all the coded data of the V3C components has not been received.

6.7 Test bitstreams

6.7.1 General

The test bitstreams are part of the mechanism to verify decoder conformance according to ISO/IEC 23090-5.

The zipped log files are stored at https://standards.iso.org/iso-iec/23090/-20/ed-1/en/ for the V3C conformance bitstreams test.

Subclause 6.7.2 lists test bitstreams coded with basic toolset and reconstructed with Rec0 profiles, as indicated in Table 2 .

Table 2 — Basic toolset bitstreams list

No	Bitstream name	MD5 Sum for decoded bitstream (BITSTRMD5)
1	HEVCMain10_Basic_Rec0_STLINTRA_SONY	5fb-5d5e2434168c07330527f23e14095
2	HEVCMain10_Basic_Rec0_STLINTRA_MC1_INTERDIGITAL	0937d8615746da43ac-c0dee5fb927520
3	HEVCMain10_Basic_Rec0_STLINTRA_MC2_INTERDIGITAL	b16a41e5b11160b9a20efed-860a6253b
4	HEVCMain10_Basic_Rec0_MTLINTRA_tileT2M2P21MC1_INTER-DIGITAL	9989f3757815dab0459a2c3464275327
5	HEVCMain10_Basic_Rec0_MTLINTRA_tileT2M2P21MC2_INTER-DIGITAL	4d16e79e58750329e3a6462d-49d39df5
6	HEVCMain10_Basic_Rec0_MTLINTRA_tileT2M3P11MC1_INTER-DIGITAL	0e6e2f2742d49b-b1462976024a442b7b
7	HEVCMain10_Basic_Rec0_MTLINTRA_tileT2M3P11MC2_INTER-DIGITAL	b7ecfb5bd-c78476968331661918d1d42
8	HEVCMain10_Basic_Rec0_MTLINTRA_tileT2M3P21MC1_INTER-DIGITAL	9989f3757815dab0459a2c3464275327
9	HEVCMain10_Basic_Rec0_MTLINTRA_tileT2M3P21MC2_INTER-DIGITAL	4d16e79e58750329e3a6462d-49d39df5
10	HEVCMain10_Basic_Rec0_STLLRA_MC1_INTERDIGITAL	9955e89a55b-35832785f9630ed1655f5
11	HEVCMain10_Basic_Rec0_STLLRA_MC2_INTERDIGITAL	511e459e5797fb179285a79f04293fb6
12	HEVCMain10_Basic_Rec0_MTLLRA_tileT2M2P21MC1_INTERDIG-ITAL	5c91cd236b5ed9c-99d542a78c0691fdf
13	HEVCMain10_Basic_Rec0_MTLLRA_tileT2M2P21MC2_INTERDIG-ITAL	a17fbe41da9412a87174b0ae3f7ecfb5
14	HEVCMain10_Basic_Rec0_MTLLRA_tileT2M3P21MC1_INTERDIG-ITAL	5c91cd236b5ed9c-99d542a78c0691fdf
15	HEVCMain10_Basic_Rec0_MTLLRA_tileT2M3P21MC2_INTERDIG-ITAL	a17fbe41da9412a87174b0ae3f7ecfb5
16	MP4RA_Basic_Rec0_SEICCM_MC1_INTERDIGITAL	acf33444354598a11e2f-59c08e99e549
17	MP4RA_Basic_Rec0_SEICCM_MC2_INTERDIGITAL	49db25179023cab3c1d3802e75e-a24ed
18	HEVCMain10_Basic_Rec0_LOSSYOM_SAMSUNG_v1	39941d7b2c920f-86309305661b388aa5
19	HEVCMAIN10BASIC_MTL_1MAP_SS_basketball_player	ad92fdd94cb15e-b585099e1c3b280832