Recommendation ITU-T H.HEVC.1

Conformance specification for ITU-T H.HEVC high performance video coding

# 1 Scope

This Recommendation | International Standard[[1]](#footnote-1) specifies a set of tests and procedures designed to indicate whether encoders or decoders meet the normative requirements specified in ITU‑T H.HEVC | ISO/IEC 23008-2.

# 2 Normative references

## 2.1 General

The following Recommendations and International Standards contain provisions which, through reference in this text, constitute provisions of this Recommendation | International Standard. At the time of publication, the editions indicated were valid. All Recommendations and Standards are subject to revision, and parties to agreements based on this Recommendation | International Standard are encouraged to investigate the possibility of applying the most recent edition of the Recommendations and Standards listed below. Members of IEC and ISO maintain registers of currently valid International Standards. The Telecommunication Standardization Bureau of the ITU maintains a list of currently valid ITU-T Recommendations.

## 2.2 Identical Recommendations | International Standards

– None.

## 2.3 Paired Recommendations | International Standards equivalent in technical content

– ITU-T H.HEVC (in force), *High efficiency coding*.

ISO/IEC 23008-2: in force, *Information technology – High efficiency video coding and media delivery in heterogeneous environment – Part 2: High Efficiency Video Coding*.

– ITU-T H.HEVC.2 (in force), *Reference software for H.HEVC advanced video coding*.

ISO/IEC 14496-5: in force, *Information technology – Coding of audio-visual objects – Part 5: Reference software*.

## 2.4 Additional references

– None*.*

# 3 Definitions

For the purposes of this Recommendation | International Standard, the terms, definitions, abbreviations and symbols specified in ITU-T H.HEVC | ISO/IEC 23008-2 (particularly in clauses 3) apply. The following terms are further clarified for purposes herein as follows.

**3.1 bitstream**: An ITU-T H.HEVC | ISO/IEC 23008-2 video bitstream. A bitstream may contain I, P and B slices.

**3.2 decoder**: An ITU-T H.HEVC | ISO/IEC 23008-2 video decoder, i.e., an embodiment of the decoding process specified by ITU-T H.HEVC | ISO/IEC 23008-2. The decoder does not include the display process, which is outside the scope of this Recommendation | International Standard.

**3.3 reference software decoder**: The software decoder contained in ITU‑T H.HEVC.2 | ISO/IEC 14496‑5.

**3.4 TemporalIdMax**: Maximum value of temporal\_id in the NAL unit header extension for SVC of the coded slice NAL units or prefix NAL units of an ITU-T H.HEVC | ISO/IEC 23008-2 video bitstream.

# 4 Abbreviations and acronyms

For the purposes of this Recommendation | International Standard, relevant abbreviations and acronyms are specified in clause 4 of ITU-T H.HEVC | ISO/IEC 23008-2.

# 5 Conventions

For the purposes of this Recommendation | International Standard, relevant conventions are specified in clause 5 in ITU‑T H.HEVC | ISO/IEC 23008-2.

# 6 Conformance for ITU-T H.HEVC | ISO/IEC 23008-2

## 6.1 Introduction

The following clauses specify the normative tests for verifying conformance of video bitstreams as well as decoders. Those normative tests make use of test data (bitstream test suites) provided as an electronic annex to this Recommendation | International Standard and the reference software decoder with source code included in electronic format.

## 6.2 Bitstream conformance

The bitstream conformance of ITU-T H.HEVC | ISO/IEC 23008-2 is specified by clause C.4 of ITU‑T H.HEVC | ISO/IEC 23008-2.

## 6.3 Decoder conformance

The decoder conformance of ITU-T H.HEVC | ISO/IEC 23008-2 is specified by clause C.5 of ITU‑T H.HEVC | ISO/IEC 23008-2.

## 6.4 Procedure to test bitstreams

A bitstream that claims conformance with ITU‑T H.HEVC | ISO/IEC 23008-2 shall pass the following normative test:

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 highly likely to result in bitstreams that lack conformance to ITU-T H.HEVC | ISO/IEC 23008-2.

Successfully passing the reference software decoder test provides only a strong presumption that the bitstream under test is conforming to the video layer, i.e., that it does indeed meet all the requirements for the video layer (except Annexes C, D and E) specified in ITU-T H.HEVC | ISO/IEC 23008-2 that are tested by the reference software decoder.

Additional tests may be necessary to more thoroughly check that the bitstream properly meets all the requirements specified in ITU-T H.HEVC | ISO/IEC 23008-2 including the hypothetical reference decoder (HRD) conformance (based on Annexes C, D and E). These complementary tests may be performed using other video bitstream verifiers that perform more complete tests than those implemented by the reference software decoder.

ITU-T H.HEVC | ISO/IEC 23008-2 contains several informative recommendations that are not an integral part of that Recommendation | International Standard. When testing a bitstream for conformance, it may also be useful to test whether or not the bitstream follows those recommendations.

To check correctness of a bitstream, it is necessary to parse the entire bitstream and to extract all the syntax elements and other values derived from those syntactic elements and used by the decoding process specified in ITU‑T H.HEVC | ISO/IEC 23008-2.

A verifier may not necessarily perform all stages of the decoding process specified in ITU‑T H.HEVC | ISO/IEC 23008-2 in order to verify bitstream correctness. Many tests can be performed on syntax elements in a state prior to their use in some processing stages.

## 6.5 Procedure to test decoder conformance

### 6.5.1 Conformance bitstreams

A bitstream has values of general\_profile\_idc, general\_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 ITU-T H.HEVC | ISO/IEC 23008-2 to properly perform the decoding process.

### 6.5.2 Contents of the bitstream file

The conformance bitstreams are included in this Recommendation | International Standard as an electronic attachment. The following information is included in a single zipped file for each such bitstream.

– bitstream;

– decoded pictures or hashes of decoded pictures (may not be present);

– short description of the bitstream;

– trace file (the bitstream in ASCII format).

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.

### 6.5.3 Requirements on output of the decoding process and timing

Two classes of decoder conformance are specified:

– output order conformance; and

– output timing conformance.

The output of the decoding process is specified in clauses 8 and Annex C of ITU‑T H.HEVC | ISO/IEC 23008-2.

For output order conformance, it is a requirement that all of the decoded pictures specified for output in Annex C of ITU‑T H.HEVC | ISO/IEC 23008-2 shall be output by a conforming decoder in the specified order and that the values of the decoded samples in all of the pictures that are output shall be (exactly equal to) the values specified in clause 8 of ITU-T H.HEVC | ISO/IEC 23008-2.

For output timing conformance, it is a requirement that a conforming decoder shall also output the decoded samples at the rates and times specified in Annex C of ITU-T H.HEVC | ISO/IEC 23008-2.

The display process, which ordinarily follows the output of the decoding process, is outside the scope of this Recommendation | International Standard.

### 6.5.4 Recommendations (informative)

This clause does not form an integral part of this Recommendation | International Standard.

In addition to the requirements, it is desirable that conforming decoders implement various informative recommendations specified in ITU-T H.HEVC | ISO/IEC 23008-2 that are not an integral part of that Recommendation | International Standard. This clause lists some of these recommendations.

It is recommended that a conforming decoder be able to 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 resume decoding at the next start code or slice header. It is recommended that a conforming decoder be able to perform concealment for the macroblocks or video packets for which all the coded data has not been received.

### 6.5.5 Static tests for output order conformance

Static tests of a video decoder require testing of the decoded samples. This clause will explain how this test can be accomplished when the decoded samples at the output of the decoding process are available. It may not be possible to perform this type of test with a production decoder (due to the lack of an appropriate accessible interface in the design at which to perform the test). In that case this test should be performed by the manufacturer during the design and development phase. Static tests are used for testing the decoding process. The test will check that the values of the samples decoded by the decoder under test shall be identical to the values of the samples decoded by the reference decoder. When a hash of the values of the samples of the decoded pictures is attached to the bitstream file, a corresponding hash operation performed on the values of the samples of the decoded pictures produced by the decoder under test shall produce the same results.

### 6.5.6 Dynamic tests for output timing conformance

Dynamic tests are applied to check that all the decoded samples are output and that the timing of the output of the decoder's decoded samples conforms to the specification of clauses 8; and Annex C of ITU‑T H.HEVC | ISO/IEC 23008-2, and to verify that the HRD models (as specified by the CPB and DPB specification in Annex C of ITU-T H.HEVC | ISO/IEC 23008-2) are not violated when the bits are delivered at the proper rate.

The dynamic test is often easier to perform on a complete decoder system, which may include a systems decoder, a video decoder and a display process. It may be possible to record the output of the display process and to check that display order and timing of fields or frames are correct at the output of the display process. However, since the display process is not within the normative scope of ITU-T H.HEVC | ISO/IEC 23008-2, there may be cases where the output of the display process differs in timing or value even though the video decoder is conforming. In this case, the output of the video decoder itself (before the display process) would need to be captured in order to perform the dynamic tests on the video decoder. In particular the field or frame order and timing shall be correct.

If buffering period SEI and picture timing SEI are included in the test bitstream, HRD conformance shall be verified using the values of initial\_cpb\_removal\_delay, initial\_cpb\_removal\_delay\_offset, cpb\_removal\_delay and dpb\_removal\_delay that are included in the bitstream.

If buffering period SEI and picture timing SEI are not included in the bitstream, the following inferences shall be made to generate the missing parameters:

– fixed\_pic\_rate\_flag shall be inferred to be 1.

– low\_delay\_hrd\_flag shall be inferred to be 0.

– cbr\_flag shall be inferred to be 0.

– The frame rate of the bitstream shall be inferred to be the frame rate value specified in the corresponding table of clause 6.7, where the bitstream is listed. If this is missing, then a frame rate of either 25 or 30000 ÷ 1001 can be inferred.

– time\_scale shall be set to 90,000 and the value of num\_units\_in\_tick shall be computed based on field rate (twice the frame rate).

– The bit rate of the bitstream shall be inferred to be the maximum value for the level specified in Table A‑1 in ITU-T H.HEVC | ISO/IEC 23008-2.

– CPB and DPB sizes shall be inferred to be the maximum value for the level specified in Table A-1 in ITU‑T H.HEVC | ISO/IEC 23008-2.

With the above inferences, the HRD shall be operated as follows.

– The CPB is filled starting at time t = 0, until it is full, before removal of the first access unit. This means that the initial\_cpb\_removal\_delay shall be inferred to be equal to the total CPB buffer size divided by the bit rate divided by 90000 (rounded downwards) and initial\_cpb\_removal\_delay\_offset shall be inferred to be equal to zero.

– The first access unit is removed at time t = initial\_cpb\_removal\_delay ÷ 90000 and subsequent access units are removed at intervals based on the frame distance, i.e., 2 \* (90000 ÷ num\_units\_in\_tick) or the field distance, i.e., (90000 / num\_units\_in\_tick), depending on whether the access unit is coded as a frame picture or field picture.

– Using these inferences, the CPB will not overflow or underflow and the DPB will not overflow.

### 6.5.7 Decoder conformance test of a particular profile-and-level

In order for a decoder of a particular profile-and-level to claim output order conformance to ITU‑T H.HEVC | ISO/IEC 23008-2 as specified by this Recommendation | International Standard, the decoder shall successfully pass the static test specified in clause 6.5.5 with all the bitstreams of the normative test suite specified for testing decoders of this particular profile-and-level.

In order for a decoder of a particular profile and level to claim output timing conformance to ITU‑T H.HEVC | ISO/IEC 23008-2 as specified by this Recommendation | International Standard, the decoder shall successfully pass both the static test specified in clause 6.5.5 and the dynamic test specified in clause 6.5.6 with all the bitstreams of the normative test suite specified for testing decoders of this particular profile-and-level. Tables 1 through 5 specify the normative test suites for each profile-and-level combination. The test suite for a particular profile‑and level combination is the list of bitstreams that are marked with an 'X' in the column corresponding to that profile‑and‑level combination.

'X' indicates that the bitstream is designed to test both the dynamic and static conformance of the decoder.

The bitstream column specifies the bitstream used for each test.

A decoder that conforms to the Main profile at a specific level shall be capable of decoding the specified bitstreams in Tables 1.

## 6.6 Specification of the test bitstreams

Some characteristics of each bitstream listed in Tables 1 are specified in this clause. In Tables 1, the value "29.97" shall be interpreted as an approximation of an exact value of 30000 ÷ 1001 and the value "59.94" shall be interpreted as an approximation of an exact value of 60000 ÷ 1001.

### 6.6.1 Test bitstreams – General

#### 6.6.1.1

## Normative test suites for ITU‑T H.HEVC | ISO/IEC 23008-2

*Legend:*

X – Bitstream is for static and dynamic test

| Table 1 – Bitstreams for the Main profiles | | | | | | | | | |
| --- | --- | --- | --- | --- | --- | --- | --- | --- | --- |
| Categories | Bitstream | Donated by | File name |  |  |  | Main | Level | Frame rate (Frames/sec) |
| General | HEVCNL-1 |  |  |  |  |  | X | 1.2 and higher | 15 |

1. This Recommendation | International Standard includes an electronic attachment containing the conformance bitstreams identified within the text. The bitstreams can also be downloaded from the ITU-T Test Signal Database. [↑](#footnote-ref-1)