
**Information technology — MPEG
audio technologies —**

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

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ISO/IEC 23003-7:2022

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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.

The procedures used to develop this document and those intended for its further maintenance are described in the ISO/IEC Directives, Part 1. In particular, the different approval criteria needed for the different types of document should be noted. This document was drafted in accordance with the editorial rules of the ISO/IEC Directives, Part 2 (see www.iso.org/directives or www.iec.ch/members_experts/refdocs).

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

A list of all parts in the ISO/IEC 23003 series can be found on the ISO and IEC websites.

Any feedback or questions on this document should be directed to the user's national standards body. A complete listing of these bodies can be found at www.iso.org/members.html and www.iec.ch/national-committees.

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, *Information technology — MPEG audio technologies — Part 3: Unified speech and audio coding*

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 ("ISO_IEC_23003-7_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 this document are accessible using 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, 4.3.10 | 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 | 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 |
| Mpeg surround 212 | stereoConfigIndex test condition | Mps |
| | 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> |
| Bitstream extensions | Temporal Shaping Enabling test condition | Tse<X> |
| | Smoothing mode test condition | Smg |
| | 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()

| | |
|-----------------------------------|--|
| usacSamplingFrequencyIndex | 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 4.3.11 . |
| usacSamplingFrequency | No restrictions apply. For profile and level dependent restrictions, see 4.3.11 . |
| coreSbrFrameLengthIndex | No restrictions apply. |
| channelConfigurationIndex | 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 4.3.11 . In the case of channelConfigurationIndex == 0 further restrictions apply as described in 4.3.2.2.2 . |
| usacConfigExtensionPresent | No restrictions apply. |

4.3.2.2.2 UsacChannelConfig()

| | |
|---------------------------|---|
| numOutChannels | No restrictions apply. For profile and level dependent restrictions, see 4.3.11 . |
| bsOutputChannelPos | 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()

| | |
|------------------------|---|
| numElements | 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 4.3.2.2.1 . |
| usacElementType | No restrictions apply. For profile and level dependent restrictions, see 4.3.11 . |

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](#)).

| | |
|--------------------------|------------------------|
| stereoConfigIndex | No restrictions apply. |
|--------------------------|------------------------|

4.3.2.2.6 UsacLfeElementConfig()

No restrictions are applicable to this bitstream element.

4.3.2.2.7 UsacCoreConfig()

| | |
|---------------------|---|
| tw_mdct | No restrictions apply. For profile and level dependent restrictions, see 4.3.11 . |
| noiseFilling | No restrictions apply. |

4.3.2.2.8 SbrConfig()

| | |
|--------------------|------------------------|
| harmonicSBR | No restrictions apply. |
| bs_interTes | No restrictions apply. |
| bs_pvc | No restrictions apply. |

4.3.2.2.9 SbrDfltHeader()

| | |
|----------------------------|------------------------|
| dflt_start_freq | No restrictions apply. |
| dflt_stop_freq | No restrictions apply. |
| dflt_header_extra1 | No restrictions apply. |
| dflt_header_extra2 | No restrictions apply. |
| dflt_freq_scale | No restrictions apply. |
| dflt_alter_scale | No restrictions apply. |
| dftl_nose_bands | No restrictions apply. |
| dflt_limiter_bands | No restrictions apply. |
| dflt_limiter_gains | No restrictions apply. |
| dflt_interpol_freq | No restrictions apply. |
| dflt_smoothing_mode | No restrictions apply. |

4.3.2.2.10 Mps212Config()

| | |
|-------------------------------|---|
| bsFreqRes | Shall not be encoded with a value of 0. |
| bsFixedGainDMX | No restrictions apply. |
| bsTempShapeConfig | No restrictions apply. |
| bsDecorrConfig | Shall not be encoded with a value of 3. |
| bsHighRateMode | No restrictions apply. |
| bsPhaseCoding | No restrictions apply. |
| bsOttBandsPhasePresent | No restrictions apply. |
| bsOttBandsPhase | 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. |
| bsResidualBands | 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. |
| bsPseudoLr | No restrictions apply. |
| bsEnvQuantMode | Shall be 0. |

4.3.2.2.11 UsacExtElementConfig()

| | |
|---|------------------------|
| usacExtElementType | No restrictions apply. |
| usacExtElementConfigLength | No restrictions apply. |
| usacExtElementDefaultLengthPresent | No restrictions apply. |
| usacExtElementDefaultLength | No restrictions apply. |
| usacExtElementPayloadFrag | No restrictions apply. |

4.3.2.2.12 UsacConfigExtension()

| | |
|------------------------------|------------------------|
| numConfigExtensions | No restrictions apply. |
| usacConfigExtType[] | No restrictions apply. |
| usacConfigExtLength[] | No restrictions apply. |
| fill_byte | Should be '10100101'. |

4.3.3 Framework**4.3.3.1 Characteristics**

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

- a) signalling of independently decodable frames;
- b) presence of extension elements;
- c) `core_mode`;
- d) presence of TNS.

4.3.3.2 Test procedure**4.3.3.2.1 UsacFrame()**

| | |
|-----------------------------|------------------------|
| usacIndependencyFlag | 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

| | |
|---------------------------------------|------------------------|
| usacExtElementPresent | No restrictions apply. |
| usacExtElementUseDefaultLength | No restrictions apply. |
| usacExtElementPayloadLength | No restrictions apply. |
| usacExtElementStart | No restrictions apply. |
| usacExtElementStop | No restrictions apply. |
| usacExtElementSegmentData | No restrictions apply. |

4.3.3.2.6 UsacCoreCoderData

| | |
|-------------------------|------------------------|
| core_mode | No restrictions apply. |
| tns_data_present | 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.

4.3.4.2 Test procedure

4.3.4.2.1 fd_channel_stream

| | |
|-------------------------|--|
| global_gain | No restrictions apply. |
| noise_level | No restrictions apply. |
| noise_offset | No restrictions apply. |
| fac_data_present | 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

| | |
|------------------------------|--|
| window_sequence | 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. |
| window_shape | 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. |
| max_sfb | Shall be $\leq \text{num_swb_long}$ or num_swb_short as appropriate for window_sequence and sampling frequency and core coder frame length. |
| scale_factor_grouping | No restrictions apply. |

4.3.4.2.3 tw_data

| | |
|------------------------|------------------------|
| tw_data_present | No restrictions apply. |
| tw_ratio | No restrictions apply. |

4.3.4.2.4 scale_factor_data

hcod_sf 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.

4.3.4.2.5 tns_data

n_filt No restrictions apply.
coef_res No restrictions apply.
length 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.
order Shall not exceed the values listed in ISO/IEC 23003-3:2020, Table 135.
direction No restrictions apply.
coef_compress No restrictions apply.
coef No restrictions apply.

4.3.4.2.6 ac_spectral_data

arith_reset_flag No restrictions apply.

4.3.4.2.7 StereoCoreToolInfo

tns_active No restrictions apply.
common_window No restrictions apply.
common_max_sfb No restrictions apply.
max_sfb1 Shall be $\leq \text{num_swb_long} \text{ or } \text{num_swb_short}$ as appropriate for window_sequence and sampling frequency and core coder frame length.
ms_mask_present No restrictions apply.
ms_used No restrictions apply.
common_tw No restrictions apply.
common_tns No restrictions apply.
tns_on_lr No restrictions apply.
tns_present_both No restrictions apply.
tns_data_present No restrictions apply.

4.3.4.2.8 cplx_pred_data

cplx_pred_all No restrictions apply.
cplx_pred_used No restrictions apply.
pred_dir No restrictions apply.
complex_coef 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.

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:

- a) `acelp_core_mode`;
- b) `lpd_mode` (use of ACELP, short TCX, medium TCX, and long TCX);
- c) activation of bass-post filter.

4.3.5.2 Test procedure

4.3.5.2.1 `lpd_channel_stream`

| | |
|--------------------------------------|---|
| <code>acelp_core_mode</code> | Shall be encoded with a value in the range of 0 to 5, both inclusive. |
| <code>lpd_mode</code> | Shall be encoded with a non-reserved value listed in ISO/IEC 23003-3:2020, Table 94. |
| <code>bpf_control_info</code> | No restrictions apply. |
| <code>core_mode_last</code> | Shall be encoded with the value of data element <code>core_mode</code> of the previous frame. |
| <code>fac_data_present</code> | Shall be 0, if the <code>core_mode</code> of the preceding frame of the same channel was 0 and <code>mod[0]</code> of the current frame is > 0, or if <code>mod[0]</code> of the current frame is > 0 and <code>mod[3]</code> of the preceding frame of the same channel was > 0. |
| <code>short_fac_flag</code> | Shall be encoded with a value of 1 if the <code>window_sequence</code> of the previous frame was 2 (EIGHT_SHORT_SEQUENCE). Otherwise, <code>short_fac_flag</code> shall be encoded with a value of 0. |

4.3.5.2.2 `lpc_data`

| | |
|---|------------------------|
| <code>lpc_first_approximation_index</code> | No restrictions apply. |
|---|------------------------|

4.3.5.2.3 `qn_data`

| | |
|-----------------------------|--|
| <code>qn</code> | The codebook number shall be encoded as described in ISO/IEC 23003-3:2020, 7.13.7.2. |
| <code>qn_base</code> | No restrictions apply. |
| <code>qn_ext</code> | No restrictions apply. |

4.3.5.2.4 `get_mode_lpc`

| | |
|---------------------------------|---|
| <code>binary_code</code> | Shall be encoded with the values listed in ISO/IEC 23003-3:2020, Table 148 in the column Binary Code. |
|---------------------------------|---|

4.3.5.2.5 `code_book_indices`

| | |
|-------------------------------------|------------------------|
| <code>code_book_index</code> | No restrictions apply. |
| <code>kv</code> | No restrictions apply. |