

FINAL  
DRAFT

INTERNATIONAL  
STANDARD

ISO/IEC  
FDIS  
23003-7

ISO/IEC JTC 1/SC 29

Secretariat: JISC

Voting begins on:  
2021-11-15

Voting terminates on:  
2021-01-10

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## Information technology — MPEG audio technologies —

### Part 7: Unified speech and audio coding conformance testing

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Published in Switzerland

# Contents

	Page
Foreword.....	iv
<b>1 Scope.....</b>	<b>1</b>
<b>2 Normative references.....</b>	<b>1</b>
<b>3 Terms and definitions.....</b>	<b>1</b>
<b>4 Conformance testing.....</b>	<b>1</b>
4.1 General.....	1
4.2 USAC conformance testing.....	1
4.2.1 Profiles.....	1
4.2.2 Conformance tools and test procedure.....	2
4.3 USAC bitstreams.....	5
4.3.1 General.....	5
4.3.2 USAC configuration.....	5
4.3.3 Framework.....	8
4.3.4 Frequency domain coding (FD mode).....	9
4.3.5 Linear predictive domain coding (LPD mode).....	11
4.3.6 Common core coding tools.....	13
4.3.7 Enhanced spectral band replication (eSBR).....	13
4.3.8 eSBR – Predictive vector coding (PVC).....	15
4.3.9 eSBR – Inter temporal envelope shaping (inter-TES).....	16
4.3.10 MPEG Surround 2-1-2.....	16
4.3.11 Configuration Extensions.....	18
4.3.12 AudioPreRoll.....	18
4.3.13 DRC.....	19
4.3.14 Restrictions depending on profiles and levels.....	19
4.4 USAC decoders.....	21
4.4.1 General.....	21
4.4.2 FD core mode tests.....	21
4.4.3 LPD core mode tests.....	28
4.4.4 Combined core coding tests.....	33
4.4.5 eSBR Tests.....	34
4.4.6 MPEG Surround 212 Tests.....	42
4.4.7 Bitstream extensions.....	45
4.5 Decoder settings.....	47
4.5.1 General.....	47
4.5.2 Target loudness [Lou-<x>].....	47
4.5.3 DRC effect type request [Eff-<x>].....	48
4.6 Decoding of MPEG-4 file format parameters to support exact time alignment in file-to-file coding.....	48

## Foreword

ISO (the International Organization for Standardization) and IEC (the International Electrotechnical Commission) form the specialized system for worldwide standardization. National bodies that are members of ISO or IEC participate in the development of International Standards through technical committees established by the respective organization to deal with particular fields of technical activity. ISO and IEC technical committees collaborate in fields of mutual interest. Other international organizations, governmental and non-governmental, in liaison with ISO and IEC, also take part in the work.

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For an explanation of the voluntary nature of standards, the meaning of ISO specific terms and expressions related to conformity assessment, as well as information about ISO's adherence to the World Trade Organization (WTO) principles in the Technical Barriers to Trade (TBT) see [www.iso.org/iso/foreword.html](http://www.iso.org/iso/foreword.html). In the IEC, see [www.iec.ch/understanding-standards](http://www.iec.ch/understanding-standards).

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/IEC 23003 series can be found on the ISO and IEC websites.

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# Information technology — MPEG audio technologies —

## Part 7: Unified speech and audio coding conformance testing

### 1 Scope

This document specifies conformance criteria for both bitstreams and decoders compliant with the MPEG-D Unified speech and audio coding standard as defined in ISO/IEC 23003-3. This is done to assist implementers and to ensure interoperability.

### 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 23003-3:2020, *Information technology — MPEG audio technologies — Part 3: Unified speech and audio coding*

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### 3 Terms and definitions

No terms and definitions are listed in this document.

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/>

### 4 Conformance testing

#### 4.1 General

This clause specifies conformance criteria for both bitstreams and decoders compliant with the USAC standard as defined in this document. This is done to assist implementers and to ensure interoperability.

#### 4.2 USAC conformance testing

##### 4.2.1 Profiles

Profiles are defined in ISO/IEC 23003-3:2020, Subclause 4.5. Some conformance criteria apply to USAC in general, while others are specific to certain profiles and their respective levels. Conformance shall be tested for the level of the profile with which a given bitstream or decoder claims to comply.

In addition to the conformance requirements described in this clause, a decoder, which claims to comply with the Extended HE AAC Profile, shall fulfil conformance for the HE AAC v2 profile according to ISO/IEC 14496-26.

## 4.2.2 Conformance tools and test procedure

### 4.2.2.1 General

To test USAC compliant audio decoders, this document provides a number of conformance test sequences. Supplied sequences cover all profiles as defined in ISO/IEC 23003-3:2020, Subclause 4.5. For a given test sequence, testing can be performed by comparing the output of a decoder under test with a reference waveform. For some test sequences, the decoder requires additional input parameters, so-called decoder settings, which are defined in 4.5. In cases where the decoder under test is followed by additional operations (e.g. quantizing a signal to a 16 bit output signal) the conformance point is prior to such additional operations, i.e. it is permitted to use the actual decoder output (e.g. with more than 16 bit) for conformance testing.

Measurements are carried out relative to full scale where the output signals of the decoders are normalized to be in the range between -1,0 and +1,0.

In ISO/IEC 14496-26, a set of test methods is defined to test the output of the decoder under test against the reference output. RMS/LSB Measurement, Segmental SNR and PNS conformance criteria are used for the comparison. A particular test method for a certain test sequence is specified in 4.5.

For elements producing output that cannot be tested with the methods described in ISO/IEC 14496-26 specific conformance testing procedures are described in 4.5.

### 4.2.2.2 Conformance data

All test sequences and a worksheet (“Usac\_Conformance\_Tables.xlsx”) that lists all test sequences for each module are accessible at <https://standards.iso.org/iso-iec/23003/-7/ed-1/en>.

NOTE All conformance test sequences for ISO/IEC 23003-3 are accessible using this link. All previous electronic attachments to this document (and its Amendments) are replaced by those at this link.

For all conformance test sequences, the file names are composed of several parts, which convey information about:

- which module of the decoder is tested;
- which channelConfigurationIndex is employed;
- which test conditions apply to the test sequence;
- which coreSbrFrameLengthIndex applies to the test sequence;
- which sampling frequency is signalled in the test sequence.

The file naming convention given in Table 1 shall be used.

**Table 1 — File name conventions**

Module	File	File name
Frequency domain coding (FD mode), 4.3.4	compressed mp4	Fd_<cCI>_c<cSFLI>_<testCase>_<uSFI>.mp4
	reference wav	Fd_<cCI>_c<cSFLI>_<testCase>_<uSFI>.wav
Linear predictive domain coding (LPD mode), 4.3.5	compressed mp4	Lpd_<cCI>_c<cSFLI>_<testCase>_<uSFI>.mp4
	reference wav	Lpd_<cCI>_c<cSFLI>_<testCase>_<uSFI>.wav
Combined core coding tools, 4.3.6	compressed mp4	Cct_<cCI>_c<cSFLI>_<testCase>_<uSFI>.mp4
	reference wav	Cct_<cCI>_c<cSFLI>_<testCase>_<uSFI>.wav
Enhanced spectral band replication (eSBR), 4.3.7	compressed mp4	eSbr_<cCI>_c<cSFLI>_<testCase>_<uSFI>.mp4
	reference wav	eSbr_<cCI>_c<cSFLI>_<testCase>_<uSFI>.wav

Table 1 (continued)

Module	File	File name
MPEG Surround 2-1-2, <a href="#">4.3.10</a>	compressed mp4	Mps_<cCI>_c<cSFLI>_fr<bsFR>_Sc<sCI>_<testCase>_<uSFI>.mp4
	reference wav	Mps_<cCI>_c<cSFLI>_fr<bsFR>_Sc<sCI>_<testCase>_<uSFI>.wav
Bitstream Extensions	compressed mp4	Ext_<cCI>_c<cSFLI>_<testCase>_<uSFI>.mp4
	reference wav	Ext_<cCI>_c<cSFLI>_<testCase>_<uSFI>_<decoderSetting>.wav

- <cCI>** channelConfigurationIndex as described in ISO/IEC 23003-3:2020, Table 73.
- <testCase>** Setup string. May consist of a concatenation of one or more abbreviations as listed in [Table 2](#). If no setup, string is specified the basic test conditions apply. If no testCase is added, only one single underline character shall occur at that position.
- <cSFLI>** coreSbrFrameLengthIndex as described in .
- <uSFI>** usacSamplingFrequencyIndex as described in ISO/IEC 23003-3:2020, Table 75. If the sampling rate is specified explicitly and signalled by means of the escape value index the sampling rate value in Hz is placed in the file name instead of the index value, e.g. "Lpd\_1\_c1\_Bpf\_6000.mp4" for a sampling frequency of 6000 Hz.
- <bsFR>** bsFreqRes as described in ISO/IEC 23003-1:2007, Table 39.
- <sCI>** stereoConfigIndex as described in ISO/IEC 23003-3:2020, Table 77.
- <decoderSetting>** Setup string. May consist of a concatenation of one or more abbreviations as listed in [Table 3](#). If no decoderSetting is added, no underline character shall occur after <uSFI>.

Table 2 — Test conditions and abbreviations

Module	Test condition	Abbrev.
FD core mode	FD window switching test condition	Win
	Noise filling test condition	Nf
	Temporal Noise Shaping (TNS) test condition	Tns
	Varying max_sfb test condition	Sfb
	Handling of extensions condition	Ex
	Context adaptive arithmetic coder test condition	Ac
	Non-meaningful FD window switching test condition	Nmf
	M/S stereo test condition	Ms
	Complex prediction stereo test condition	Cp
LPD core mode	Linear predictive coding (LPC) test condition	Lpc
	Algebraic code excited linear prediction (ACELP) core mode test condition	Ace
	Transform coded excitation (TCX) and noise filling test condition	Tcx
	LPD mode coverage and FAC test condition	Lpd
	Bass-post filter test condition	Bpf
	Algebraic vector quantizer (AVQ) test condition	Avq

**Table 2 (continued)**

Module	Test condition	Abbrev.
Combined core coding	FD-LPD transition and FAC test condition	Flt
	FD/TCX noise filling test condition	Cnf
	Bass-post filter test condition	Cbf
	synchr. FD-LPD transition and FAC test condition	Flts
	asynchr. FD-LPD transition and FAC test condition	Flta
	Context adaptive arithmetic coder test condition	CAC
eSbr	Quadrature mirror filter (QMF) accuracy test condition	Qma
	Envelope adjuster accuracy and SBR preprocessing test condition	Eaa
	Header and grid control test condition test condition	Hgt
	Inverse filtering test condition	Ift
	Additional sine test (missing harmonics) test condition	Ast
	Sampling rate test condition	Sr
	Channel mode test condition	Cm
	interTes test condition	Tes
	Predictive vector coding (PVC) test condition	Pvc
	Harmonic transposition (QMF) test condition	Htq
	Harmonic transposition (crossproducts) test condition	Xp
	Transposer toggle test condition	Ttt
	Envelope shaping toggle (PVC on/off) test condition	Est
	Varying crossover frequency test condition	Xo
	stereoConfigIndex test condition	Mps
Mpeg surround 212	Transient steering decorrelator (TSD) test condition	Tsd
	Rate mode test condition	Rm
	Phase coding test condition	Pc
	Decorrelator configuration. test condition	Dc
	Downmix (DMX) gain test condition	Dm
	Bands phase test condition	Bp<X>
	Pseudo lr test condition	Plr
	Residual bands test condition	Rb<X>
	Temporal Shaping Enabling test condition	Tse<X>
	Smoothing mode test condition	Smg
Bitstream extensions	AudioPreRoll() and streamID condition, immediate play-out frame (IPF)	I-foo-<x>
	Loudness normalization test condition	Ln
	Dynamic range control test condition	Drc<x>

**Table 3 — Decoder setting conditions**

Decoder setting	Abbrev.
Target loudness	Lou-<x>
DRC effect type request	Eff-<x>



## 4.3 USAC bitstreams

### 4.3.1 General

#### 4.3.1.1 Characteristics

Characteristics of bitstreams specify the constraints that are applied by the encoder in generating the bitstreams. These syntactic and semantic constraints may for example restrict the range or the values of parameters that are encoded directly or indirectly in the bitstreams. The constraints applied to a given bitstreams may or may not be known a priori.

#### 4.3.1.2 Test procedure

Each USAC bitstream shall meet the syntactic and semantic requirements specified in this document. The present subclause defines the conformance criteria that shall be fulfilled by a compliant bitstream. These criteria are specified for the syntactic elements of the bitstream and for some parameters decoded from the USAC bitstream payload.

For each tool, a set of semantic tests to be performed on the bitstreams is described. To verify whether the syntax is correct is straightforward and therefore not defined herein after. In the description of the semantic tests, it is assumed that the tested bitstreams contains no errors due to transmission or other causes. For each test the condition or conditions that shall be satisfied are given, as well as the prerequisites or conditions in which the test can be applied.

### 4.3.2 USAC configuration

#### 4.3.2.1 Characteristics

Encoders may apply restrictions to the following parameters of the bitstream:

- a) usacSamplingFrequencyIndex;
- b) usacSamplingFrequency;
- c) coreSbrFrameLengthIndex;
- d) channelConfigurationIndex;
- e) presence of configuration extensions;
- f) numOutChannels;
- g) bsOutputChannelPos;
- h) numElements;
- i) stereoConfigIndex;
- j) use of time warped MDCT;
- k) use of noise filling in FD mode;
- l) use of the eSBR harmonic transposer;
- m) use of the eSBR inter-TES tool;
- n) use of the eSBR PVC tool;
- o) SBR default header, for details see [4.3.7](#);
- p) MPS config, for details see [4.3.10](#).

#### 4.3.2.2 Test procedure

##### 4.3.2.2.1 UsacConfig()

<b>usacSamplingFrequencyIndex</b>	Shall be encoded with a non-reserved value specified in ISO/IEC 23003-3:2020, Table 72. For further profile and level dependent restrictions see <a href="#">4.3.11</a> .
<b>usacSamplingFrequency</b>	No restrictions apply. For profile and level dependent restrictions, see <a href="#">4.3.11</a> .
<b>coreSbrFrameLengthIndex</b>	No restrictions apply.
<b>channelConfigurationIndex</b>	Shall be encoded with a non-reserved value specified in ISO/IEC 23003-3:2020, Table 73. For further profile and level dependent restrictions see <a href="#">4.3.11</a> . In the case of channelConfigurationIndex == 0 further restrictions apply as described in <a href="#">4.3.2.2.2</a> .
<b>usacConfigExtensionPresent</b>	No restrictions apply.

##### 4.3.2.2.2 UsacChannelConfig()

<b>numOutChannels</b>	No restrictions apply. For profile and level dependent restrictions, see <a href="#">4.3.11</a> .
<b>bsOutputChannelPos</b>	A bsOutputChannelPos of value 3 or 26 (LFE speaker positions) shall be associated with an LFE channel. Any other value shall be associated with a main audio channel.

##### 4.3.2.2.3 UsacDecoderConfig()

<b>numElements</b>	The value of this data element shall be such that the accumulated sum of all channels contained in the bitstream complies with the restrictions outlined in <a href="#">4.3.2.2.1</a> .
<b>usacElementType</b>	No restrictions apply. For profile and level dependent restrictions, see <a href="#">4.3.11</a> .

##### 4.3.2.2.4 UsacSingleChannelElementConfig()

No restrictions are applicable to this bitstream element.

##### 4.3.2.2.5 UsacChannelPairElementConfig()

The UsacChannelPairElementConfig() element and all included elements can only be present when coding more than one output channel (see restrictions applying to UsacConfig() in [4.3.2.2.1](#)).

<b>stereoConfigIndex</b>	No restrictions apply.
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##### 4.3.2.2.6 UsacLfeElementConfig()

No restrictions are applicable to this bitstream element.

##### 4.3.2.2.7 UsacCoreConfig()

<b>tw_mdct</b>	No restrictions apply. For profile and level dependent restrictions, see <a href="#">4.3.11</a> .
<b>noiseFilling</b>	No restrictions apply.

**4.3.2.2.8 SbrConfig()**

<b>harmonicSBR</b>	No restrictions apply.
<b>bs_interTes</b>	No restrictions apply.
<b>bs_pvc</b>	No restrictions apply.

**4.3.2.2.9 SbrDfltHeader()**

<b>dflt_start_freq</b>	No restrictions apply.
<b>dflt_stop_freq</b>	No restrictions apply.
<b>dflt_header_extra1</b>	No restrictions apply.
<b>dflt_header_extra2</b>	No restrictions apply.
<b>dflt_freq_scale</b>	No restrictions apply.
<b>dflt_alter_scale</b>	No restrictions apply.
<b>dftl_nose_bands</b>	No restrictions apply.
<b>dflt_limiter_bands</b>	No restrictions apply.
<b>dflt_limiter_gains</b>	No restrictions apply.

**dflt\_interpol\_freq**

No restrictions apply.

**dflt\_smoothing\_mode**

No restrictions apply.

**4.3.2.2.10 Mps212Config()**

<b>bsFreqRes</b>	Shall not be encoded with a value of 0.
<b>bsFixedGainDMX</b>	No restrictions apply.
<b>bsTempShapeConfig</b>	No restrictions apply.
<b>bsDecorrConfig</b>	Shall not be encoded with a value of 3.
<b>bsHighRateMode</b>	No restrictions apply.
<b>bsPhaseCoding</b>	No restrictions apply.
<b>bsOttBandsPhasePresent</b>	No restrictions apply.
<b>bsOttBandsPhase</b>	Shall not be encoded with a value larger than the value of numBands as given by ISO/IEC 23003-1:2007, 5.2, Table 39 and depends on bsFreqRes.
<b>bsResidualBands</b>	Shall not be encoded with a value larger than the value of numBands as given by ISO/IEC 23003-1:2007, 5.2, Table 39 and depends on bsFreqRes.
<b>bsPseudoLr</b>	No restrictions apply.
<b>bsEnvQuantMode</b>	Shall be 0.

**4.3.2.2.11 UsacExtElementConfig()**

<b>usacExtElementType</b>	No restrictions apply.
<b>usacExtElementConfigLength</b>	No restrictions apply.
<b>usacExtElementDefaultLengthPresent</b>	No restrictions apply.
<b>usacExtElementDefaultLength</b>	No restrictions apply.
<b>usacExtElementPayloadFrag</b>	No restrictions apply.

#### 4.3.2.2.12 UsacConfigExtension()

<b>numConfigExtensions</b>	No restrictions apply.
<b>usacConfigExtType[]</b>	No restrictions apply.
<b>usacConfigExtLength[]</b>	No restrictions apply.
<b>fill_byte</b>	Should be '10100101'.

### 4.3.3 Framework

#### 4.3.3.1 Characteristics

Encoders may apply restrictions to the following parameters of the bitstream:

- signalling of independently decodable frames;
- presence of extension elements;
- core\_mode;
- presence of TNS.

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#### 4.3.3.2 Test procedure

##### 4.3.3.2.1 UsacFrame()

<b>usacIndependencyFlag</b>	No restrictions apply.
-----------------------------	------------------------

##### 4.3.3.2.2 UsacSingleChannelElement

No restrictions are applicable to this bitstream element.

##### 4.3.3.2.3 UsacChannelPairElement

No restrictions are applicable to this bitstream element.

##### 4.3.3.2.4 UsacLfeElement

No restrictions are applicable to this bitstream element.

##### 4.3.3.2.5 UsacExtElement

<b>usacExtElementPresent</b>	No restrictions apply.
<b>usacExtElementUseDefaultLength</b>	No restrictions apply.

<b>usacExtElementPayloadLength</b>	No restrictions apply.
<b>usacExtElementStart</b>	No restrictions apply.
<b>usacExtElementStop</b>	No restrictions apply.
<b>usacExtElementSegmentData</b>	No restrictions apply.

#### 4.3.3.2.6 UsacCoreCoderData

<b>core_mode</b>	No restrictions apply.
<b>tns_data_present</b>	No restrictions apply.

### 4.3.4 Frequency domain coding (FD mode)

#### 4.3.4.1 Characteristics

Encoders may apply restrictions to the following parameters of the bitstream:

- a) use of noise filling;
- b) window\_shape;
- c) M/S Stereo;
- d) use of TNS;
- e) complex prediction stereo coding;
- f) max\_sfb;
- g) use of time warped MDCT;
- h) use of long blocks;
- i) use of short blocks.

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#### 4.3.4.2 Test procedure

##### 4.3.4.2.1 fd\_channel\_stream

<b>global_gain</b>	No restrictions apply.
<b>noise_level</b>	No restrictions apply.
<b>noise_offset</b>	No restrictions apply.
<b>fac_data_present</b>	Shall be 0, if the core_mode of the preceding frame of the same channel was 0 or if mod[3] of the preceding frame of the same channel was > 0.

##### 4.3.4.2.2 ics\_info

<b>window_sequence</b>	A conformant bitstream shall consist of only meaningful window_sequence transitions. However, decoders are required to handle non-meaningful window_sequence transitions as well. The meaningful window_sequence transitions are shown in ISO/IEC 23003-3:2020, Table 138.
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<b>window_shape</b>	A compliant bitstream shall set window_shape to 0 if the next block is encoded in LPD coding mode. However, decoders are required to handle both window_shapes for all transitions.
<b>max_sfb</b>	Shall be $\leq$ num_swb_long or num_swb_short as appropriate for window_sequence and sampling frequency and core coder frame length.
<b>scale_factor_grouping</b>	No restrictions apply.
<b>4.3.4.2.3 tw_data</b>	
<b>tw_data_present</b>	No restrictions apply.
<b>tw_ratio</b>	No restrictions apply.
<b>4.3.4.2.4 scale_factor_data</b>	
<b>hcod_sf</b>	Shall only be encoded with the values listed in the scalefactor Huffman table. Shall be encoded such that the decoded scalefactors sf[g][sfb] are within the range of zero to 255, both inclusive.
<b>4.3.4.2.5 tns_data</b>	
<b>n_filt</b>	No restrictions apply.
<b>coef_res</b>	No restrictions apply.
<b>length</b>	Shall be small enough such that the lower bound of the filtered region does not exceed the start of the array containing the spectral coefficients.
<b>order</b>	Shall not exceed the values listed in ISO/IEC 23003-3:2020, Table 135.
<b>direction</b>	No restrictions apply.
<b>coef_compress</b>	No restrictions apply.
<b>coef</b>	No restrictions apply.
<b>4.3.4.2.6 ac_spectral_data</b>	
<b>arith_reset_flag</b>	No restrictions apply.
<b>4.3.4.2.7 StereoCoreToolInfo</b>	
<b>tns_active</b>	No restrictions apply.
<b>common_window</b>	No restrictions apply.
<b>common_max_sfb</b>	No restrictions apply.
<b>max_sfb1</b>	Shall be $\leq$ num_swb_long or num_swb_short as appropriate for window_sequence and sampling frequency and core coder frame length.

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<b>ms_mask_present</b>	No restrictions apply.
<b>ms_used</b>	No restrictions apply.
<b>common_tw</b>	No restrictions apply.
<b>common_tns</b>	No restrictions apply.
<b>tns_on_lr</b>	No restrictions apply.
<b>tns_present_both</b>	No restrictions apply.
<b>tns_data_present</b>	No restrictions apply.

#### 4.3.4.2.8 cplx\_pred\_data

<b>cplx_pred_all</b>	No restrictions apply.
<b>cplx_pred_used</b>	No restrictions apply.
<b>pred_dir</b>	No restrictions apply.
<b>complex_coef</b>	No restrictions apply.

**use\_prev\_frame** Shall be 0 if the core transform length of previous frame is different from the core transform length of the current frame or if the core\_mode of the previous frame is 1.

**delta\_code\_time** No restrictions apply.

**hcod\_sf** No restrictions apply.

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### 4.3.5 Linear predictive domain coding (LPD mode)

#### 4.3.5.1 Characteristics

Encoders may apply restrictions to the following parameters of the bitstream:

- acelp\_core\_mode;
- lpd\_mode (use of ACELP, short TCX, medium TCX, and long TCX);
- activation of bass-post filter.

#### 4.3.5.2 Test procedure

##### 4.3.5.2.1 lpd\_channel\_stream

<b>acelp_core_mode</b>	Shall be encoded with a value in the range of 0 to 5, both inclusive.
<b>lpd_mode</b>	Shall be encoded with a non-reserved value listed in ISO/IEC 23003-3:2020, Table 94.
<b>bpf_control_info</b>	No restrictions apply.
<b>core_mode_last</b>	Shall be encoded with the value of data element core_mode of the previous frame.