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Technical Specification

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Universal Mobile Telecommunications System (UMTS);
General audio codec audio processing functions;
Enhanced aacPlus general audio codec;
Conformance testing
(3GPP TS 26.406 version 6.1.0 Release 6)**

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Foreword

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Contents

Foreword

This Technical Specification (TS) has been produced by the 3rd Generation Partnership Project (3GPP).

The contents of the present document are subject to continuing work within the TSG and may change following formal TSG approval. Should the TSG modify the contents of the present document, it will be re-released by the TSG with an identifying change of release date and an increase in version number as follows:

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1 Scope

The present document specifies the digital test sequences and conformance criteria for the Enhanced aacPlus audio codec.

2 Normative references

The following documents contain provisions which, through reference in this text, constitute provisions of the present document.

- References are either specific (identified by date of publication, edition number, version number, etc.) or non-specific.
- For a specific reference, subsequent revisions do not apply.
- For a non-specific reference, the latest version applies. In the case of a reference to a 3GPP document (including a GSM document), a non-specific reference implicitly refers to the latest version of that document *in the same Release as the present document.*

[1] 3GPP TS 26.401: "General audio codec audio processing functions; Enhanced aacPlus general audio codec; General description".

[2] 3GPP TS 26.403: "General audio codec audio processing functions; Enhanced aacPlus general audio codec; Encoder specification; Advanced Audio Coding (AAC) part".

[3] 3GPP TS 26.404: "General audio codec audio processing functions; Enhanced aacPlus general audio codec; Encoder specification; Spectral Band Replication (SBR) part".

[4] 3GPP TS 26.405: "General audio codec audio processing functions; Enhanced aacPlus general audio codec; Encoder specification; Parametric stereo part".

[5] 3GPP TS 26.410: "General audio codec audio processing functions; Enhanced aacPlus general audio codec; Floating-point ANSI-C code".

[6] 3GPP TS 26.411: "General audio codec audio processing functions; Enhanced aacPlus general audio codec; Fixed-point ANSI-C code".

[7] ISO/IEC 14496-4:2004: "Information technology - Coding of audio-visual objects - Part 4: Conformance testing".

[8] ISO/IEC 14496-4:2004/FDAM 8:2004: "Information technology - Coding of audio-visual objects - Part 4: Conformance testing – Amendment 8".

[9] ITU-R Recommendation BS.1387-1: "Method for objective measurements of PErceived Audio Quality (PEAQ)".

3 Definitions and abbreviations

3.1 Definitions

For the purposes of the present document, the terms and definitions given in 3GPP TS 26.401 [1], 3GPP TS 26.403 [2], 3GPP TS 26.404 [3], 3GPP TS 26.405 [4], 3GPP TS 26.410 [5]and 3GPP TS 26.411 [6] apply.

3.2 Abbreviations

For the purposes of the present document, the following abbreviations apply:

AAC-LC	Advanced Audio Coding-Low Complexity audio object type
ODG	Objective Difference Grade
PEAQ	Perceptual Evaluation of Audio Quality
SBR	Spectral Band Replication

4 General

Conformance testing is an important tool to verify that implementations of Enhanced aacPlus match the relevant specifications. It is also helpful in verifying the proper use of the source code provided in 3GPP TS 26.410 [5] and 3GPP TS 26.411 [6]. Conformance testing focuses on the core algorithm, therefore no criteria are defined for error concealment, downsampling and file I/O.

Clause 5 describes the proposed method of conformance testing for the decoder. Clause 6 discusses encoder conformance.

5 Decoder conformance testing

Decoder conformance for both fixed-point and floating-point implementations shall be tested in accordance with clauses 5.1 and 5.2. Conformance shall be verified by either bit-exact behaviour to the reference output or by meeting the objective criteria defined below. Bit-exact behaviour should be preferred for fixed-point implementations where it can be achieved without undue penalty on computational complexity.

5.1 AAC-LC and SBR conformance testing

Conformance testing for AAC-LC and SBR shall be performed according to the relevant clauses in ISO/IEC 14496-4 [7] and ISO/IEC 14496-4 [8]. The reference output shall be the output created by the respective 3GPP reference code (floating- or fixed-point).

5.2 Parametric Stereo conformance testing

The 3GPP floating-point reference code implementation shall be used as the reference implementation. Conformance of an implementation shall be tested via objective quality assessments, using ITU-R Recommenadtion BS.1387-1 [9]. An Objective Difference Grade comparison between the output of the reference decoder and the output of the decoder implementation under test shall result in a maximum ODG deviation of 0,25 for each single test vector.. The tests shall be run over bitrate configurations of 16 kbit/s, 21 kbit/s and 28 kbit/s, stereo.

The set of test vectors shall be the same as used for characterization testing. The attached zip file "ps_bitstream_testvec.zip" contains the bitstream test vectors, a filename list given in Annex A. The attached zip file "ps_testvec_creation.zip" shall be used to derive the output test vectors. The zip file contains:

- A Win32 precompiled version of the 3GPP floating-point decoder.

- A batch file which calls the reference decoder to produce reference decoded output test vectors for each bitstream test vector.

6 Encoder conformance

6.1 Floating point encoder

No specific routines for floating-point encoder conformance testing are defined. It is recommended to use the floating-point code from 3GPP TS 26.410 [5]. In addition, it is recommended to verify that the implementation meets the criteria defined in clause 6.2 (Fixed-point encoder). If the floating-point code is used for an implementation in mobile equipment, the criteria defined in 6.2 shall be met.

6.2 Fixed point encoder

Conformance of fixed-point encoder implementations for use in mobile equipment shall be verified by bit-exact behaviour to the fixed-point reference code [6] as defined in 6.2.1, or by meeting the objective criteria as defined in 6.2.2, or by performing subjective tests as described in 6.2.3. Fixed-point encoder implementations which are not used in mobile equipment, should meet the conformance criteria defined in this clause.

Bit-exact behaviour should be preferred for fixed-point implementations where it can be achieved without undue penalty on computational complexity.

If an implementer chooses to implement only a mono-encoder functionality, then conformance of only this functionality shall be tested. This shall apply irrespective of the conformance testing method chosen.

6.2.1 Bit-exact Behaviour

If the bit-exact conformance method is chosen, the conformance of a fixed-point encoder implementation under test shall be verified by checking the bit-exactness of the raw payload of the encoded output as produced by the fixed-point reference encoder code [6] for all 23 test vectors as given in Annex B.

6.2.2 Objective criteria

If the objective criteria conformance method is chosen, the conformance of a fixed-point encoder implementation under test shall be verified by checking objective conformance criteria for each of the three tools of the Enhanced aacPlus encoder: AAC, SBR and PS. The tests shall be conducted with the test vectors as given in Annex B. The configurations under test shall be 16 kbit/s mono, 32 kbit/s parametric stereo and 48 kbit/s stereo. All tests shall use the fixed-point encoder as reference.

For the purpose of fixed-point encoder conformance testing a tool has been developed which can be used to extract the various parts of an Enhanced aacPlus bitstream such that conformance of each of those parts can be tested independently. The source code for this tool can be found in an electronic attachment (fixp_enc_test_tool.zip) to this document. For a description on how to invoke the various conformance tests, please refer to the 'readme.txt' file that is part of the attached package. This tool is henceforth referenced as 'fixed-point encoder test tool'.

6.2.2.1 AAC encoder conformance

Conformance testing of the AAC encoder tool shall be conducted using an implementation of ITU-R BS.1387 (PEAQ) [9]. The test consists of a statistical analysis comparison of the reference encoder performance with the performance of the encoder under test. The following pseudo-code and the succeeding description outlines how the performance shall be assessed.

```
cfg = 0;

foreach (bitrate, channels, aacbandwidth) {
```

```
    tv = 0;
    foreach (item) {
        bandlimit (item, item_bandlimited, aacbandwidth);
        encoder_reference (item, reference_bitstream, bitrate, channels);
        encoder_test (item, test_bitstream, bitrate, channels);
        decoder_bandlimiting (reference_bitstream, reference_waveform);
        decoder_bandlimiting (test_bitstream, test_waveform);
        odg_ difference [cfg][tv] =   PEAQ_advanced (item_bandlimited, reference_waveform) -
                                      PEAQ_advanced (item_bandlimited, test_waveform);
        tv++;
    }
    cfg++;
}
```

where:

- bandlimit (in, out, bw) is a function that limits the bandwidth of the waveform 'in' to 'bw' and stores the result in the waveform 'out'
- encoder_reference (in, out, br, ch) is a function that calls the reference encoder such that the waveform 'in' is encoded to the bitstream 'out' at the bitrate 'br' and using channelmode 'ch'
- encoder_test (in, out, br, ch) is a function that calls the encoder under test such that the waveform 'in' is encoded to the bitstream 'out' at the bitrate 'br' and using channelmode 'ch'
- decoder_bandlimiting (in, out) is a function that calls the fixed-point encoder test tool such that it decodes the AAC part of the bitstream "in" to the waveform "out", while limiting the bandwidth to the AAC part and performing QMF-domain upsampling
- PEAQ_advanced (ref, deg) is a function that compares the reference waveform 'ref' with the degraded waveform 'deg' returning the ODG resulting from that comparison

The mean of the resulting vector odg_difference[cfg] shall not indicate an average performance of the encoder under test that is worse by more than 0.2. Moreover the worstcase difference shall not exceed 0.5. These criteria shall be fulfilled for all configurations.

6.2.2.2 SBR encoder conformance

Conformance for the SBR part of the encoder shall be measured for the various elements of the SBR bitstream independently. To eliminate the influence of potentially differing delays between the encoder under test and the reference encoder, the input waveforms shall be zero-padded at the beginning such that both encoders produce equivalent framing.

The fixed-point encoder test tool shall be used to first extract the various SBR parameters that are embedded in the SBR bitstream under test and subsequently compare them to the output of the reference encoder.

The following is an overview of how parameter extraction and parameter comparison work for the various modules. For further details, please consult the attached source code of the fixed-point encoder test tool:

- The envelope energies signaled by the encoder under test are combined to the equivalent envelope energies for one envelope. This is done after dequantization and M/S -> L/R unmapping. The comparison however takes place in the log-domain. For higher energies only low deviations are allowed, while lower energies are permitted to deviate more: Differences of up to 3dB are allowed for all energies, differences of up to 6dB are

allowed for energies up to 42 dB below a full scale sine, differences of up to 9 dB are allowed for energies up to 60 dB below a full scale sine.

- The test of the transient detector is performed by comparing the bitstream element sbr_grid() from both encoders. The RMS of the difference between the transient position vector of the encoder under test and the reference encoder shall not be greater than 0.2.

- The test of the missing harmonics detector is carried out by comparing the bitstream elements sbr_sinusoidal_coding() from both encoders. The vector that is constructed by subtracting the missing harmonics vectors from both bitstreams and concatenating the result over all frames shall not have an RMS greater than 0.2.

- The test of the whitening level detector is performed by comparing the bitstream element sbr_invf() from both encoders. The vector that is constructed by subtracting the whitening level vectors of the encoder under test and the reference encoder shall not have an RMS greater than 0.2.

- The test for the noise floor estimator module is identical to the test for the envelope energy conformance test, except that the actual noise floor energies are compared instead of the envelope energies. The maximum permissible noise floor energy difference for a given deviation between reference encoder and encoder under test are as follows: Differences of up to 6 dB are allowed for all energies, differences of up to 9 dB are allowed for energies up to 42 dB below a full scale sine, differences of up to 12 dB are allowed for energies up to 60 dB below a full scale sine.

6.2.2.3 PS encoder conformance

All comparisons shall be limited to frames and bands in the bitstream that contain an energy greater than -87 dB below a full-scale sine. Prior to the actual conformance test, the stereo parameters from both encoders are mapped to the highest available stereo frequency resolution.

- the signal that is constructed from the differences between all IID values signaled by the encoder under test and the reference encoder shall have a maximum absolute difference of 2 and the RMS must not exceed 0.25

- the signal that is constructed from the differences between all ICC values signaled by the encoder under test and the reference encoder shall have a maximum absolute difference of 2 and the RMS must not exceed 0.25

6.2.3 Subjective criteria

Subjective tests shall cover the encoder configurations tested during the characterization phase. The requirement for passing the subjective tests is that the encoder under test does not perform worse in a statistically significant sense in any test case when compared to the fixed-point reference encoder.

Annex A (normative): Bitstream test vectors for testing Parametric Stereo decoding

Table 1: Test vectors for Parametric Stereo decoding

#	Bitstream test vector file name	Bitrate configuration
1	m_cl_x_2_16s.3gp	16 kbit/s, stereo
2	m_ot_x_1_16s.3gp	16 kbit/s, stereo
3	m_p_x_1_16s.3gp	16 kbit/s, stereo
4	m_si_x_1_16s.3gp	16 kbit/s, stereo
5	s_cl_2t_1_16s.3gp	16 kbit/s, stereo
6	s_cl_2t_2_16s.3gp	16 kbit/s, stereo
7	s_cl_mt_1_16s.3gp	16 kbit/s, stereo
8	s_no_ft_2_16s.3gp	16 kbit/s, stereo
9	sbm_sm_x_1_16s.3gp	16 kbit/s, stereo
10	sbm_sm_x_2_16s.3gp	16 kbit/s, stereo
11	som_fi_x_2_16s.3gp	16 kbit/s, stereo
12	som_ot_x_1_16s.3gp	16 kbit/s, stereo
13	m_cl_x_2_21s.3gp	21 kbit/s, stereo
14	m_ot_x_1_21s.3gp	21 kbit/s, stereo
15	m_p_x_1_21s.3gp	21 kbit/s, stereo
16	m_si_x_1_21s.3gp	21 kbit/s, stereo
17	s_cl_2t_1_21s.3gp	21 kbit/s, stereo
18	s_cl_2t_2_21s.3gp	21 kbit/s, stereo
19	s_cl_mt_1_21s.3gp	21 kbit/s, stereo
20	s_no_ft_2_21s.3gp	21 kbit/s, stereo
21	sbm_sm_x_1_21s.3gp	21 kbit/s, stereo
22	sbm_sm_x_2_21s.3gp	21 kbit/s, stereo
23	som_fi_x_2_21s.3gp	21 kbit/s, stereo
24	som_ot_x_1_21s.3gp	21 kbit/s, stereo
25	m_cl_x_2_28s.3gp	28 kbit/s, stereo
26	m_ot_x_1_28s.3gp	28 kbit/s, stereo
27	m_p_x_1_28s.3gp	28 kbit/s, stereo
28	m_si_x_1_28s.3gp	28 kbit/s, stereo
29	s_cl_2t_1_28s.3gp	28 kbit/s, stereo
30	s_cl_2t_2_28s.3gp	28 kbit/s, stereo
31	s_cl_mt_1_28s.3gp	28 kbit/s, stereo
32	s_no_ft_2_28s.3gp	28 kbit/s, stereo
33	sbm_sm_x_1_28s.3gp	28 kbit/s, stereo
34	sbm_sm_x_2_28s.3gp	28 kbit/s, stereo
35	som_fi_x_2_28s.3gp	28 kbit/s, stereo
36	som_ot_x_1_28s.3gp	28 kbit/s, stereo

Annex B (normative): Test vectors for fixed-point encoder conformance

Table 2: Testvectors specifically relevant for the objective testing of the AAC tool

#	Test vector file name
1	ct_castagnettes.wav
2	ct_glockenspiel.wav
3	ct_test_1_48.wav
4	ct_test_2_48.wav
5	ct_test_3_48.wav
6	cymbal.wav
7	gong.wav
8	guitar_1.wav
9	guitar_2.wav
10	guitar_cymbals.wav
11	handcuff.wav
12	hihat.wav
13	laugh.wav
14	shaker.wav
15	speech_female.wav
16	speech_male_german.wav
17	speech_male_portuguese.wav
18	triangle.wav
19	wooden_toys_1.wav
20	wooden_toys_2.wav

Table 3: Testvectors specifically relevant for the objective testing of the SBR tool

#	Test vector file name	SBR module
21	noise_fade.wav	Envelope
12	hihat.wav	Transients
1	ct_castagnettes.wav	Transients
22	sines.wav	Sines
21	noise_fade.wav	Noise
23	invf.wav	Whitening

Table 4: Testvectors specifically relevant for the objective testing of the PS tool

#	Test vector file name	PS parameter
3	ct_test_1_48.wav	IID
2	ct_glockenspiel.wav	IID
3	ct_test_1_48.wav	ICC
18	triangle.wav	ICC

Annex C (informative): Change history

Change history							
Date	**TSG SA#**	**TSG Doc.**	**CR**	**Rev**	**Subject/Comment**	**Old**	**New**
2005-06	28	SP-050242			Approved at TSG SA#28	2.0.0	6.0.0
2005-12	30	SP-050786	0001	2	Correction to Enhanced aacPlus Encoder conformance	6.0.0	6.1.0

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