

I n t e r n a t i o n a l   T e l e c o m m u n i c a t i o n   U n i o n

# ITU-T

TELECOMMUNICATION  
STANDARDIZATION SECTOR  
OF ITU

# H.266.1

(04/2022)

SERIES H: AUDIOVISUAL AND MULTIMEDIA SYSTEMS  
Infrastructure of audiovisual services – Coding of moving  
video

---

## Conformance specification for ITU-T H.266 versatile video coding

Recommendation ITU-T H.266.1

ITU-T

ITU-T H-SERIES RECOMMENDATIONS  
AUDIOVISUAL AND MULTIMEDIA SYSTEMS

|                                                                                             |                    |
|---------------------------------------------------------------------------------------------|--------------------|
| CHARACTERISTICS OF VISUAL TELEPHONE SYSTEMS                                                 | H.100–H.199        |
| INFRASTRUCTURE OF AUDIOVISUAL SERVICES                                                      |                    |
| General                                                                                     | H.200–H.219        |
| Transmission multiplexing and synchronization                                               | H.220–H.229        |
| Systems aspects                                                                             | H.230–H.239        |
| Communication procedures                                                                    | H.240–H.259        |
| <b>Coding of moving video</b>                                                               | <b>H.260–H.279</b> |
| Related systems aspects                                                                     | H.280–H.299        |
| Systems and terminal equipment for audiovisual services                                     | H.300–H.349        |
| Directory services architecture for audiovisual and multimedia services                     | H.350–H.359        |
| Quality of service architecture for audiovisual and multimedia services                     | H.360–H.369        |
| Telepresence, immersive environments, virtual and extended reality                          | H.420–H.439        |
| Supplementary services for multimedia                                                       | H.450–H.499        |
| MOBILITY AND COLLABORATION PROCEDURES                                                       |                    |
| Overview of Mobility and Collaboration, definitions, protocols and procedures               | H.500–H.509        |
| Mobility for H-Series multimedia systems and services                                       | H.510–H.519        |
| Mobile multimedia collaboration applications and services                                   | H.520–H.529        |
| Security for mobile multimedia systems and services                                         | H.530–H.539        |
| Security for mobile multimedia collaboration applications and services                      | H.540–H.549        |
| VEHICULAR GATEWAYS AND INTELLIGENT TRANSPORTATION SYSTEMS (ITS)                             |                    |
| Architecture for vehicular gateways                                                         | H.550–H.559        |
| Vehicular gateway interfaces                                                                | H.560–H.569        |
| BROADBAND, TRIPLE-PLAY AND ADVANCED MULTIMEDIA SERVICES                                     |                    |
| Broadband multimedia services over VDSL                                                     | H.610–H.619        |
| Advanced multimedia services and applications                                               | H.620–H.629        |
| Content delivery and ubiquitous sensor network applications                                 | H.640–H.649        |
| IPTV MULTIMEDIA SERVICES AND APPLICATIONS FOR IPTV                                          |                    |
| General aspects                                                                             | H.700–H.719        |
| IPTV terminal devices                                                                       | H.720–H.729        |
| IPTV middleware                                                                             | H.730–H.739        |
| IPTV application event handling                                                             | H.740–H.749        |
| IPTV metadata                                                                               | H.750–H.759        |
| IPTV multimedia application frameworks                                                      | H.760–H.769        |
| IPTV service discovery up to consumption                                                    | H.770–H.779        |
| Digital Signage                                                                             | H.780–H.789        |
| E-HEALTH MULTIMEDIA SYSTEMS, SERVICES AND APPLICATIONS                                      |                    |
| Personal health systems                                                                     | H.810–H.819        |
| Interoperability compliance testing of personal health systems (HRN, PAN, LAN, TAN and WAN) | H.820–H.859        |
| Multimedia e-health data exchange services                                                  | H.860–H.869        |
| Safe listening                                                                              | H.870–H.879        |

*For further details, please refer to the list of ITU-T Recommendations.*

## Conformance specification for ITU-T H.266 versatile video coding

### Summary

Recommendation ITU-T H.266.1 V1 "Conformance specification for ITU-T H.266 versatile video coding" specifies tests for (non-exhaustive) testing to verify whether bitstreams and decoders meet the normative requirements specified in Rec. ITU-T H.266 | ISO/IEC 23090-3 Versatile video coding (VVC). The bitstreams provided with this document correspond to the 08/2020 (V1) edition of Rec. ITU-T H.266.

This Recommendation was developed collaboratively with ISO/IEC JTC 1, Information technology, Subcommittee SC 29, Coding of audio, picture, multimedia and hypermedia information, and corresponds with ISO/IEC 23090-15 as technically aligned twin text.

The conformance bitstreams needed for this Recommendation are available at:

<https://www.itu.int/net/itu-t/sigdb/spevideo/VideoForm-s.aspx?val=102002661>

NOTE – The link above will be replaced after approval with a link in the ITU-Test Signal Database.

### History

| Edition | Recommendation | Approval   | Study Group | Unique ID*                                                                |
|---------|----------------|------------|-------------|---------------------------------------------------------------------------|
| 1.0     | ITU-T H.266.1  | 2022-04-29 | 16          | <a href="http://handle.itu.int/11.1002/1000/14969">11.1002/1000/14969</a> |

---

\* To access the Recommendation, type the URL <http://handle.itu.int/> in the address field of your web browser, followed by the Recommendation's unique ID. For example, <http://handle.itu.int/11.1002/1000/11830-en>.

## FOREWORD

The International Telecommunication Union (ITU) is the United Nations specialized agency in the field of telecommunications, information and communication technologies (ICTs). The ITU Telecommunication Standardization Sector (ITU-T) is a permanent organ of ITU. ITU-T is responsible for studying technical, operating and tariff questions and issuing Recommendations on them with a view to standardizing telecommunications on a worldwide basis.

The World Telecommunication Standardization Assembly (WTSA), which meets every four years, establishes the topics for study by the ITU-T study groups which, in turn, produce Recommendations on these topics.

The approval of ITU-T Recommendations is covered by the procedure laid down in WTSA Resolution 1.

In some areas of information technology which fall within ITU-T's purview, the necessary standards are prepared on a collaborative basis with ISO and IEC.

## NOTE

In this Recommendation, the expression "Administration" is used for conciseness to indicate both a telecommunication administration and a recognized operating agency.

Compliance with this Recommendation is voluntary. However, the Recommendation may contain certain mandatory provisions (to ensure, e.g., interoperability or applicability) and compliance with the Recommendation is achieved when all of these mandatory provisions are met. The words "shall" or some other obligatory language such as "must" and the negative equivalents are used to express requirements. The use of such words does not suggest that compliance with the Recommendation is required of any party.

## INTELLECTUAL PROPERTY RIGHTS

ITU draws attention to the possibility that the practice or implementation of this Recommendation may involve the use of a claimed Intellectual Property Right. ITU takes no position concerning the evidence, validity or applicability of claimed Intellectual Property Rights, whether asserted by ITU members or others outside of the Recommendation development process.

As of the date of approval of this Recommendation, ITU had not received notice of intellectual property, protected by patents/software copyrights, which may be required to implement this Recommendation. However, implementers are cautioned that this may not represent the latest information and are therefore strongly urged to consult the appropriate ITU-T databases available via the ITU-T website at <http://www.itu.int/ITU-T/ipr/>.

© ITU 2022

All rights reserved. No part of this publication may be reproduced, by any means whatsoever, without the prior written permission of ITU.

# CONTENTS

|                                                                                                                        | <i>Page</i> |
|------------------------------------------------------------------------------------------------------------------------|-------------|
| 1 Scope .....                                                                                                          | 1           |
| 2 Normative references .....                                                                                           | 1           |
| 2.1 General.....                                                                                                       | 1           |
| 2.2 Identical Recommendations   International Standards .....                                                          | 1           |
| 2.3 Paired Recommendations   International Standards equivalent in technical content.....                              | 1           |
| 3 Definitions .....                                                                                                    | 1           |
| 4 Abbreviated terms .....                                                                                              | 1           |
| 5 Conventions .....                                                                                                    | 2           |
| 6 Conformance testing for ITU-T H.266   ISO/IEC 23090-3.....                                                           | 2           |
| 6.1 Introduction.....                                                                                                  | 2           |
| 6.2 Bitstream conformance.....                                                                                         | 2           |
| 6.3 Decoder conformance.....                                                                                           | 2           |
| 6.4 Procedure to test bitstreams .....                                                                                 | 2           |
| 6.5 Procedure to test decoder conformance.....                                                                         | 3           |
| 6.5.1 Conformance bitstreams .....                                                                                     | 3           |
| 6.5.2 Contents of the bitstream file .....                                                                             | 3           |
| 6.5.3 Requirements on output of the decoding process and timing .....                                                  | 3           |
| 6.5.4 Static tests for output order conformance .....                                                                  | 4           |
| 6.5.5 Dynamic tests for output timing conformance.....                                                                 | 4           |
| 6.5.6 Decoder conformance test for a particular profile, tier, and level.....                                          | 5           |
| 6.6 Specification of the test bitstreams.....                                                                          | 5           |
| 6.6.1 General .....                                                                                                    | 5           |
| 6.6.2 Test bitstreams – Coding tools for Main 10 profile with 4:2:0 chroma format and 10 bit depth.....                | 5           |
| 6.6.3 Test bitstreams – High-level syntax features for Main 10 profile with 4:2:0 chroma format and 10 bit depth ..... | 29          |
| 6.6.4 Test bitstreams – Additional chroma formats and bit depths for Main 10 profile .....                             | 40          |
| 6.6.5 Test bitstreams – Coding tools for Main 10 4:4:4 profile for 4:4:4 chroma format and 10 bit depth.....           | 41          |
| 6.6.6 Test bitstreams – Additional chroma formats and bit depths for Main 10 4:4:4 profile .....                       | 44          |
| 6.6.7 Test bitstreams – Multilayer Main 10 profile.....                                                                | 47          |
| 6.6.8 Test bitstreams – Multilayer Main 10 4:4:4 profile.....                                                          | 49          |
| 6.6.9 Test bitstreams – Main 10 Still Picture profile .....                                                            | 49          |
| 6.6.10 Test bitstreams – Main 10 4:4:4 Still Picture profile.....                                                      | 49          |
| 6.7 Conformance test suites for Rec. ITU-T H.266   ISO/IEC 23090-3 .....                                               | 50          |
| 6.7.1 Bitstreams for Main 10 profile .....                                                                             | 50          |
| 6.7.2 Bitstreams for Main 10 4:4:4 profile .....                                                                       | 54          |
| 6.7.3 Bitstreams for Multilayer Main 10 profile.....                                                                   | 55          |
| 6.7.4 Bitstreams for Multilayer Main 10 4:4:4 profile .....                                                            | 55          |
| 6.7.5 Bitstreams for Main 10 Still Picture profile.....                                                                | 55          |
| 6.7.6 Bitstreams for Main 10 4:4:4 Still Picture profile .....                                                         | 55          |



## Conformance specification for ITU-T H.266 versatile video coding

### 1 Scope

This Recommendation | International Standard<sup>1</sup> specifies a set of tests and procedures designed to indicate whether encoders or decoders meet the normative requirements specified in Rec. ITU-T H.266 | ISO/IEC 23090-3.

### 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

- Recommendation ITU-T H.266 (in force), *Versatile video coding*.  
ISO/IEC 23090-3:in force, *Information technology – Coded representation of immersive media– Part 3: Versatile video coding*.
- Recommendation ITU-T H.266.2 (in force), *Reference software for ITU-T H.266 Versatile video coding*.  
ISO/IEC 23090-16:in force, *Information technology – Coded representation of immersive media – Part 16: Reference software for versatile video coding*.

### 3 Definitions

For the purposes of this Recommendation | International Standard, the terms, definitions, abbreviations and symbols specified in Rec. ITU-T H.266 | ISO/IEC 23090-3 (particularly in clause 3) apply. The following terms are further clarified for purposes herein:

- 3.1 bitstream:** A Rec. ITU-T H.266 | ISO/IEC 23090-3 video bitstream.
- 3.2 decoder:** A Rec. ITU-T H.266 | ISO/IEC 23090-3 video decoder, i.e., an embodiment of the decoding process specified by Rec. ITU-T H.266 | ISO/IEC 23090-3. The decoder does not include the display process, which is outside the scope of this Recommendation | International Standard.
- 3.3 encoder:** An embodiment of a process, not specified in this Recommendation | International Standard (except in regard to identification of the reference software encoder), that produces a bitstream.
- 3.4 reference software decoder:** The software decoder provided in Rec. ITU-T H.266.2 | ISO/IEC 23090-16.
- 3.5 reference software encoder:** The software encoder provided in Rec. ITU-T H.266.2 | ISO/IEC 23090-16.

### 4 Abbreviations

For the purposes of this Recommendation | International Standard, relevant abbreviations and acronyms specified in clause 4 of Rec. ITU-T H.266 | ISO/IEC 23090-3 and the following abbreviations apply.

|      |                                   |
|------|-----------------------------------|
| AMVP | Adaptive Motion Vector Prediction |
| CCLM | Cross-Component Linear Model      |

---

<sup>1</sup> This Recommendation | International Standard includes an electronic attachment containing the conformance bitstreams identified within the text. The conformance bitstreams needed for this Recommendation are available in the the ITU-T Test Signal Database at the following link: <https://www.itu.int/net/itu-t/sigdb/spevideo/VideoForm-s.aspx?val=102002661/>

|        |                                                   |
|--------|---------------------------------------------------|
| CIIP   | Combined Inter/Intra Prediction                   |
| CST    | Chroma Separate Tree                              |
| CTC    | Common Test Conditions                            |
| DCT    | Discrete Cosine Transform                         |
| DMVR   | Decoder-side Motion Vector Refinement             |
| DQ     | Dependent Quantization                            |
| DST    | Discrete Sine Transform                           |
| FTP    | File Transfer Protocol                            |
| ISP    | Intra Subblock Partitioning                       |
| JCCR   | Joint Coding of Chroma Residuals                  |
| MMVD   | Merge with MVD                                    |
| MPM    | Most Probable Mode                                |
| MRL    | Multiple Reference Line                           |
| MVD    | Motion Vector Difference                          |
| NUT    | NAL Unit Type                                     |
| PDPC   | Position-Dependent (intra) Prediction Combination |
| PERP   | Padded Equirectangular Projection                 |
| RPR    | Reference Picture Resampling                      |
| SAD    | Sum of Absolute Differences                       |
| SBT    | Subblock Transform                                |
| SbTMVP | Subblock based Temporal Motion Vector Prediction  |
| SCC    | Screen Content Coding                             |
| SMVD   | Symmetric MVD                                     |
| TMVP   | Temporal Motion Vector Prediction                 |

## 5 Conventions

For the purposes of this Recommendation | International Standard, relevant conventions are specified in clause 5 of Rec. ITU-T H.266 | ISO/IEC 23090-3.

## 6 Conformance testing for ITU-T H.266 | ISO/IEC 23090-3

### 6.1 Introduction

The following clauses specify normative tests for verifying conformance of video bitstreams as well as decoders. These normative tests make use of the reference software decoder specified in Rec. ITU-T H.266.2 | ISO/IEC 23090-16, and the normative tests for decoder conformance also make use of test data (bitstream test suites) provided as an electronic annex to this Recommendation | International Standard.

### 6.2 Bitstream conformance

Bitstream conformance for Rec. ITU-T H.266 | ISO/IEC 23090-3 is specified by clause C.4 of Rec. ITU-T H.266 | ISO/IEC 23090-3.

### 6.3 Decoder conformance

Decoder conformance for Rec. ITU-T H.266 | ISO/IEC 23090-3 is specified by clause C.5 of Rec. ITU-T H.266 | ISO/IEC 23090-3.

### 6.4 Procedure to test bitstreams

A bitstream that is claimed to conform to Rec. ITU-T H.266 | ISO/IEC 23090-3 shall pass the following normative test. 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 Rec. ITU-T H.266 | ISO/IEC 23090-3.

The bitstream under test 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. When the bitstream under test contains decoded picture hash SEI messages, the hash values signalled in the decoded picture hash SEI messages in the bitstream shall match those calculated by the reference software decoder.

Successfully passing this test provides only a strong presumption that the bitstream under test does indeed meet all the requirements specified in Rec. ITU-T H.266 | ISO/IEC 23090-3 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 Rec. ITU-T H.266 | ISO/IEC 23090-3, including hypothetical reference decoder (HRD) conformance (based on Annexes C and D). Such complementary tests may be performed using other video bitstream verifiers that perform more complete tests than those implemented by the reference software decoder.

Rec. ITU-T H.266 | ISO/IEC 23090-3 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 the 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 Rec. ITU-T H.266 | ISO/IEC 23090-3.

A bitstream verifier may not necessarily perform all stages of the decoding process specified in Rec. ITU-T H.266 | ISO/IEC 23090-3 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 that conforms to Rec. ITU-T H.266 | ISO/IEC 23090-3 has values of `general_profile_idc`, `general_tier_flag`, and `general_level_idc` corresponding to a set of specified constraints on a bitstream for which a decoder conforming to a corresponding specified profile, tier, and level is required in Annex A of Rec. ITU-T H.266 | ISO/IEC 23090-3 to properly perform the decoding process.

### **6.5.2 Contents of the bitstream file**

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

- \*.bit – bitstream (provided for all bitstreams)
- \*.txt – description (provided for all bitstreams)
- \*.yuv.md5 – MD5 checksum of the complete decoded yuv file (provided for all bitstreams)
- \*.md5 – MD5 checksum of the bitstream file (provided for all bitstreams)
- \*.opl – output picture log (provided for all bitstreams)
- \*.cfg – config file used to generate bitstream with VTM encoder software (not provided for all bitstreams, not applicable if a VTM encoder release version was not used)

### **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 clause 8 and Annex C of Rec. ITU-T H.266 | ISO/IEC 23090-3.

For output order conformance, it is a requirement that all of the cropped decoded pictures specified for output in Annex C of Rec. ITU-T H.266 | ISO/IEC 23090-3 shall be output by a conforming decoder in the specified order and that the values of the decoded samples of the cropped decoded pictures that are output shall be (exactly equal to) the values specified in clause 8 of Rec. ITU-T H.266 | ISO/IEC 23090-3.

For output timing conformance, it is a requirement that a conforming decoder shall also output the cropped decoded pictures at the picture rates and times specified in Annex C of Rec. ITU-T H.266 | ISO/IEC 23090-3.

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

#### 6.5.4 Static tests for output order conformance

Static tests of a video decoder require testing of the samples of the cropped decoded pictures that are output from the decoder, and 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 such a 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 pictures that are output by the decoder under test are checked to ensure that the following requirements are fulfilled:

- The cropped decoded pictures that are output by the decoder under test shall correspond to those that are output by the reference software decoder.
- The cropped decoded pictures that are output by the decoder under test shall be output in the same order as those that are output by the reference software decoder.
- The values of the samples of the cropped decoded pictures that are output by the decoder under test shall be identical to those that are output by the reference software decoder.

To assist with the checking of the decoding process and the cropped decoded pictures, hash values for the cropped decoded pictures that are output by conforming decoders are provided in a corresponding output picture log file for each test bitstream that is used in the specified conformance tests, and most of these test bitstreams also contain decoded picture hash SEI messages that may be used for checking the results of the decoding process of the decoder under test.

#### 6.5.5 Dynamic tests for output timing conformance

Dynamic tests are applied to check that all the decoded samples of the cropped decoded pictures are output and that the timing of the output of the decoder's decoded samples conforms to the specifications of clause 8 and Annex C of Rec. ITU-T H.266 | ISO/IEC 23090-3, and to verify that the decoder under test can operate according to bitstream flow characteristics prescribed by the specified HRD models (as specified by the CPB and DPB specification in Annex C of Rec. ITU-T H.266 | ISO/IEC 23090-3) when the bits of the bitstream are delivered at the proper rate.

The dynamic test is often easier to perform on a complete decoding 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 the cropped decoded pictures are correct at the output of the display process. However, since the display process is not within the normative scope of Rec. ITU-T H.266 | ISO/IEC 23090-3, 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 output order and timing of the output of the cropped decoded pictures shall be correct.

If buffering period and picture timing SEI messages are included in the test bitstream, HRD conformance shall be verified using the values of `nal_initial_cpb_removal_delay`, `nal_initial_cpb_removal_offset`, `au_cpb_removal_delay_minus1` and `pic_dpb_output_delay` that are included in the bitstream.

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

- `fixed_pic_rate_general_flag[ i ]` shall be inferred to be equal to 1.
- `low_delay_hrd_flag[ i ]` shall be inferred to be equal to 0.
- `cbr_flag[ subLayerId ][ j ]` shall be inferred to be equal to 0.
- The frame rate of the bitstream shall be inferred to be equal to the frame rate value specified in the .txt file for the bitstream. If this is missing, then a frame rate of either 25 or  $30000 \div 1001$  can be inferred.
- The bit rate of the bitstream shall be inferred to be equal to the maximum value for the level specified in Rec. ITU-T H.266 | ISO/IEC 23090-3.
- CPB and DPB sizes shall be inferred to be equal to the maximum value for the level specified in Rec. ITU-T H.266 | ISO/IEC 23090-3.

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 `bp_nal_initial_cpb_removal_delay[ i ][ j ]` shall be inferred to be equal to the total CPB buffer size divided by the bit rate divided by 90000 (rounded downwards) and `bp_vcl_initial_cpb_removal_offset[ i ][ j ]` shall be inferred to be equal to zero.

- The first access unit is removed at time  $t = \text{bp\_nal\_initial\_cpb\_removal\_delay}[i][j] \div 90000$  and subsequent access units are removed at intervals based on the picture distance
- Using these inferences with the accompanying bitstreams, the CPB will not overflow or underflow and the DPB will not overflow.

### 6.5.6 Decoder conformance test for a particular profile, tier, and level

In order for a decoder for a particular profile, tier, and level to claim output order conformance to Rec. ITU-T H.266 | ISO/IEC 23090-3, the decoder shall successfully pass the static test specified in clause 6.5.4 with all the bitstreams of the normative test suite specified for testing decoders of this particular profile, tier, and level combination.

In order for a decoder of a particular profile, tier, and level to claim output timing conformance to Rec. ITU-T H.266 | ISO/IEC 23090-3, the decoder shall successfully pass both the static test specified in clause 6.5.4 and the dynamic test specified in clause 6.5.5 with all the bitstreams of the normative test suite specified for testing decoders of this particular profile, tier, and level.

Tables 1 through 10 specify the normative test suites. The profile, tier, and level combinations are described in the tables or in the .txt file associated with the bitstream.

## 6.6 Specification of the test bitstreams

### 6.6.1 General

Some characteristics of each bitstream listed in Table 1 are specified in this clause.

### 6.6.2 Test bitstreams – Coding tools for Main 10 profile with 4:2:0 chroma format and 10 bit depth

#### 6.6.2.1 Chroma separate tree (CST)

##### 6.6.2.1.1 Test bitstream CST\_A\_MediaTek

**Specification:** All pictures are coded in I slices with CST enabled. CST is tested with all possible luma and chroma block sizes, and luma-chroma block size combinations (e.g., luma block size is larger than, equal to, or smaller than the corresponding chroma block size).

**Functional stage:** Reconstruction process.

**Purpose:** Check that the decoder can properly decode slices with CST enabled.

#### 6.6.2.2 Dependent quantization (DQ)

##### 6.6.2.2.1 Test bitstream DQ\_A\_HHI

**Specification:** The bitstream consists of three CVSs, with the following properties:

- The first CVS uses dependent quantization for all pictures, all non-related features (inter tools, ALF, ...) are disabled, and MTS and LFNST are disabled.
- The second CVS uses dependent quantization for all pictures, all non-related features (inter tools, ALF, ...) are disabled, and MTS (for intra) and LFNST are enabled.
- The third CVS exercises a picture-level selection between dependent quantization, sign data hiding, and standard quantization, all non-related features (inter tools, ALF, ...) are disabled, and MTS (for intra) and LFNST are enabled.

**Functional stage:** Dependent quantization.

**Purpose:** Check that the decoder can properly decode slices with DQ enabled.

##### 6.6.2.2.2 Test bitstream DQ\_B\_HHI

**Specification:** The bitstream consists of three CVSs of resolution 1920 x 1080, with the following properties:

- The first CVS uses dependent quantization for all pictures, all non-related features (inter tools, ALF, ...) are disabled, and MTS and LFNST are disabled.
- The second CVS uses dependent quantization for all pictures, all non-related features (inter tools, ALF, ...) are disabled, and MTS (for intra) and LFNST are enabled.

- The third CVS exercises a picture-level selection between dependent quantization, sign data hiding, and standard quantization, all non-related features (inter tools, ALF, ...) are disabled, and MTS (for intra) and LFNST are enabled.

**Functional stage:** Dependent quantization.

**Purpose:** Check that the decoder can properly decode slices with DQ enabled.

### 6.6.2.3 Cross-component linear model (CCLM)

#### 6.6.2.3.1 Test bitstream CCLM\_A\_KDDI

**Specification:** The bitstream exercises corner cases for coding structures using CCLM with the following properties:

- POC0: Chroma CU size is 64x64.
- POC1: First split of CU is horizontal, i.e., CU size is 64x32.
- POC2: First split of CU is quad, i.e., CU size is 32x32.
- POC3: First and second split of CU are horizontal and vertical, respectively.
- POC4: First split of CU is vertical or ternary, i.e., none of condition is satisfied for CCLM.
- POC5: CU size is 64x64 and ISP is enabled.
- POC6: First luma split is something else than quad.

**Functional stage:** Intra prediction.

**Purpose:** Check that the decoder can properly decode slices with CCLM enabled.

### 6.6.2.4 Multiple transform set (MTS)

#### 6.6.2.4.1 Test bitstream MTS\_A\_LGE

**Specification:** The bitstream exercises the following transform features:

- 1st part
  - Explicit intra MTS on and explicit inter MTS off with low frequency non-separable transform (LFNST) disabled.
  - Include all test cases for ISP, MIP, luma tree, and CST.
  - Include all candidates of explicit MTS, i.e., DCT2-DCT2, DST7-DST7, DCT8-DST7, DST7-DCT8, and DCT8-DCT8.
  - Include all possible block sizes and partitions where all MTS combinations can happen.
- 2nd part
  - Implicit MTS on and explicit inter MTS off with LFNST disabled.
  - Include all test cases for ISP, MIP, luma tree, and CST.
  - Include all possible block sizes and partitions (especially for ISP) for all allowable MTS combinations.

**Functional stage:** Transform.

**Purpose:** Check that the decoder can properly decode slices with MTS enabled.

#### 6.6.2.4.2 Test bitstream MTS\_B\_LGE

**Specification:** The bitstream exercises the following transform features:

- 1st part
  - Explicit intra MTS on and explicit inter MTS off with LFNST disabled.
  - Include all test cases for SBT, single tree and TU-tiling based on maximum transform size (64).
  - Include all candidates of explicit MTS, i.e., DCT2-DCT2, DST7-DST7, DCT8-DST7, DST7-DCT8, and DCT8-DCT8.
  - Include all possible block sizes and partitions (especially for SBT) where all MTS combinations can happen.
- 2nd part
  - Implicit intra MTS on and explicit inter MTS off with LFNST disabled.

- Include all test cases for SBT, single tree, and TU-tiling based on maximum transform size (64).
- Include all possible block sizes and partitions (especially for SBT) where all MTS combinations can happen.
- 3rd part
  - Implicit MTS on and explicit inter MTS off with LFNST disabled.
  - Include all test cases for SBT and single tree.
  - Include all possible block sizes and partitions (especially for SBT) where all MTS combinations can happen.
- 4th part
  - Explicit intra MTS on and explicit inter MTS on with LFNST disabled.
  - Include all test cases for SBT and single tree.
  - Include all possible block sizes and partitions (especially for SBT) where all MTS combinations can happen.

**Functional stage:** Transform.

**Purpose:** Check that the decoder can properly decode slices with MTS enabled.

### 6.6.2.5 Adaptive loop filter (ALF)

#### 6.6.2.5.1 Test bitstream ALF\_A\_Huawei

**Specification:** This bitstream uses both ALF and virtual boundary, as follows:

- Applies ALF virtual boundary (VB) at non-CTC CTU sizes (CTU size of 64 is used).
- Positions luma VB at 4 lines (Pos : 60) and chroma VB at 2 lines (Pos : 62) above the CTU height.

**Functional stage:** Adaptive loop filter.

**Purpose:** Check that the decoder can properly decode slices with ALF enabled.

#### 6.6.2.5.2 Test bitstream ALF\_B\_Huawei

**Specification:** This bitstream uses both ALF and virtual boundary, as follows:

- Applies ALF virtual boundary (VB) to sequences whose picture height is 1 CTU (CTU size of 128 is used as per CTC).
- Positions luma VB at 4 lines (Pos : 124) and chroma VB at 2 lines (Pos : 62) above the CTU height.

**Functional stage:** Adaptive loop filter.

**Purpose:** Check that the decoder can properly decode slices with ALF enabled.

#### 6.6.2.5.3 Test bitstream ALF\_C\_KDDI

**Specification:** Bitstream exercises clipping values of non-linear ALF.

**Functional stage:** Adaptive loop filter.

**Purpose:** Check that the decoder can properly decode slices with ALF enabled.

#### 6.6.2.5.4 Test bitstream ALF\_D\_Qualcomm

**Specification:** Bitstream uses multiple ALF APSs with LMCS enabled.

**Functional stage:** Adaptive loop filter.

**Purpose:** Check that the decoder can properly decode slices with ALF enabled.

### 6.6.2.6 Affine motion model (AFF)

#### 6.6.2.6.1 Test bitstream AFF\_A\_HUAWEI

**Specification:** The bitstream enables 6-parameter affine mode by SPS flag. All allowed blocks sizes of Affine merge mode are exercised multiple times. All allowed blocks sizes of Affine AMVP mode, including 4-parameter and 6-parameter Affine mode, are exercised multiple times. All allowed candidates for Affine merge mode, including two

inherited candidates, four 6-parameter constructed candidates, two 4-parameter constructed candidates, and zero padding candidate are exercised multiple times. Inheritance of affine model from top CTU are exercised multiple times. Fallback mode for affine memory bandwidth restriction is triggered multiple times.

**Functional stage:** Affine mode inter prediction.

**Purpose:** Check that the decoder can properly decode slices with affine mode enabled.

#### 6.6.2.6.2 Test bitstream *AFF\_B\_HUAWEI*

**Specification:** The bitstream uses affine mode, with 6-parameter affine mode disabled by SPS flag. All allowed blocks sizes of Affine merge mode are exercised multiple times. All allowed blocks sizes of 4-parameter Affine AMVP mode are exercised multiple times. All allowed candidates for Affine merge mode, including two inherited candidates, two 4-parameter constructed candidates, and zero padding candidate are exercised multiple times. Inheritance of affine model from top CTU are exercised multiple times. Fallback mode for affine memory bandwidth restriction is triggered multiple times. All allowed blocks sizes of Affine merge mode are exercised multiple times. All allowed blocks sizes of 4-parameter Affine AMVP mode are exercised multiple times. All allowed candidates for Affine merge mode, including two inherited candidates, two 4-parameter constructed candidates, and zero padding candidate are exercised multiple times. Inheritance of affine model from top CTU are exercised multiple times. Fallback mode for affine memory bandwidth restriction is triggered multiple times.

**Functional stage:** Affine mode inter prediction.

**Purpose:** Check that the decoder can properly decode slices with affine mode enabled.

#### 6.6.2.7 Subblock-based temporal merging candidates (SbTMVP)

##### 6.6.2.7.1 Test bitstream *SbTMVP\_A\_Bytedance*

**Specification:** The bitstream uses SbTMVP when affine is disabled.

**Functional stage:** Inter prediction process.

**Purpose:** Check that the decoder can properly decode PUs with SbTMVP on and affine off.

##### 6.6.2.7.2 Test bitstream *SbTMVP\_B\_Bytedance*

**Specification:** This bitstream disables SbTMVP.

**Functional stage:** Inter prediction process.

**Purpose:** Check that the decoder can properly decode PUs with SbTMVP off.

#### 6.6.2.8 Adaptive motion vector resolution (AMVR)

##### 6.6.2.8.1 Test bitstream *AMVR\_A\_HHI*

**Specification:** The bitstream exercises translational and affine AMVR with different settings. It represents a concatenation of five CVSs with the following properties:

- The first CVS exercises translational AMVR with *amvr\_precision\_idx* equal to 1 (i.e., 1 luma sample motion vector resolution).
- The second CVS exercises translational AMVR with *amvr\_precision\_idx* equal to 2 (i.e., 4 luma samples motion vector resolution).
- The third CVS exercises translational AMVR with *amvr\_precision\_idx* equal to 0 (i.e., 1/2 luma sample motion vector resolution). This implies application of the Switchable Interpolation Filter (SIF).
- The fourth CVS exercises affine AMVR with *amvr\_precision\_idx* equal to 0 (i.e., 1/16 luma sample motion vector resolution).
- The fifth CVS exercises affine AMVR with *amvr\_precision\_idx* equal to 1 (i.e., 1 luma sample motion vector resolution).

**Functional stage:** Inter prediction.

**Purpose:** Check that the decoder can properly decode bitstreams with AMVR enabled.

#### 6.6.2.8.2 Test bitstream AMVR\_B\_HHI

**Specification:** The bitstream exercises AMVR. It cycles frame-by-frame between the following variants:

- Translational AMVR with `amvr_precision_idx` equal to 1 (i.e., 1 luma sample motion vector resolution).
- Translational AMVR with `amvr_precision_idx` equal to 2 (i.e., 4 luma samples motion vector resolution).
- Translational AMVR with `amvr_precision_idx` equal to 0 (i.e., 1/2 luma sample motion vector resolution), this implies application of the Switchable Interpolation Filter (SIF).
- Affine AMVR with `amvr_precision_idx` equal to 0 (i.e., 1/16 luma sample motion vector resolution).
- Affine AMVR with `amvr_precision_idx` equal to 1 (i.e., 1 luma sample motion vector resolution).

**Functional stage:** Inter prediction.

**Purpose:** Check that the decoder can properly decode bitstreams with AMVR enabled.

#### 6.6.2.9 Bi-directional optical flow (BDOF)

##### 6.6.2.9.1 Test bitstream BDOF\_A\_MediaTek

**Specification:** Bitstream exercises all possible implicit BDOF on/off conditions and subblock usages.

**Functional stage:** Inter prediction process.

**Purpose:** Check that the decoder can properly decode CUs with BDOF enabled.

#### 6.6.2.10 Combined intra/inter prediction (CIIP)

##### 6.6.2.10.1 Test bitstream CIIP\_A\_MediaTek

**Specification:** The bitstream exercises all possible inter direction, block sizes, and combining weights for CIIP.

**Functional stage:** Inter prediction process.

**Purpose:** Check that the decoder can properly decode CUs with CIIP enabled.

#### 6.6.2.11 Merge with MVD (MMVD)

##### 6.6.2.11.1 Test bitstream MMVD\_A\_SAMSUNG

**Specification:** The bitstream uses MMVD with different numbers of MMVD distance entries.

**Functional stage:** Inter prediction process.

**Purpose:** Check that the decoder can properly decode bitstreams with merge with MMVD enabled.

#### 6.6.2.12 Bi-predictive with CU weights (BCW)

##### 6.6.2.12.1 Test bitstream BCW\_A\_MediaTek

**Specification:** The bitstream exercises all possible combining weights for BCW.

**Functional stage:** Inter prediction process.

**Purpose:** Check that the decoder can properly decode CUs with BCW enabled.

#### 6.6.2.13 Multi-reference line prediction (MRLP)

##### 6.6.2.13.1 Test bitstream MRLP\_A\_HHI

**Specification:** The bitstream contains all possible combinations of extended intra reference lines for luma indicated by `intra_luma_ref_idx` = {1, 2} and most probable modes except the DC, indicated by `intra_luma_mpm_idx` = {0, 1, 2, 3, 4}. For the CUs at the top border of a CTU, extended references lines are not used in the MRL index is not present in the bitstream. All CTC tools are enabled.

**Functional stage:** Intra prediction and mode signalling processes.

**Purpose:** Test all combinations of reference line indices and associated MPM signalling with all tools on.

#### 6.6.2.13.2 *Test bitstream MRLP\_B\_HHI*

**Specification:** The bitstream contains all possible combinations of extended intra reference lines for luma indicated by  $\text{intra\_luma\_ref\_idx} = \{1, 2\}$  and most probable modes except the DC, indicated by  $\text{intra\_luma\_mpm\_idx} = \{0, 1, 2, 3, 4\}$ . For the CUs at the top border of a CTU, extended references lines are not used in the MRL index is not present in the bitstream. The following prediction modes have been disabled: Intra: ISP and MIP, Inter: SBT, MMVD, Affine, SubPuMvp, IMV, BCW, BIO, CIIP, GPM, DisFracMMVD, AffineAmvr, DMVR, SMVD, and PROF.

**Functional stage:** Intra prediction and mode signalling processes.

**Purpose:** Test all combinations of reference line indices and associated MPM signalling with specific intra and inter tools turned off.

#### 6.6.2.14 **Intra block copy mode (IBC)**

##### 6.6.2.14.1 *Test bitstream IBC\_A\_Tencent*

**Specification:** This bitstream exercises general IBC features, merge, skip and AMVP modes.

**Functional stage:** Intra prediction.

**Purpose:** Check that the decoder can properly decode bitstreams with IBC enabled.

##### 6.6.2.14.2 *Test bitstream IBC\_B\_Tencent*

**Specification:** This bitstream exercises general IBC features, merge, skip and AMVP modes, with BV predictor size equal to 1 ( $\text{MaxNumIBCMergeCand}=1$ ).

**Functional stage:** Intra prediction.

**Purpose:** Check that the decoder can properly decode bitstreams with IBC enabled.

##### 6.6.2.14.3 *Test bitstream IBC\_C\_Tencent*

**Specification:** This bitstream exercises general IBC features, merge, skip and AMVP modes, with Dual Tree disabled ( $\text{DualTree}=0$ ).

**Functional stage:** Intra prediction.

**Purpose:** Check that the decoder can properly decode bitstreams with IBC enabled.

##### 6.6.2.14.4 *Test bitstream IBC\_D\_Tencent*

**Specification:** This bitstream exercises general IBC features, merge, skip and AMVP modes, with AMVR disabled.

**Functional stage:** Intra prediction.

**Purpose:** Check that the decoder can properly decode bitstreams with IBC enabled.

##### 6.6.2.14.5 *Test bitstream IBC\_E\_Tencent*

**Specification:** This bitstream exercises general IBC blocks with all possible block sizes.

**Functional stage:** Intra prediction.

**Purpose:** Check that the decoder can properly decode bitstreams with IBC enabled.

#### 6.6.2.15 **Intra sub-partitioning (ISP)**

##### 6.6.2.15.1 *Test bitstream ISP\_A\_HHI*

**Specification:** The bitstream contains various combinations of block sizes, ISP split types, intra modes and LFNST indices. It uses an AI configuration and 34 frames with QP 28.

**Functional stage:** Intra prediction.

**Purpose:** Check that the decoder can properly decode bitstreams with ISP enabled.

#### 6.6.2.15.2 *Test bitstream ISP\_B\_HHI*

**Specification:** The bitstream contains various combinations of block sizes, ISP split types, intra modes and LFNST indices. It uses a RA configuration and 161 frames with QP 34.

**Functional stage:** Intra prediction.

**Purpose:** Check that the decoder can properly decode bitstreams with ISP enabled.

#### 6.6.2.16 **Decoder motion vector refinement (DMVR)**

##### 6.6.2.16.1 *Test bitstream DMVR\_A\_Huawei*

**Specification:** This bitstream exercises DMVR with the following features:

- All allowed blocks sizes of DMVR are exercised multiple times.
- Motion vector wraparound is enabled where DMVR uses wrapped around reference samples.
- BCW and explicit weighted biprediction is turned on for luma and chroma components, to test disabling of DMVR.
- All integer delta motion vector combinations are exercised multiple times.
- All fractional delta MV are exercised multiple times.

**Functional stage:** Inter prediction.

**Purpose:** Check that the decoder can properly decode bitstreams with DMVR enabled.

##### 6.6.2.16.2 *Test bitstream DMVR\_B\_KDDI*

**Specification:** This bitstream exercises DMVR with corner cases of SAD variations.

**Functional stage:** Inter prediction process.

**Purpose:** Check that the decoder can properly decode bitstreams with DMVR enabled.

#### 6.6.2.17 **Sub-block transform (SBT)**

##### 6.6.2.17.1 *Test bitstream SBT\_A\_Huawei*

**Specification:** The bitstream exercises SVT with all allowed blocks sizes exercised multiple times (at least once for each SBT mode for each allowed CU size).

**Functional stage:** Transform process.

**Purpose:** Check that the decoder can properly decode bitstreams with DMVR enabled.

#### 6.6.2.18 **Luma mapping with chroma scaling (LMCS)**

##### 6.6.2.18.1 *Test bitstream LMCS\_A\_Dolby*

**Specification:** This bitstream tests control of LMCS at the slice level, with the picture split into 4 tiles and 4 rectangular slices.

**Functional stage:** In-loop filter process.

**Purpose:** Check that the decoder can properly decode bitstreams with LMCS enabled.

##### 6.6.2.18.2 *Test bitstream LMCS\_B\_Dolby*

**Specification:** This bitstream tests control of LMCS at the slice level, with the picture split into 8 rectangular slices, 12 tiles and 2 subpictures.

**Functional stage:** In-loop filter.

**Purpose:** Check that the decoder can properly decode bitstreams with LMCS enabled.

##### 6.6.2.18.3 *Test bitstream LMCS\_C\_Dolby*

**Specification:** This bitstream tests control of LMCS for the entire CVS according to NoLmcsConstraintFlag.

**Functional stage:** In-loop filter.

**Purpose:** Check that the decoder can properly decode bitstreams with LMCS enabled.

#### 6.6.2.19 Sign data hiding (SDH)

##### 6.6.2.19.1 Test bitstream SDH\_A\_Dolby

**Specification:** This bitstream tests SDH on/off control at picture level.

**Functional stage:** In-loop filter.

**Purpose:** Check that the decoder can properly decode bitstreams with LMCS enabled.

#### 6.6.2.20 Symmetric motion vector difference (SMVD)

##### 6.6.2.20.1 Test bitstream SMVD\_A\_HUAWEI

**Specification:** This bitstream exercises all allowed blocks sizes of SMVD mode multiple times.

**Functional stage:** Inter prediction.

**Purpose:** Check that the decoder can properly decode bitstreams with SMVD enabled.

#### 6.6.2.21 Block-based delta pulse code modulation (BDPCM)

##### 6.6.2.21.1 Test bitstream BDPCM\_A\_Orange

**Specification:** This bitstream exercises BDPCM-coded block of each possible block size, in both luma and chroma.

**Functional stage:** Intra coding.

**Purpose:** Check that the decoder can properly decode bitstreams with BDPCM enabled.

#### 6.6.2.22 Matrix based intra prediction (MIP)

##### 6.6.2.22.1 Test bitstream MIP\_A\_HHI

**Specification:** This bitstream exercises MIP in different combinations with other tools. The bitstream consists of three CVSs with the following properties:

- First CVS: For each M, N in {4, 8, 16, 32, 64}, the bitstream contains an MxN-luma-intra-block in which the intra-prediction signal is generated by a mip-mode and in which `intra_mip_transposed_flag` is false and it contains an MxN-luma-intra-block in which the intra-prediction signal is generated by a mip-mode and in which `intra_mip_transposed_flag` is true. For each mip-matrix occurring in the spec, the bitstream contains a luma-intra-block in which the intra-prediction signal is generated by a mip-mode that uses this mip-matrix.
- Second CVS: MIP is enabled, MTS and intra tools LFNST, ISP, MRL are disabled. Each slice is an intra slice.
- Third CVS: MIP is enabled, all other intra tools are enabled. Each slice is an intra slice.

**Functional stage:** Intra coding.

**Purpose:** Check that the decoder can properly decode bitstreams with MIP enabled.

##### 6.6.2.22.2 Test bitstream MIP\_B\_HHI

**Specification:** This bitstream exercises MIP with all other CTC tools enabled.

**Functional stage:** Intra coding.

**Purpose:** Check that the decoder can properly decode bitstreams with MIP enabled.

#### 6.6.2.23 Low frequency non-separable transform (LFNST)

##### 6.6.2.23.1 Test bitstream LFNST\_A\_LGE

**Specification:** This bitstream exercises LFNST with MTS disabled, as follows:

- Include all test cases for ISP, MIP, luma tree, and CST with LFNST.
- Include all sets and candidates of LFNST, i.e., 4 sets and 2 candidates per set.
- Include all possible block sizes and partitions (especially for ISP) where LFNST can be applied.

**Functional stage:** Transform.

**Purpose:** Check that the decoder can properly decode bitstreams with LFNST enabled.

#### 6.6.2.23.2 *Test bitstream LFNST\_B\_LGE*

**Specification:** This bitstream exercises LFNST with MTS disabled, as follows:

- Include all test cases for single tree with LFNST.
- Include all sets and candidates of LFNST, i.e., 4 sets and 2 candidates per set.
- Include all possible block sizes where LFNST can be applied.

**Functional stage:** Transform.

**Purpose:** Check that the decoder can properly decode bitstreams with LFNST enabled.

#### 6.6.2.23.3 *Test bitstream LFNST\_C\_HHI*

**Specification:** This bitstream exercises LFNST and its signalling in different combination with other tools. The bitstream consists of four CVSs with the following properties:

- The first CVS enables LFNST and explicit MTS; ISP and MIP are enabled.
- The second CVS enables LFNST and explicit MTS; ISP and MIP are disabled.
- The third CVS enables LFNST and explicit MTS; ISP is enabled and MIP is disabled.
- The fourth CVS enables LFNST and explicit MTS; ISP is disabled and MIP is enabled.

**Functional stage:** Transform.

**Purpose:** Check that the decoder can properly decode bitstreams with LFNST enabled.

#### 6.6.2.23.4 *Test bitstream LFNST\_D\_HHI*

**Specification:** This bitstream exercises LFNST and its signalling in different combination with other tools. The bitstream consists of four CVSs with the following properties:

- The first CVS enables LFNST and explicit MTS; ISP and MIP are enabled.
- The second CVS enables LFNST and explicit MTS; ISP and MIP are disabled.
- The third CVS enables LFNST and explicit MTS; ISP is enabled and MIP is disabled.
- The fourth CVS enables LFNST and explicit MTS; ISP is disabled and MIP is enabled.

**Functional stage:** Transform.

**Purpose:** Check that the decoder can properly decode bitstreams with LFNST enabled.

### 6.6.2.24 Transform tool set (MTS\_LFNST)

#### 6.6.2.24.1 *Test bitstream MTS\_LFNST\_A\_LGE*

**Specification:** This bitstream exercises various types of enabling of MTS and LFNST. The bitstream consists of five parts with the following properties:

- 1st part
  - Explicit intra MTS on and explicit inter MTS off (CTC).
  - Include all test cases for ISP, MIP, luma tree, and CST.
  - Include all candidates of explicit MTS, i.e., DCT2-DCT2, DST7-DST7, DCT8-DST7, DST7-DCT8, and DCT8-DCT8.
  - Include all sets and candidates of LFNST, i.e., 4 sets and 2 candidates per set.
  - Include all possible block sizes and partitions (especially for ISP) where all combinations of MTS and LFNST can happen.

- 2nd part
  - Explicit intra MTS on and explicit inter MTS off with maximum transform size set to 32.
  - Include all test cases for ISP, MIP, luma tree, CST, and TU-tiling based on maximum transform size (32).
  - Include all candidates of explicit MTS, i.e., DCT2-DCT2, DST7-DST7, DCT8-DST7, DST7-DCT8, and DCT8-DCT8.
  - Include all sets and candidates of LFNST, i.e., 4 sets and 2 candidates per set.
  - Include all possible block sizes and partitions (especially for ISP) where all combinations of MTS and LFNST can happen.
- 3rd part
  - Implicit MTS on and explicit inter MTS off.
  - Include all test cases for ISP, MIP, luma tree, and CST.
  - Include all candidates of explicit MTS, i.e., DCT2-DCT2, DST7-DST7, DCT8-DST7, DST7-DCT8, and DCT8-DCT8.
  - Include all sets and candidates of LFNST, i.e., 4 sets and 2 candidates per set.
  - Include all possible block sizes and partitions (especially for ISP) where all combinations of MTS and LFNST can happen.
- 4th part
  - Implicit MTS on and explicit inter MTS on.
  - Include all test cases for ISP, MIP, luma tree, and CST.
  - Include all candidates of explicit MTS, i.e., DCT2-DCT2, DST7-DST7, DCT8-DST7, DST7-DCT8, and DCT8-DCT8.
  - Include all sets and candidates of LFNST, i.e., 4 sets and 2 candidates per set.
  - Include all possible block sizes and partitions (especially for ISP) where all combinations of MTS and LFNST can happen.
- 5th part
  - Explicit MTS on and explicit inter MTS on.
  - Include all test cases for ISP, MIP, luma tree, and CST.
  - Include all candidates of explicit MTS, i.e., DCT2-DCT2, DST7-DST7, DCT8-DST7, DST7-DCT8, and DCT8-DCT8.
  - Include all sets and candidates of LFNST, i.e., 4 sets and 2 candidates per set.
  - Include all possible block sizes and partitions (especially for ISP) where all combinations of MTS and LFNST can happen.

**Functional stage:** Transform.

**Purpose:** Check that the decoder can properly decode bitstreams with MTS and LFNST enabled.

#### 6.6.2.4.2 *Test bitstream MTS\_LFNST\_B\_LGE*

**Specification:** This bitstream exercises various types of enabling of MTS and LFNST. The bitstream consists of five parts with the following properties:

- 1st part
  - Explicit intra MTS on and explicit inter MTS off (CTC).
  - Include all test cases for SBT, single tree, and TU-tiling based on maximum transform size (64).
  - Include all candidates of explicit MTS, i.e., DCT2-DCT2, DST7-DST7, DCT8-DST7, DST7-DCT8, and DCT8-DCT8.
  - Include all sets and candidates of LFNST, i.e., 4 sets and 2 candidates per set.
  - Include all possible block sizes and partitions (especially for SBT) where all combinations of MTS and LFNST can happen.
- 2nd part
  - Explicit intra MTS on and explicit inter MTS off with maximum transform size set to 32.